IMPLEMENTING ENVIRONMENTAL MANAGEMENT ACCOUNTING:
STATUS AND CHALLENGES

ECO-EFFICIENCY IN INDUSTRY AND SCIENCE

VOLUME 18

The titles published in this series are listed at the end of this volume.

Implementing Environmental Management Accounting: Status and Challenges

Edited by

Pall M. Rikhardsson
The Aarhus School of Business, Aarhus, Denmark

Martin Bennett
University of Gloucestershire Business School, Cheltenham, U.K.

Jan Jaap Bouma
Erasmus University, Rotterdam, The Netherlands

and

Stefan Schaltegger
Centre for Sustainability Management (CSM), University of Lüneburg, Germany

Springer

A C.I.P. Catalogue record for this book is available from the Library of Congress.

ISBN 10 1-4020-3372-9 (PB)
ISBN 13 978-1-4020-3372-8 (PB)
ISBN 10 1-4020-3371-0 (HB)
ISBN 10 1-4020-3373-7 (e-book)
ISBN 13 978-1-4020-3371-1 (HB)
ISBN 13 978-1-4020-3373-5 (e-book)

Published by Springer,
P.O. Box 17, 3300 AA Dordrecht, The Netherlands.

www.springeronline.com

Printed on acid-free paper

Printed in the Netherlands.

CONTENTS

PREFACE

This is the third volume in the Environmental Management Accounting Network (EMAN) series of selected refereed papers on environmental management accounting drawn primarily from papers presented at EMAN-Europe's annual conferences. Most of the papers in this volume were first presented at the 6th EMAN-Europe Annual Conference at the Aarhus School of Business, Denmark, on 23-24 January 2003.

The focus of the conference and the papers presented was on implementation of Environmental Management Accounting. That is to say what challenges there are in getting EMA to work in companies, how governments are promoting EMA and how EMA can be supported by for instance IT. From the papers in this volume it can be seen that EMA is becoming more established as a field of practice as well as an academic endeavour. EMA is no longer the sole interest of large multinational companies but is being adopted by SMEs as well as being promoted by various government agencies.

EMAN has continued to play an important role in this development by providing a medium through which those interested can contact others with similar interests, and by organising regular events for the dissemination and exchange of news and ideas. EMAN aims to provide a forum in which academics and practitioners can meet to exchange and share ideas and experiences, and this has guided the selection of these papers which include both academic papers grounded in the relevant literature and with reference to theory as appropriate.

Continuing and increasing interest in Europe is evidenced by the support for the 2003 EMAN-Europe Conference, which was attended by over 100 presenters and participants. We would like to thank the various organisations whose generous financial support has helped ensure its success:

- the European Commission, Research DG, who supported the conference as a High-Level Scientific Conference under the EC's Human Potential Programme,
- PricewaterhouseCoopers
- Aarhus School of Business

In particular, the editors of this volume and the Steering Committee of EMAN-Europe would like to thank all those participants who, by joining and presenting at its conferences, have been part of the continuing development of EMA.

We would also like to take this opportunity to invite anyone interested to join the EMAN network. Further information can be obtained from the EMAN-Europe Chairperson Jan Jaap Bouma (bouma@fsw.eur.nl), or from the EMAN-Europe website (www.eman-eu.net).

The editors:

Pall Rikhardsson Martin Bennett
Jan Jaap Bouma Stefan Schaltegger

INTRODUCTION

ENVIRONMENTAL MANAGEMENT ACCOUNTING: INNOVATION OR MANAGERIAL FAD?

PALL RIKHARDSSON*, MARTIN BENNETT‡, JAN JAAP BOUMA≠ AND STEFAN SCHALTEGGER△

**Aarhus School of Business, Denmark ‡*
Gloucestershire Business School, United Kingdom,
≠Erasmus University, The Netherlands,
△Centre for Sustainability Management, University of Lueneburg Germany

par@asb.dk, mbennett@glos.ac.uk,
Bouma@fsw.eur.nl, schaltegger@uni-lueneburg.de

INTRODUCTION

This is the third book from Kluwer Academic Publishers (now Springer) in the Environmental Management Accounting series of a refereed selection of papers, mostly originating from the annual conferences of the Environmental Management Accounting Network. As with the other books in this series there is an overall theme that has guided the editing process. Whereas the focus of the previous books to some extent has been on the development of theories and models regarding environmental management accounting (EMA), the overall theme of this book is the implementation of EMA in

P.M. Rikhardsson et al. (eds.), Implementing Environmental Management Accounting, 1-16

various contexts. These contexts are how companies have implemented EMA using for instance software support, how governments in for example Japan and Korea have supported the spreading of EMA, and how EMA links have been established between different contexts such as environmental risk measurement and environmental reporting.

The main premise here is that EMA is a form of technology. Not in the sense that a car or a computer is a technology, but in the sense of a managerial technology which combines knowledge, methodology and practice and applies these to linking environmental management and economic results. Technology is often defined as putting knowledge to practical use (Burgelman and Maidique, 1988), and EMA covers various tools and techniques of targeted information collection, analysis and communication and is thus a type of information management technology or managerial technology. Tushman and Anderson (1986 p. 440, as cited by Abrahamson, 1991) define 'managerial technologies' as "those tools, devices and knowledge that mediate between inputs and outputs". As such these tools and technologies are comparable to other managerial technologies such as different costing methods such as activity-based costing, or the tools and techniques of quality management. In the following we use the term "managerial technology" in the field of EMA as relating to the field as a whole but "techniques" as being those specific methods or procedures used for producing different results.

As with other innovations it has an innovation cycle with invention, diffusion and adoption and rejection patterns (Geroski, 2000). Furthermore, it is more or less relevant to some companies and not of high priority for others. Some companies for which it is relevant will decide to adopt it, some will not, despite its relevance. Furthermore some academic and theoretical developments are adopted by companies in practice and some are tested and rejected (corporate practice either following, or deciding not to follow, theory) whereas in other cases managerial practice is observed and analysed by academics and conceptualised into theories (academia following practice). So discussions about the diffusion and adoption of EMA focus on the diffusion and adoption of certain ideas and certain managerial practices rather than physical objects. In the following we refer to EMA as a managerial technology. In this context it is important to emphasize that EMA covers a large set of different tools (Schaltegger and Burritt, 2000) ranging from environmental cost accounting (ECA) to investment appraisal, budgeting, performance measurement and material flow accounting (for an overview, see Burritt et al., 2002a, 2002b).

THE DIFFUSION OF MANAGERIAL TECHNOLOGIES

Research into the diffusion and adoptions of innovations has a long history (Geroski, 2000, Rogers, 1995). In many cases the definition of an innovation has been a technical one such as new production technology or a new product, but innovation theories can also be applied to the spread of ideas, methodologies and concepts (Rogers and Schoemaker, 1971). As demonstrated by the S-curve (shown in figure 1) which illustrates that the adoption rate of innovations is well known and is applied in a variety of contexts (Rogers, 1995).

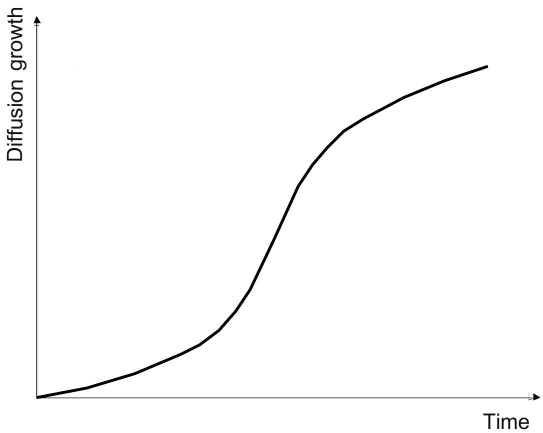


***Figure 1**. The innovation diffusion S-curve (Rogers, 1995).*

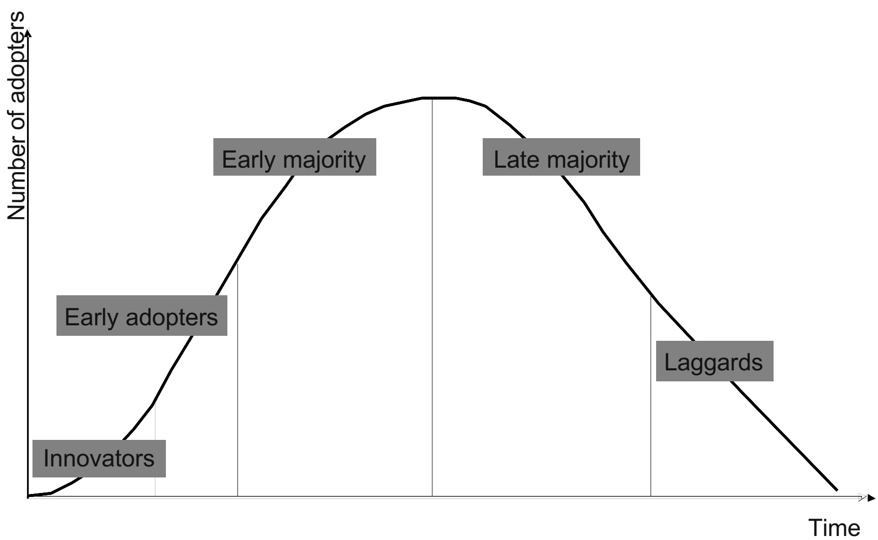


***Figure 2**. Adoption groups (Rogers, 1995)*

Furthermore the adoption curve, which is shown in figure 2 (Rogers, 1995), has been used to illustrate the spread of innovations between different adoption groups.

The innovation diffusion literature – be it the spread of physical technology or managerial technologies – often focuses on three questions (Rogers and Schoemaker, 1971). The first is what processes and contingencies affect the rates of diffusion; the second is what characterises different adopter groups; and the third is how these characteristics affect the sequence and speed by which innovations diffuse.

These questions are also relevant in the context of EMA, although to date there have been few studies which have addressed questions such as how widespread EMA actually is, which companies respectively adopt or do not adopt EMA, how fast EMA is spreading, what factors influence thespeed of diffusion, and the processes by which it spreads. To date there has not been much research into these issues.

However, ultimately diffusion is about companies adopting and implementing EMA as a new managerial technology. But what makes them do so? EMA is relatively new as a field of research and practice in which the first uses of the term date back only to the 1990s (Bartolomeo et al., 1999). Thus EMA can still be characterised as a field of innovation. There is no shortage of literature focusing on the experiences of companies implementing e.g. activity-based costing, balanced scorecards, decentralisation, new motivation structures, etc. (see e.g. Luft and Shields, 2003 for an overview of tools related to management accounting). Some of these issues have even been framed in an innovation – diffusion perspective (Abrahamson, 1991, Granlund and Lukka, 1998). However, literature on the experiences of companies adopting and recommending EMA tools is still sparse (for exceptions see Bennett et al., 2001, Bennett et al., 2002, Schaltegger and Burritt, 2000).

There are various explanations to be found in the innovation diffusion literature which explain why companies adopt certain (managerial) technologies and not others. These can, however, be classified into two main categories. The first is what could be called the *efficient choice* explanation and the other is what could be called the *institutional* explanation. The former stresses the efficiency of adopting something that in some way improves corporate performance, and the latter focuses on more sociological and psychological factors that determine the adoption or rejection of innovations.

The efficient choice explanations (Abrahamson, 1991) basically assume that the company and the innovations it adopts are tools for the production of goods or services in society. The key words are efficiency and effectiveness, which are used as the ultimate yardstick when measuring the success of innovations (Røvik, 1998). That is to say, the new managerial technology will have to be technically and/or economically more efficient than the technology it replaces as well as to provide the company with some measurable advantages. This implies in turn that the companies adopting the innovation have efficient explicit goals against which to measure the difference and evaluate the advantage offered by the new managerial technology. The efficient choice perspective also includes the situation where external finance is available to support the introduction of a new technology in the form of government grants, research projects etc. leaving the company little or no financial risk to bear by implementing EMA. Initiatives like the Danish Environmental Accounting Law, the UN DSD expert group on EMA, the EMA guideline of the Japanese Ministry of Environment, the Environmental Cost Accounting guidelines of the German Ministry of Environment or the EMA-SEA project of InWent[1] could be mentioned as examples. An additional dimension is also introduced by Abrahamson (1991): it focuses on whether the adoption is voluntary or not – i.e. whether the company is forced by external groups to adopt an innovation which is based on for instance legal or contractual power.

At first sight these explanations seem straightforward. In some cases the adoption of EMA is an efficient activity prompted by a need for quantification of environmental performance to show for instance whether the company is living up to its environmental policy. In some cases researchers or consultants provide external financing enabling the company to implement EMA cheaply. Efficient choice theory might thus explain some cases of EMA adoption where there are either clear measurable advantages of adopting EMA, no risk, or where the company is forced to do so. In other cases companies might adopt EMA practices because government agencies demand certain information or impose legislation requiring the use of certain EMA practices.

Efficient choice explanations, although alluring, might not always be sufficient. Most people who work in organisations have examples of new practices being adopted or new technologies implemented where the arguments for change were less than clear-cut and the eventual advantages were at best dubious (Abrahamson, 1991). Regarding EMA (and other new managerial technologies) the potential advantages regarding existing managerial technologies might be hard to measure in advance because there is no prior technology that it replaces. EMA usually does not replace any existing managerial technology nor are the benefits always clear before the project is completed. Furthermore, EMA being a managerial technology, the benefits reaped from an EMA implementation are also to some extent based on the effect EMA has on managerial behaviour including decision making, awareness and priorities. Thus while some EMA tools are adopted because of their benefit, potential others are launched "on good faith" with the expected benefits being uncertain, difficult to calculate and not always even apparent. Studies of other managerial technologies have shown that this may be the case (Abrahamson, 1991). So why are these tools adopted if the company cannot efficiently calculate the benefits or argue for its impact on efficiency and effectiveness? This suggests a need for additional explanations of why companies adopt or reject managerial innovations.

Based on the above, a second strand of explanations for adoption or rejection of innovations has evolved which has to a large extent drawn on institutional theory (Abrahamson, 1991, 1996). Institutional theory as developed by for instance Di-

Maggio and Powell (1983), DiMaggio (1988) and Powell (1991) stresses that organisational choices are not always purely efficient and based on efficiency or effectiveness criteria. Organisations tend to imitate each other, as well as other institutions in society: this has been called organisational isomorphism (DiMaggio and Powell, 1983) or simply imitation (Abrahamson, 1991). In the context of managerial technologies Abrahamson (1991) and Røvik (1998) argue that imitation processes are based on three main elements. One is the strength of the influence of outside groups such as companies, government, trade organisations etc. The second is the social legitimisation of the innovation which means that the managerial technology comes with a "reference" from some institutions in society that are accepted and convey legitimacy to the innovation. The third is the transferability of the managerial technology, i.e. how easy it is to transfer it from one organisational context to another. The more complex and context-specific the technology, the more limited its spread and adoption.

Summing up, the diffusion of EMA as a managerial technology can be explained by companies choosing on the grounds of effiency to implement EMA either because it adds value, it is risk-free and/or some outside group has an influence motivating the implementation. An additional or alternative explanation is that companies imitate either each other or organisations outside the group of companies which are implementing EMA. These explanations are presented in table 1. As can be seen the efficient choice and forced selection are supplemented by two additional explanations which are called managerial *fads* and *fashions* (Abrahamson, 1991). A managerial fad is when organisations imitate other similar organisations, such as a company following the example of another company which is generally recognised as being in the forefront of leading management practice. A managerial fashion is when organisations outside of the group of companies, including consultancies, academia or companies in other industries, influence the adoption process. The terms 'fashion' and 'fad' may perhaps be unfortunate here, since in common usage they usually carry a rather derogatory connotation of a change which is prompted by merely transitory and trivial motives. In the present context, however, and in conditions of uncertainty, following the example of a recognised leader may be the most rational course of action, and a readiness to experiment with new technologies, even if some soon prove to be worthless and can be quickly discarded, may still be justified by the few that do persist.

It should be added that even management approaches whose adoption can be justified by good reasons for efficiency also need a certain positive connotation in order to gain managerial acceptance. Thus at a certain stage of diffusion, imitation pressures may be necessary in order to realise widespread applications and the acceptance of efficiently justified management technologies.

Table 1. *Explanations for adoption or rejection of managerial technologies (Abrahamson, 1991)*

		Imitation focus dimension	
		Imitation processes do not impel the diffusion or rejection	Imitation processes impel the diffusion or rejection
Outside influence dimension	Organisations within the group determine the diffusion and rejection within this group	Efficient choice perspective	Fad perspective
	Organisations outside the group determine the diffusion and rejection within this group	Forced selection perspective	Fashion perspective

As with other types of fashions, managerial fashion implies that there is a fashion setting network which determines what is "hot" and what is not. These include for instance consultants, business mass media and business schools. In some cases government institutions would fall into this category when they promote certain managerial innovations by offering funding for projects which address these issues in companies.

Table 1 also draws the attention to the fact that the explanation for EMA adoption can differ between companies. Some might adopt or reject it due to considerations of efficiency, others might be more influenced by imitation processes or outside influences in some way. These perspectives can be valuable when reading through the chapters in this book.

Table 1 depicts the set of possible explanations of diffusion in two dimensions. The 'Outside-Influence' dimension reflects the locus of control of an organisation, and the extent to which it is able to act autonomously rather than being subject to pressures imposed on it by outside organisations such as governments and labour unions. The 'Imitation-Focus' dimension reflects the extent to which the organisation is likely to be influenced by others in deciding on whether or not to adopt a new technology, rather than to reach its own decision independently through its own logical calculation of a rational choice. To attempt such a logical rational calculation requires some degree of confidence on both goals and means. This may be unlikely with a new and as yet unknown new technology where it may be difficult to assess the potential impact on that specific individual organisation, so that a more sensible and cautious approach might be instead to imitate the prior examples of others, particularly where these are other organisations or sources of influence which are perceived as being of high reputation and status – for example, other companies which are recognised leaders in the sector, and leading business schools and management gurus.

A similar set of possible explanations of the diffusion of innovations, with a differing terminology, has been defined by Baas (2000) who distinguished four separate 'mechanisms of innovation': competition, mimetic isomorphism, normative isomorphism, and coercive isomorphism. A mechanism of competition would be where decisions were based on the likelihood of an improved competitive position through technological innovations, and broadly equates to Abrahamson's rational choice perspective. Coercive isomorphism involves the adoption of an innovation as a result of pressure exerted by some external actor, such as when companies are compelled by government policies of a traditional "command-and-control" type to adopt certain technologies in order to manage environmental problems. This clearly equates to the forced-selection perspective.

Mimetic isomorphism refers to individual firms copying the behaviourof others in reaction to their perception of a significant degree of uncertainty in their situation, and equates to the fad perspective, whilst normative isomorphism reflects a process of professionalisation in which new technologies become accepted as features of evolving good practice in management and other professional areas. If these prove their value in practice by persisting in use by organisations over time, they may become integrated into generally accepted good practice as reflected in professional and business school syllabuses. This typology has already been applied in evaluating the effectiveness of an environmental innovation by the United Nations Environment Programme which aimed to promote the adoption of Cleaner Production technologies in developing countries by developing and disseminating training materials in environmental accounting and finance (Bennett et al., 2004), and from this in drawing lessons to guide the design and implementation of future similar projects.

THE FUTURE DIFFUSION OF EMA

Røvik (1998) has proposed a model (Table 2) to classify the diffusion of managerial technologies in terms of both their geographical spread and the length of organisational lifetimes following adoption.

In the context of table 2, regardless whether EMA implementation is the result of an efficient choice, forced adoption or imitation processes, the question remains what will the future of EMA be? Will it become a long-term global managerial technology or end up as only relatively local and short-lived?

The answer obviously depends on the number of companies which adopts EMA. If EMA "catches on" and its concepts and tools are implemented in a large number of organisations, adopted by the employees and integrated in information systems, then EMA is here to stay and will evolve as a logical link between environmental management and management accounting. If its concepts are implemented only because "others are doing it", because they come with cheap or free consultancy services or even because managers feel bored and need some diversion (Abrahamson, 1991), then EMA will probably disappear from view within a short period of time.

Table 2. *The spread of managerial technologies (Røvik, 1998 p. 23)*

		Geographical spread	
		Local	**Global**
Temporal spread	**Long**	Company-specific long-term innovative managerial technologies	Institutionalised long-term managerial technologies
	Short	Local short-term innovative managerial technologies	Institutionalised short-term managerial technologies

The title of this book is Environmental Management Accounting – Status and Challenges. Although the chapters in this book do not provide unequivocal evidence regarding the spread of EMA, they document that EMA as a concept and as a practice is developing and is far from static. EMA is no longer a local western phenomenon as it is spreading throughout the world including in developing countries as well as developed, and it has recently enjoyed a particularly strong rate of adoption in several Asian countries. Both governments and companies are currently focusing on it as a set of valuable tools and implementing them in various contexts. While some EMA tools have been widely accepted and are applied in various contexts, others are mere academic developments and in an early research stage. Which EMA tools will spread to become common practice in many companies – i.e. a global standard – and which will receive limited adoption remains to be seen. Furthermore, the current development towards sustainability accounting and its links to sustainability reporting open new areas of research and applications (Bennett et al., 2002, Bennett et al., 2003). Will this extension development be sustainable and add value to company management? Clearly the context in which corporations operate and their strategies will partly shape the future answer to that question. Research in other fields than EMA shows that the relevant contextual issues are the degree of uncertainty in the organisation's environment and the degree of interconnectedness in the institutional environment (Oliver, 1991), meaning that corporations will react differently depending on their contexts. What management perceives as the added value of EMA is in this respect a fundamental question, as value concepts themselves change over time. Lessons learned from the processes and mechanisms of the institutionalisation of ethical investment (Louche, 2004), for instance, show that the values adopted by a firm have a significant effect on its adoption of business initiatives related to sustainable development. Hence EMA provides another example of how companies deal with environmental concern and how this concern is institutionalised at a micro level.

THE STRUCTURE OF THE BOOK

This book focuses on the issue of implementation and thus the experiences gained from applying EMA in various companies, countries and contexts.

It is structured into three main sections. Section 1 gives a broad overview of some of the issues including implementation of EMA systems.

In the second chapter Roger Burritt focuses on the range of challenges faced by EMA today. The author concludes that to achieve broad dissemination to a wide range of organisations, environmental management accounting systems need to be relevant to the issues at hand, available at low cost, provide simple integration with existing management accounting systems and/or environmental management systems, and be reliable.

In the third chapter Stefan Schaltegger and Marcus Wagner focus more specifically on ECA; they provide an overview of current trends, state of the art and best-practice in ECA as well as a discussion on how it complements environmental performance and eco-efficiency indicators. They conclude that the focus of the debate on environmental accounting and environmental indicators should be on the efficient and effective integration of both.

The fourth chapter, by Pontus Cerin and Staffan Laestadius, focuses on different dimensions of physical environmental accounting at the level of each of a region, a company and a product. In the globalised and highly specialised economy of today, company activities and their services are multinational and are to a decreasing degree to be seen as a subset of regions. Consequently, these accounting practices intersect each other, on three dimensions, from the micro to the macro levels. The chapter explores several aspects of these three environmental accounting dimensions. The conclusion is that the three accounting dimensions are similar in construction in spite of having developed along independent paths. The differences are primarily in their objectives and scope of control, but it is argued that adopting a common framework and a global all-dimensional nomenclature contains potentials for increasing work efficiency.

In chapter five Dick Osborn addresses the diffusion of EMA practices. This chapter presents an innovation adoption curve at the global scale by using environmental disclosure as an indicator of pro-environmental behavior and of EMA practice providing supporting evidence. The main conclusion is that at a global level, the spread of EMA practices has yet been very limited. Furthermore, academia and practitioners who provide EMA advice to policy-makers and policy-takers need to shift their interest from content to process, especially at the interface between an organisation considering the adoption of EMA and the rest of the world.

The second section of the book contains chapters addressing different issues inherent in the implementation of EMA in organisations including the links between EMA and environmental performance measurement, environmental risk management, IT support and small and medium-sized enterprises.

The sixth chapter, by Marcus Wagner, analyses and discusses whether there is an association between environmental performance and corporate environmental reporting in the paper and electricity industries in Germany and the UK and the nature of the influence of EMA on this link. The author concludes that there is no strong association between the quality of corporate environmental reports and the actual environmental performance of firms. The results also indicate that environmental performance is significantly linked to country location. Furthermore, it shows that the use of a higher number of indicators, or the production of detailed environmental reports across whole industries, are unlikely to be related significantly to better environmental performance of companies.

The seventh chapter, by Roger Burritt, focuses on the link between EMA information and risk (and environmental risk) management. The paper is a first step in the exploration of an under-examined aspect of EMA, which is the link with external reporting. Management accounting has expanded to incorporate strategic issues that engage external parties as well as the provision of information to management. External communication thus forms an integral part of the process of EMA generally and risk management specifically. The paper draws conclusions and discusses possible future research opportunities in the context of links between environmental management accounting and environmental risk management.

Chapter eight, by Claus Lang, Daniel Heubach and Thomas Loew, addresses how environmental accounting functionalities can be integrated into a business information system by using a systematic process model. Furthermore, a case study is presented that shows how an environmental performance indicator system can be implemented in a large enterprise resource planning (ERP) system. The authors conclude that in general, environmental accounting instruments which are integrated into a company's information technology can lead to advantages such as increased quality of information and higher transparency within the enterprise. However, different requirements have to be met in order to support these instruments with information technology. The existing business information system such as an ERP system can often be used to integrate environmental accounting instruments. Using a company-wide software system without modifications is one approach that can be used with most ERP systems nowadays. This is shown in a case study presented in this chapter, which demonstrates a structured approach using a nine-phase process model for the

IT implementation of ECA. Such a structured approach is crucial for project success and to ensure the use of the instrument in day-to-day routines in the company.

The issue of EMAsoftware support is further explored in chapter nine by Tuula Pohjola. With the purpose of supporting decision-makers in companies, the paper describes an environmental modeling system which has been designed to identify, analyse, manage and report environmental factors in relation to operational, efficient and financial functions in business processes. The model addresses the process, environmental and financial aspects of operations on the basis of process management, environmental management and environmental business accounting. The author points out that modeling systems of this type advances companies' knowledge of environmental aspects, and thus in the long run might enable an extension of the scope of environmental management to social and ethical issues.

In chapter ten, Natalie Wendisch, and Thomas Heupel explore how ECAcan be integrated into a software-based application, through the example of a case study selected from a research project that the authors carried out in several companies. The implementation of process-based ECA in these companies has gained broad acceptance and an openness towards such enhancement of an existing accounting system. In addition to clear-cut results from an analysis of weak points achieved by the process-orientation of the accounting system, the user obtains a clear and consistent basis for planning and decision making with data generated from the appropriate database application. The authors conclude that ECA should also take advantage of beginning diffusion processes in process-related ECA concepts to provide new impulses for its further innovation and evolution.

Chapter eleven, by Alessia Venturelli and Aldo Pilisi, focuses on the implementation of EMA in small and medium-sized enterprises (SMEs). The research project described in this chapter shows how EMA can be constructed and implemented in ten different pilot companies. The chapter presents three complete case studies of EMA implementations in SMEs, and concludes that the main benefit of adopting an EMA in the SMEs analyzed was not only in identifying and monitoring environmental costs but also in the improvement of overall management of the company.

The third section of the book focuses on the experiences with EMA implementations in different parts of the world including Korea, Argentina, Japan, the Czech Republic and Bangladesh.

In chapter twelve, Byung-Wook Lee, Seung-Tae Jung, and Jeong-Heui Kim present the status of EMA in Korea. Since the mid-1990s in Korea, as a wide range of stakeholders have been interested in corporate environmental performance and its disclosure, some leading Korean companies have started to introduce EMA. Furthermore, the Korean government has made efforts to disseminate environmental accounting into the industrial sector. Through experiences in Korea, the authors discuss potential implications for the introduction and promotion of environmental accounting in Korea and developing countries. Among the lessons learned in Korea is the importance of top management support, integration into existing information systems, and building trust and cooperation between departments.

In chapter thirteen, Graciela María Scavone describes the status of EMA in Argentina. The author describes and analyses efforts to integrate economic, social and environmental issues and how EMA can be used in this context. The paper concludes that although environmental issues are a considerable challenge to business performance, they also offer a significant opportunity for a geographical region, and that when applied consistently over a period of time EMA can help to achieve meaningful results and to obtain integrated information that creates value for the organisations.

In chapter fourteen, Jaroslava Hyrslová and Miroslav Hájek explore the status of EMA implementations in the Czech Republic. The Czech Republic has included requirements on implementation of EMA in the framework of EMAS. If an enterprise is attempting to implement EMAS, then an essential part of the system consists of the obligation to establish and maintain procedures to trace environmental costs. The chapter includes some of the results acquired from a qualitative study of the state of preparedness of those enterprises which have registered under EMAS to implement EMA. The main objective of the study was to determine the existing state of EMA implementation in selected enterprises and to identify problems that could arise in the enterprises in connection with requirements following from EMAS.

In chapter fifteen, Abdul Hannan Mia describes the roles of government in promoting and implementing EMA in the light of the benefits in developing countries in general and in Bangladesh in particular. The main conclusion is that governments in both the developed and developing world can play a role in promoting and implementing EMA through a variety of measures including formulating a policy package on EMA promotion and implementation, developing guidelines for companies on the process of EMA reporting, and for the government agencies regarding the implementation of EMA.

In chapter sixteen, Katsuhiko Kokubu and Eriko Nashioka describe the status of EMA in Japan. Environmental accounting practices in Japan have been led by two governmental initiatives: one which emphasized external disclosures and one which emphasized the applications of environmental accounting to internal management. The authors present the results of a survey of all companies listed in the first section of the Tokyo Stock Market. It is found that environmental accounting is still oriented mainly toward external information disclosure, but that the application to internal management (EMA) has increased steadily. The authors also reach several conclusions on the factors which affect the diffusion of EMA in Japanese companies, which include a well-established environment department actively engaged in decision making across the firm, an understanding of environmental accounting concepts by top and middle management, and the use of specialised EMA tools.

In chapter seventeen, Christine Jasche and Myrtille Danse report on project conducted in Costa Rica in November 2002. The project was a "train the trainer" program on EMA, following the approach developed for the United Nations Division for Sustainable Development Working Group on Environmental Management Accounting. The chapter describes the project organisation and applied methodology, and compares the obtained results to similar case studies in Austria. The general conclusion is that the UN methodology is very suitable to SMEs in Costa Rica. It helps decision makers identify the environmental costs the production processes generate and to defend possible investments with data.

CONCLUSION AND FUTURE CHALLENGES

If some overall conclusions are to be drawn from the chapters of this volume then the main one would be that the field of EMA is still diffusing and there is no sign of EMA as a whole disappearing from view. However, an interesting question is how the various tools of EMA will diffuse. The most likely answer is that some tools will find broad applicability in business and be integrated in many companies, whereas the use of other EMA tools will rise and fall over a short period of time. However, considering the level of development, the number of tools available, the companies implementing them and the initiatives by governments to promote EMA, then it cannot be concluded that EMA is a passing fad. On the contrary it can be concluded that some EMA tools are becoming well integrated into management practice. In the end EMA may be regarded by managers not as "Environmental Management Accounting" but simply as an integrated part of management accounting.

Based on the diffusion perspective which has been adopted in this introduction, as well as the different contributions in our view the main challenges regarding the implementation of EMA in the future are the following:

1. There is no single optimal route through which EMA is likely to become diffused through companies and other organisations with environmental impacts, but rather there are a number of different possible mechanisms, the relative importance of which will depend on the situation of the particular organisation and the potential new technology which is being considered. The two crucial parameters of the situation are the extent to which the organisation is able to implement its own decisions rather than be influenced by others, and the extent of the uncertainty which it perceives over either its goals or the means which are offered by the new technology.
2. Although the relative importance of the four distinct mechanisms identified will vary between organisations and situations, in most instances they are likely to be complementary rather than mutually exclusive alternatives. The example of adoption of an innovation by competitors may prompt an organisation to seek further

guidance from consultants and business schools, in order to carry out an analysis to identify a rational choice; and similarly, mandatory requirements by governments for companies to collect environmental management data in order to support statistical returns, or legislation to compel external environmental reporting, may then encourage those companies also to use that data internally through EMA. As research provides more insights into the different contexts of organizations, the adoption of EMA will become more effective.

3. One crucial aspect of the situation of any organisation will be its size. Most EMA initiatives and research to date has been concentrated on large organisations, also because their motives for environmentally responsible behavior may often be stronger than those of smaller companies, and because organisational size per se tends to necessitate more sophisticated management methods, including techniques of management accounting and financial management. However a substantial proportion of total environmental impacts are attributable to the small and medium-sized company sector, and to influence the environmental performance of this sector positively may require either adapted forms of EMA to suit smaller companies' needs, or a dependence on other, non-accounting, methods of exerting influence.

4. Recognition of a range of different and mutually reinforcing channels through which new technologies can be diffused indicates the wide range of actions that can be taken, by actors in different sectors, to help promote this diffusion. In particular, it may be noted that there is a role available for government and intergovernment agencies (UN DSD, 2001) in promoting the use of EMA by companies and other organisations as a less confrontational and potentially more effective way of implementing environmental policy than traditional "command-and-control" regulation; and that EMA needs to be a core element in the education of future managers by being integrated into undergraduate and MBA courses as an integral part of management accounting practices.

5. EMA needs to be integrated into corporate business processes and information systems in the course of an implementation. If EMA may not be integrated then it is doomed to be a "bolt-on" activity risking sudden death when other more exciting projects surface in the organisation. Clearly existing accounting practices define the setting in which EMA will be implemented. These practices are country-specific as the institutionalisation of accounting itself is largely affected by the relevant formal rules (such as corporate guidelines and legislation) and informal rules (such as values) but will in the future be affected by further the trend to harmonisation of accounting practices.

NOTES

1 http://www.inwent.org/en/

REFERENCES

Abrahamson, E. (1991), Managerial Fads and Fashions: The Diffusion and Rejection of Innovations. *Academy of Management Review 16* (3): 586-612.

Abrahamson, E. (1996), Management Fashion. *Academy of Management Review.* 21 (1): 254-285.

Bartolomeo, M., Bennett, M., Bouma, J.J., Heydkamp, P., James, P., de Walle, F. and Wolters, T. (1999). *Eco-Management Accounting: Based upon the Ecomac Research Project Sponsored by the EU's Environment & Climate Programme*. Dordrecht (NL): Kluwer Academic Publishers.

Bennett, M., Bouma, J.J. and Wolters, T. (2002), *Environmental Management Accounting: Informational and Institutional Developments*. Dordrecht (NL): Kluwer Academic Publishers.

Bennett, M., Rikhardsson, P.M. and Schaltegger, S. (2003), *Environmental Management Accounting: Purpose and Progress*. Dordrecht (NL): Kluwer Academic Publications.

Burritt, R., Hahn, T. and Schaltegger, S. (2002a), An Integrative Framework of Environmental Management Accounting. In: Bennett, M., Bouma, J.J. and Wolters, T. (eds.), *Environmental Management Accounting: Informational and Institutional Developments,* pp. 21-35. Dordrecht: Kluwer Academic Publishers.

Burritt R., Hahn, T. and Schaltegger, S. (2002b), Towards a Comprehensive Framework for Environmental Management Accounting. Links Between Business Actors and Environmental Management Accounting Tools, *Australian Accounting Review, 12* (2): 39-50.

DiMaggio, P. J. and Powell, W. (1983), The Iron Cage Revisited: Institutional Isomorphism and Collective Efficient in Organisational Fields, *American Sociological Review, 48*: 147-160.

Geroski, P. A. (2000), Models of Technology Diffusion. *Research Policy, 29*: 603-625.

Granlund M. and Lukka, K. (1998), It's a Small World of Management Accounting Practices. *Journal of Management Accounting Research*, (10), 153-179.

Louche, C. (2004), *Ethical Investment. Process and mechanisms of institutionalization in the Netherlands, 1990-2002*. PhD Dissertation, Erasmus University Rotterdam.

Luft , J. and Shields, M. (2003), Mapping Management Accounting: Graphics and Guidelines for Theory-consistent Empirical Research. Accounting, *Organisations and Society, 28*: 169-249.

Robinson, R. (1988). *The International Transfer of Technology*. Cambridge, MA: Ballinger Publishing Company.

Rogers, E. and Schoemaker, F. (1971), *Communication of Innovation: A Cross-Cultural Perspective*. New York: Free Press.

Rogers, E.M. (1995), *Diffusion of Innovation*s, 4th ed. New York: Free Press.

Røvik, K.A. (1998), *Moderne organisasjoner – Trender i organisationstenkningen ved tusenårsskiftet* (Modern Organisations – Trends in Organisational Thinking at the Turn of the Millennium). Copenhagen: DJOEF (Available only in Norwegian).

Schaltegger, S. and Burritt, R. (2000), C*ontemporary Environmental Accounting: Issues, Concept and Practice*. Sheffield: Greenleaf.

UN – DSD: United Nations Division for Sustainable Development (2001). *Environmental Management Accounting – Procedures and Principles*. New York: United Nations.

SECTION 1

EMA PROGRESS

CHAPTER 2

CHALLENGES FOR ENVIRONMENTAL MANAGEMENT ACCOUNTING

ROGER L. BURRITT

School of Business and Information Management
The Australian National University, Australia

roger.burritt@anu.edu.au

Abstract Environmental management accounting (EMA) is concerned about the accounting needs of managers in relation to corporate activities that affect the environment as well as environment-related impacts on the organization. This paper provides an overview of a range of challenges faced by EMA.

1 INTRODUCTION

Various reasons are given as to why an increasing number of managers are becoming interested in EMA information (Ansari, 1997 pp. 4-5, Gray and Bebbington, 2001). These include that:

- *Environmental regulations* impose requirements on companies. For example, Superfund liabilities for site cleanups (remediation) in the USA and take-back (extended producer responsibility) provisions in the European Union. These regulations, when enforced, can lead to environmental costs that, if significant, need to be *controlled* and *reduced* by management;

P.M. Rikhardsson et al. (eds.), Implementing Environmental Management Accounting, 19-44

- *An increase in voluntary acceptance* (self regulation) by managers of the importance of managing business environmental impacts. Managers are beginning to recognise the growing importance of the monetary consequences of corporate environmental impacts to the prosperity of their corporations. If managers wish to lower their costs (to improve income or profitability) or environmental impacts (to reduce penalties, e.g. cessation of business, for non-compliance or the outrage of different stakeholders), then EMA information is necessary. Voluntary acceptance leads to commitment, assessment, monitoring and elimination of the causes of adverse environmental impacts and costs, as well as *control* in order to maintain corporate legitimacy in the eyes of customers, society and other stakeholders (Deegan, 2002);
- *Promotion of EMA* is being undertaken by international, national and local government bodies and some educational institutions, although little is known about how educational institutions are embracing the area. EMA is being promoted by groups such as the United Nations Division for Sustainable Development (UN DSD), United Nations Environment Programme (UNEP) and the Tellus Institute (through The Environemntal Management Accounting Research and Information Center (eMARIC) – because of potential social and environmental benefits from widespread use of environmental management tools related to the need for organisations to include all environmental costs in operating decisions and investment project analysis and to invest in clean technology. Academic investigation into EMA practices is gathering momentum and is being organised through networks such as EMAN in Europe, Asia Pacific and the Americas. Promoters of EMA tend to encourage organizations to accept the win-win logic behind the adoption of EMA practices (UN DSD, 2003, Schaltegger and Burritt, 2000 p. 53). From this perspective, environmental performance and financial performance of the organization are promoted on the basis that organizations can take actions that improve both types of performance. Some success in the promotion and dissemination of EMA ideas has already been noted (Osborn et al., 2002).
- *EMA tools are increasingly available* to help in the management process (see Figure 1 for some practical examples of such tools). Each tool, for example full cost accounting or life cycle costing, has been defined in a number of ways, thereby adding complexity for successful implementation to be achieved. The range of tools is typified by experience in Japan, where the Ministry of Economy, Trade and Industry (METI, 2002) established an EMA project in which the use of various tools – environmental cost management, material flow cost accounting, life cycle costing, environmental capital appraisal, and environmental corporate performance evaluation – is being researched.

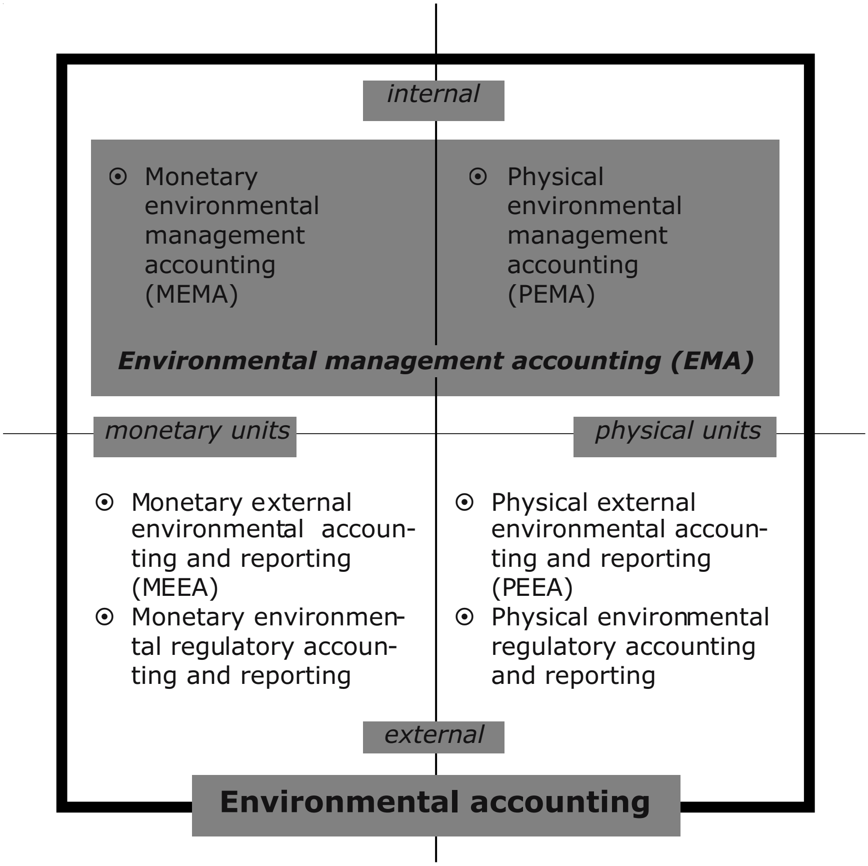


Figure 1. *Categories of Environmental Accounting (modified from Bartolomeo et al., 2000 p. 33)*

Given these incentives for the development of EMA, the paper proceeds as follows. Section 2 considers the meaning and development of EMA. Section 3 identifies some key problems with conventional management accounting along with academic and practitioner responses. Section 4 reveals challenges for EMA to address. The paper concludes that relevant, reliable, low cost EMA information is needed if the impetus already started is to continue to gather pace.

It should be noted that EMA literature is growing at a rapid rate and, in consequence, only a selective review of the literature on EMA is considered here. For a comprehensive review, a useful starting point is provided by Mathews (1997 and, 2003) and Bennett and James (1998c). No attempt is made here to provide detailed discussion of particular EMA tools, or environment-related performance indicators.

A wide repository of published information on these is located on the EMA Research and Information Center (EMARIC) web site[1]. Another diverse set of information can be found in Bennett et al.'s (2002a and 2003) papers from conferences and workshops of EMAN Europe. Finally, a recent critique of EMA is provided by Bennett, Bouma and Wolters (2002a).

2 WHAT IS ENVIRONMENTAL MANAGEMENT ACCOUNTING?

2.1 What is environmental management accounting?

Taken literally there are six possible words or phrases in the term 'environmental management accounting'. These are environmental, management, accounting, environmental management, management accounting, and EMA. Examining each in turn leads to some appreciation of discussions about the whole:

- *Environment* – does the definition include social and economic aspects as subsets? If so, the closer environmental and sustainability considerations become.
- *Management* – is this represented by functions (specific life cycle activities – from research and development, through production to product take-back), roles (the subject that manages – top, middle, production supervision, environmental, product manager, accountant, logistics, etc.), or object to be managed (people, physical objects, reputation).
- *Accounting* – the systematic gathering and use of monetary and non-monetary information about the organization that can be used by others – internally by managers and, if disclosed, externally by other stakeholders. Reporting of accounting information to stakeholders outside the organization in non-monetary terms is typified by an environmental report, and in monetary terms by a financial report.
- *Environmental Management* – a process view of management involving the continuous (continual) improvement cycle. Assumptions are made about: whether a narrow or wide view is taken of the environment; the management functions to be included; the managers that are included in environmental management; the objects being managed (people, physical objects, reputation).
- *Management Accounting* – conventionally concentrates on measurement in monetary and non-monetary terms to help managers make decisions that achieve the organization's goals. Management accounting and cost accounting are often distinguished because cost accounting is a source of information for both internal use and external reporting (Horngren et al., 2003).

- *Environmental Accounting* (see Figure 2) – various perceptions of the concept and practices of environmental accounting have emerged (for example, Adams, 2000, Bennett and James, 1998, Gray et al., 1993, Gray et al., 1996, Gray and Bebbington, 2001, Hamner and Stinson, 1995, Howes, 2002, Parker, 2000, Schaltegger, 1996, Schaltegger and Burritt, 2000, US EPA, 1995, White and Savage, 1995). Some convergence has taken place in the definition of environmental accounting, for example:
  - MEEA monetary external environmental accounting
  - PEEA physical external environmental accounting
  - MEMA monetary environmental management accounting
  - PEMA physical environmental management accounting (see Figure 2).

These classifications rely on the perceived usefulness of, and ability to distinguish between, internal and external stakeholders and the need for environmental accounting to provide monetary and physical units of measurement.

What, then, is environmental management accounting?

There has been movement towards the development of a comprehensive framework of EMA with the following characteristics:

- A focus on internal rather than external users of accounting information (e.g. Schaltegger and Burritt, 2000), and
- Separate identification of the need for monetary and non-monetary information to be gathered and tracked (Bennett and James, 1998a, Burritt et al., 2002, ECOMAC, 1996, IFAC, 1998, UN DSD, 2001 p. 39).

Figure 2 provides several contrasting definitions of EMA. Graff et al. (1998) combine material use and costs in their definition. It is a flow-orientated definition. They provide a fundamental distinction between monetary and non-monetary environment-related information. IFAC (1998) considers the combined management of environmental and economic performance and includes in their definition reference to a range of tools associated with EMA, including life-cycle costing, full cost accounting, benefits assessment, and strategic planning for environmental management. Full cost accounting addresses the range of impacts being managed (it internalises the costs of what conventionally are considered to be external impacts); while life cycle costing focuses the impacts of all functions of the business rather than a narrow group such as production, which was the special preserve of conventional cost accounting. The UN (2002) focuses on flows of environmental costs and economic (in monetary and non-monetary terms) benefits. Schaltegger and Burritt (2000) specifically identified EMA with monetary measures, but have since suggested the inclusion of monetary and non-monetary information (Burritt et al., 2002). Finally, Bennett and James (1998a p. 33) provide a definition that incorporates financial and non-financial information about environmental and economic performance, with sustainable business being a goal.

Bennett et al. (2002b p. 2) later emphasise that EMA provides a close link between environmental management and management accounting, which raises the question as to how this link occurs. Is it through supplements to existing environmental management, or supplements to conventional management accounting, through reinvention of conventional management accounting and environmental management, or through the introduction of a new system that reflects a change in management philosophy towards concern for the environment as an ongoing issue for business. Considerable emphasis seems to be placed on the reinvention of conventional management accounting as the basis for considering environmental issues (see Howes, 2002). Hence, a closer examination of conventional management accounting in the context of corporate environmental issues is merited.

2.2 Is EMA just conventional management accounting with an environmental twist?

Conventional management accounting has a number of characteristics; it has a focus on internal decision-making about the business, it looks at past information to guide future decisions, cost receives the greatest attention, manufacturing is the value chain function most widely considered, and the emphasis is on control (Otley, 2001 p. 244).

Hansen and Mowen (2003 p. 7) provide a representative definition of conventional management accounting: "…management accounting identifies, collects, measures, classifies and reports information that is useful to internal users in planning, controlling, and decision-making." Not only is management accounting seen as being relevant to internal decision makers such as managers, it also strongly emphasises providing information about the future as a basis for decision-making and management control.

In a well-established source of information about management accounting, Horngren et al. (1997 p. 2) identify several specific purposes for conventional management accounting information:

1. Formulating strategies and long-range plans (sometimes called strategic management accounting or strategic business management) – including new product development and investment in tangible and intangible assets;
2. Physical resource allocation decisions involving profitability of specific products, brands, distribution channels and customers;
3. Cost planning and cost control of operations and activities relating to different responsibility centres; and
4. Performance measurement and evaluation of people – comparing expected and actual performance.

Source	*Definition*
Graff et al. 1998 pp. 3-4 (Tellus Institute)	Environmental management accounting 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.
International Federation of Accountants (IFAC) (1998, para. 1):	[Environmental management accounting is…] the management of environmental and economic performance through the development and implementation of appropriate environment-related accounting systems and practices. While this may include reporting and auditing in some companies, environmental management accounting typically involves life-cycle costing, full cost accounting, benefits assessment, and strategic planning for environmental management.
UN DSD EMA Initiative	Environmental management accounting serves as a mechanism to identify and measure the full spectrum of environmental costs of current production processes and the economic benefits of pollution prevention or cleaner processes, and to integrate these costs and benefits into day-to-day business decision-making.
Schaltegger and Burritt (2000 p. 89)	…environmental management accounting is defined in a narrower sense to include only the environmentally induced financial aspects of accounting that help managers to make decisions and be accountable for the outcome of their decisions.
Bennett and James (1998 p. 33)	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.

Figure 2. *What is Environmental Management Accounting?*

Whereas regular, periodic information is needed to fulfil purposes 3 and 4, information for purposes 1 and 2 are often ad hoc, project based and require special reports to managers as particular opportunities arise.

One implication of the greening of management accounting is that, potentially, all of the characteristics of conventional management accounting can be reconsidered in the light of physical and monetary environmental considerations. Bennett and James (1997 p. 34) identify six areas of environment-related management accounting:

- Identifying cost reductions and improvements;
- Prioritising environmental actions;
- Guiding product pricing, mix and development decisions;
- Enhancing customer value;
- Future-proofing investment and other decisions with long term consequences; and
- Assessing the eco-efficiency and/or sustainability of a company's activities.

Wilmshurst and Frost (2001 p. 138) succinctly summarise these purposes as follows "At the core of environment-related management accounting is…the development of environmental performance indicators that provide management with both financial and non-financial information relevant for decision-making purposes".

Bennett and James (1997 p. 34) recognise that environment-related management accounting has the potential to include energy and materials accounting, environment-related financial management, life cycle assessment and costing, environmental impact assessment and environmental externalities costing, even though in practice financial data and financial management has been the prime concern.

However, management accounting is undergoing rapid change, so much that Pierce (2001) argues "There seems no doubt now that managers will take over management accounting….Relevance and timeliness are of far greater importance than who supplies the information." He observes that, based on UK, US and Irish research (Pierce, 2001), conventional management accounting techniques will continue to be widely used, will be adapted to reflect non-financial indicators of performance, and will be closely linked to strategy, but decentralized managers, not management accountants, will dominate. Otley (2001 p. 244) considers that additional changes to conventional management accounting have occurred with management accounting becoming more strategic being forward looking, concerned about planning, externally focused, value focused and with an eye on other aspects of the value chain. Support for the growing importance of non-monetary information as part of management accounting comes from Bennett and James (1998d p. 371) who examined the cost of waste at Zeneca and found that accountants are not essential to environment-related management accounting where an understanding of physical processes was the primary concern for data gathering.

Whoever does assume responsibility for management accounting information, and EMA, a number of problems with conventional management accounting remain to be addressed. These are considered in the next section.

3 GREEN ISSUES – KEY PROBLEMS WITH CONVENTIONAL MANAGEMENT ACCOUNTING

3.1 Context

Some of the key problems for EMA stem from problems with conventional management accounting, while others are related to the lack of recognition of environmental impacts. These problems and the ways that they are being addressed in theory and practice in the context of environmental issues, are examined below:

Problems with conventional management accounting:
1. Performance appraisal techniques are too narrow and short term in their focus;
2. Lack of attention to articulation of stocks and flows; and
3. A narrow focus on manufacturing.

Problems with the lack of recognition of environmental impacts in conventional management accounting:
1. Environmental costs are assumed not to be important;
2. Certain types of environmental costs are not identified or tracked;
3. Indirect environmental costs are included with general business overheads;
4. Investment appraisal excludes environmental considerations;
5. Little accounting for externalities and sustainability issues.

3.2 Problems with conventional management accounting

1. Performance appraisal techniques are too narrow and short term in their focus
The academic response: introduce a balanced scorecard that includes non-financial measurement sets relating to customer satisfaction, learning in and growth of the business, internal business processes, as well as financial measures. Physical environmental performance is one of the measurement sets that could be adopted, emphasising long-term physical and monetary environmental performance of the organization (Kaplan and Norton, 1992, 1993, 1996a, and 1996b).
The response from practice: Empirical evidence gathered about practice in Germany, Japan and Australia indicates that little attention is given to the use of EMA data in performance appraisal, either for environmental managers, or for other managers in the sample of companies examined (Burritt et al., 2003).

Also, practical implementation of material flow cost accounting illustrates the ways in which cost centres material costs are manipulated (e.g. by renaming high value materials and misposting, the volume used appears to decline in the cost centre costs) (Eco-Effizienz, 2002 p. 2).

2. Lack of attention to the articulation of stocks and flows
A focus on flows means that stocks receive less attention. This is equivalent to stressing the income statement in accounting, while ignoring the fact that income represents the difference between opening and closing balance sheets (the stock positions) (Chambers, 1986 p. 179). Both are critical for a full understanding of position and performance.
The academic response: recognition of the need to integrate financial accounts to articulate stock and flow information (Chambers, 1986, Schaltegger and Burritt, 2000), but emphasis is placed upon the flows (UN DSD, 2001).
The response from practice: in financial accounting the need for articulation is widely accepted but in conventional management accounting it is not. In EMA, however, environmental assets are largely ignored (for one exception see Burritt and Cummings, 2002). Valuation of environmental liabilities in monetary terms for management decision-making is examined by the US EPA (1996 13) but is only recommended for situations when they might make a difference to the investment appraisal. The emphasis on articulated information about environmental liabilities in the management accounts is not stressed. Articulation between stock and flow information in physical environmental terms receives less attention.

3. A narrow focus on manufacturing
The academic response: Life cycle analysis and *life cycle costing* (cradle to grave) should be adopted (Bennett and James, 1998e). Integrated Product Policy (EC, 2001 Green Paper, White Paper forthcoming from the EC. Supply chain management is required (Tellus Institute, 2003).
The response from practice: Cases explore this wider focus. For example, Yakima-Olympia Corporation, a vertically integrated but non logging forests product company has choosing between clear cutting with feller/skidder/buncher technology or harvester/forwarder technology (Shank and Govindarajan, 1992). Integrated Product Policy (IPP) is being introduced in The European Union to link business and other stakeholders and supply chain management is being introduced. For example, the European Information and Communications Technology Industry Association encourages producers to supply key data along the product chain in the electronics industry and the European Union End of Life Vehicles Directive encourages strategic alliances to gather information about materials (International Material Data System, 2003).

3.3 Problems with the lack of recognition of environmental impacts in conventional management accounting

1. Environmental costs – not important

A key criticism of conventional management accounting is that it largely considers environmental costs to be immaterial in proportion to the organization's total costs. One reason suggested is that environmental costs are not separately identified (US EPA, 1995).

The academic response: case studies have been undertaken to separately identify environmental costs as a proportion of total costs (Ditz et al., 1995). The implication is that where such costs are material they need to be separately identified and managed.

A second strand of academic work has explored the notion of what is an environmental cost. In particular, materials flow cost accounting recognises all non-product costs associated with the generation of waste, both direct costs such as materials and overheads, as being environmental (Stroebel and Redman, 2002).

The response from practice: a large number of cases identify whether environmental costs form a material part of total costs (see some major recent sources in Figure 3).

2. Some environmental costs are not identified or tracked

Given the tendency for environmental costs not to be separately identified the need to do so became apparent.

The academic response: studies tried to establish what are environmental costs (e.g. UN DSD EMA, 2001); which environmental costs are potentially important (Bennett and James, 1997); and how best to classify such costs (US EPA, 1995).

Environmental costs have been classified in several different ways. Five classifications seem to have received particular attention based on:

a) *conventional cost accounting* (Horngren et al., 2003, Schaltegger and Burritt, 2000) – job and process; direct and indirect; historical and standard; fixed and variable; ordinary and extraordinary;
b) *measurability* (US EPA, 1995 p. 14) – five tiers conventional (0), indirect hidden (1), less tangible (2), contingent (3); and societal (externalities) (4). Measurability has been the focus of many case studies in EMA;
c) *quality* (Ansari, 1997 p. 5) – prevention, assessment (appraisal), control (internal failure) and external failure;
d) *life cycle and activity* (Kreuze and Newell, 1994); life cycle – research and development, design, production, etc.; activity based – unit, batch, product sustaining and facility level costs; and
e) t*arget audience* (Schaltegger and Burritt, 2000, Burritt et al., 2002) – internal (managers and employees); external (shareholders, tax agencies, environment agencies, suppliers, creditors, general public, local communities, NGOs, etc.).

The response from practice: the majority of cases only consider internal private environmental Tier 0 (conventional) and Tier 1 (hidden) environmental costs (see Graff et al., 1998 p. 11 for analysis of 39 cases across a range of industries).

3. Indirect environmental costs are lumped in with general business overheads
The academic response: identify and measure direct environmental costs (US EPA, 1995). Revise allocation bases separating out indirect environmental costs using activity-based costing (resources consumed by activities) to reduce cross subsidisation of 'dirty' products, processes, sites and departments.
The response from practice: the focus of most EMA cases (see Figure 3).

4. Investment appraisal excludes environmental considerations
The academic response: suggests change cash flows, discount rate and include option values to reflect environmental considerations in discounted cash flow calculations (Schaltegger and Burritt, 2000, section 6.5).
The response from practice: according to Graff et al. (1998 p.12) almost all of the projects included in their snapshot of 24 capital investment projects calculate a n Net Present Value (NPV), but most ignore option values. Graff et al. (1998 p. 12) found the lowest NPV of their 24 cases was minus USD 1.4m, the highest USD 11.6m, and typical was NPV USD 10,000 to USD 100,000.

5. Little accounting for externalities and sustainability issues (Tier 4 social costs (US EPA, 1995))
The academic response: Encourage a 'full cost accounting' EMA system (Bebbington, 2001). Extend the regulatory mix of policy instruments to include voluntary initiatives, such as the adoption of full cost accounting, with a sliding scale of enforcement penalties if business does not demonstrate voluntary commitment (Li, 2001).
The response from practice: Most case studies ignore externalities associated with business environmental impacts (see cases in Figure 3). Where externalities are calculated (e.g. ex post values – travel cost, hedonic pricing, averting behaviour – ex-ante values – contingent valuation, etc) the quality of information is poor but this is considered to be better than an estimate of zero (Graff et al., 1998 p. 12).

Each of these problems has a bearing on the characteristics needed for development of a pragmatic comprehensive management accounting system (see Schaltegger and Burritt, 2000 p. 44).

Source	*Number of EMA Cases Presented*	*Sector/Industry/Name (if available)*
ICAA, EA, VicEPA, Sydney, October 2002[2]	• 4 Australia	• Private/ Education/ Methodist Ladies College, Perth • Private/ Plastic Injection/ Cormack Manufacturing • Private/ Internal services to divisions/ AMP Services • Private/ Wool manufacturing – carbonising/ Michell Group
UN DSD EMA, Lund Sweden, December 2002[3]	• 12 Austria • 1 Zimbabwe • 1 South Africa • 5 Costa Rica • 1 Romania • 1 Hungary • 1 Slovakia • 2 South Korea	• Private/ Banking, Brewery, Energy, Pulp and Paper, Galvanising, Skiing, Water Treatment • Private/ Particle and fibreboard/ Zimboard Mutare • Private/ Mining, – 4 sectors • Private/ Poultry, Labels, PVC products, coffee mill, pasta/Pipasa, Etipres, Resintech, Coopronarango, Roma Prince • Public sector/ Water authority • Private/ Chemicals/ Nitrokemia • Private/ Cardboard production • Private/ Steel, health care/POSCO, Yuhan-Kimberley
UN DSD EMA, Bristol UK, February (UN DSD2002)	• 1 Canada • 3 Slovakia	• Private/ Pulp and paper mill/ Mackenzie paper Division, Abitibi-Consolidated Corporation • Private/ Pulp and paper; railway carriage repair; cardboard manufacturer
EMAN Europe, Bristol, UK, February 2002	• 11 Austria • 14 UK	• Private/ Pilot projects • Private/ Survey
Kokubu and Nakajima (2002) /IMU	• 6 Japan	• Private/ Various / Material flow costing in: Nitto Denko, Canon, Tanabe Seiyaku, Takiron, Nippon Paint, Shionogi
Gago (2002)	• 11 Spain	• Private/ Wood boards, bricks, wood pulp, oil refining / Co-generation of energy supply in unnamed companies
EMAN Asia Pacific, Kobe, Japan September 2001	• 3 Korea • 1 Philippines	• Private/steel, electronics, chemicals/ POSCO, Samsung, LG Chemicals • Private/ conglomerate/ Lopez Group

Figure 3. continued

Source	*Number of EMA Cases Presented*	*Sector/Industry/Name (if available)*
Graff et al. (1998)	• 39 Cases	• Private/ Chemicals; metal finishing, fabrication; printing; electronics; paper; electrical utilities, other./ 24 capital investments; 9 product/process costing; 6 strategic planning
Bennett and James (1998b) The Green Bottom Line (pp. 294-372) – various authors	• USA	• Private/ medical products and technologies (Cost-benefit analysis)/ Baxter International
	• Canada	• Public sector/ Ontario Hydro
	• Switzerland	• Private/ Electric utility (Full cost accounting), machinery and engineering (Identification of environmental costs)/ Sultzer Hydro
	• USA	• Private/ (Xerox Ltd/ Packaging use by document company (Product life cycle costing)
	• UK	• Private/ waste disposal in agrochemicals division (Conventional tracking and allocation)/ Zeneca
Ditz et al. (1995) Green ledgers	• 9 USA	• Private/ 9 companies in-depth (includes pollution prevention in four small companies). *General Comment*: '…the casework presented here avoids an explicit accounting of social costs.'

***Figure 3**. Some available case studies in environmental management accounting*

4 ADDITIONAL CHALLENGES FOR THE FUTURE

Given the growing academic and practitioner interest in EMA, the availability of EMA tools and the promotion activities of various institutions, consideration needs to be given to the challenges that lie ahead. Nine of these are examined briefly below:

1. Inductive theory and the direction of case studies

A range of case studies in EMA are gradually being built up, based on experiences of organisations in practice in a number of countries (see Figure 5). Further case studies are being undertaken in each of the main categories – physical and monetary aspects of environmental cost analysis, investment appraisal, and performance management (including planning and control) in a range of countries and cultures. In time, the number should provide a sufficient base from which some generalisations can be drawn in relation to the observations of management practice in building up sustainable relationships and practices in situations of conflict, competition, cooperation and power differentials. With UN DSD cases "…the focus … is on actual company costs rather than on externalities…" (UN DSD, 2001 p. 8), and there is no intention at this stage to try and include externalities in new case studies being encouraged.

Bouma and van der Veen (2002 p. 279) observe that "Most research in EMA is prescriptive, contributing to the further development of tools, and often based on a limited number of case studies. Empirical research in EMA (e.g. Bouma and Wolters, 1998) is scarce and is focused more on describing the current state of implementation than on analysing or critically evaluating the effectiveness of the new tools." Their recommendation is to gain insight into the spread of EMA practices and to apply EMA theory to the adoption and effectiveness of EMA practices (Bouma and Wolters (1998 p. 279). As a starting point, Bouma and Wolters (1998 p. 289) attempt this in the context of environmental costs using contingency theory and institutional theory at operational, model, coalition and value levels. The analysis could be extended to each of the tools of EMA embodied in a comprehensive system (Burritt et al., 2002).

2. Small and Medium Enterprises (SMEs) and enterprises in developing countries

Case studies tend to focus on self-selecting organisations (but notice exceptions e.g. Ditz et al., 1995), usually large or environmentally sensitive organisations, or multinationals looking to improve their legitimacy with stakeholders. In larger companies divisional organisational structures can be used to educate and train managers in environmental awareness and, later having internalised this awareness, they will be equipped to run the total business.

Existing case studies in EMA are useful for understanding environmental costs, material flows and the potential for EMA. However, if the vast majority of (small and medium enterprises and developing country) businesses are not engaged in the process an holistic approach to addressing corporate environmental issues will not result, one that is essential if environmental problems are to be enthusiastically and successfully addressed. Diffusion of EMA (e.g. Osborn et al., 2002) requires the 'succession' factor with SMEs and developing countries to be taken into account.

3. Beyond win-win

Theoretical developments are needed to help guide practice and policy makers beyond win-win outcomes. The conventional view that many environmental impacts of business lead to net costs to business, and will not lead to win-win outcomes has not gone away. Case studies look for the win-win outcome, without considering how to choose when there is a net cost to the business. Case studies where there is a trade-off between environmental and economic, or environmental and social, outcomes would be invaluable because they would help generate a new mental set for managers where it is permitted for the environment to be seen as the key pillar of sustainability on some occasions.

4. Is pure physical information environmental management accounting information? Balanced scorecards can be relevant for particular purposes, for example calculation of various eco-efficiency, eco-effectiveness and eco-equity measures. However, engendering a philosophy of corporate conservation of environmental resources may require periodic, sequential focus solely on environmental indicators. In these circumstances relevant scorecards will be more important than balanced scorecards. For example, through ecological footprints[4] (Barrett and Scott, 2001, Chambers and Lewis, 2001, Wagekernagel and Rees, 1996) and rucksacks[5] (Chambers and Lewis, 2001) business may wish to empower its employees with the thought that their actions can help conserve the environment at work, or make customers aware of their environmental footprint when for example, they take a flight (e.g. the SAS emission calculator[6]). See also, in Australia, VictoriaEPA (2002) has established a series of pilot partnerships to investigate the potential development and application of eco-footprints to business, and to develop a robust method as a tool to measure and communicate the progress of business towards sustainability[7].

The implication is that pure physical information can be regarded as EMA, but that a comprehensive system may not be required to provide such information. Effort has been put into establishing whether information for accountants and environmental managers is systematically gathered and used. Using a narrow definition of EMA relating to internal decision support provided by financial data, Bartolomeo et al. (2000 p. 39) summarised the situation in Germany, Italy, the Netherlands and Great Britain and compared this with the USA. They found from a series of case studies in Europe that the financial benefits of introducing comprehensive EMA systems are not usually justified. Instead, they suggest that business piggy-back environment management accounting on other systematic changes, such as the introduction of activity-based costing.

It was also noted that in the UK and US business tends to look for short-term monetary gains from environmental projects, whereas in Germany, Italy and the Netherlands longer term benefits of eco-balancing and broad stakeholder responsibility are to the fore (Bartolomeo et al., 2000 p. 47), although there is some evidence of convergence. In contrast, evidence in Australia (Wilmshurst and Frost, 2001 p. 143) indicates that the basic structure for recording monetary environmental information already exists, even though environmental costs are not separately recorded in practice. But there is little active involvement by accountants in corporate environmental management either individually, or as a members of the environmental management team.

What remains as an issue is identification of the circumstances in which a comprehensive EMA system is or should be of benefit to the business (see Solomons (1965) for an early insight, and Johnson and Kaplan (1987) and Kaplan and Norton (1996) for recent views).

5. Software systems
Development of cheap but reliable and high-quality software systems will be one aid to the take up of EMA by smaller businesses. In a useful survey, the following questions were addressed (US EPA, 1995b).

- What tools and software systems encourage and allow a comprehensive coverage of environmental costs?
- What tools and software systems support life-cycle costing (LCC)?
- What directions might software and tool developers explore to critically evaluate and modify their products in light of new information and needs?
- What are appropriate research directions based on the current state and limitations of the available tools and software? (US EPA, 1995b)

An up-to-date summary of developments since 1995 is overdue. Current packages such as the PT Laser Systems Dynamics Model can be used to integrate: environmental and materials balance analysis; full cost accounting; life cycle economic evaluation of options; and sensitivity/influence analysis[8]. Another program, TCAce currently under revision[9], makes provision for all tiers of environmental costs, including societal costs. Software packages are only as good as the quality of the information that they produce and the links between quality of data and available software need to be synthesised for practitioners (e.g. the practice of using averaging of data is a criticism of life cycle assessment packages) (Schaltegger and Burritt, 2000 p. 249). Studies providing practical guidance with and lessons of implementation of software would be invaluable for the acceptance of EMA by business, and of the role of the internet in EMA could be examined.

6. Is the distinction between internal and external stakeholders useful?
The contention that EMA has a focus on internal uses of information is complicated when it is recognised that as part of the management process detailed internal information is sometimes shared with management of some parties conventionally considered to be outside the organisation. For example, provision of information to suppliers and customers as part of the business process.

For example, studies of environmental supply chain management explore this relationship. McDaniel (2000) provides practical guidance for managers of environmental issues through establishing partnerships, alliances and cooperations with upstream and downstream activities (suppliers, distributors, shippers, customers, etc.). The study observes that most supply chain managers do not focus on environmental concerns, one reason being that the frequency and magnitude of environmental costs are hidden by cost accounting systems (McDaniel, 2000, p. iv). Without information about these environmental costs management decisions related to converting suppliers into service providers are unlikely to occur. For example, a chemical service provider might purchase and deliver chemicals, change out drums, re-package chemicals and deliver chemicals to the point of use, provide data for some environmental reports, undertake research for chemical substitutes, process efficiency improvements, and manage waste disposal (Votta et al., 1998, Whaley and Johnson, 2001). Perceived environmental advantages from converting supplies into services, and growing take-back requirements in Europe and elsewhere encourage further studies in the cross over between internal and external relationships (Lippman, 2001 p. 14).

Internal and external stakeholder issues also arise in the context of understanding the difference between environmental management accounting and environmental cost accounting. For example, Howes (2002 p. 3) provides an introduction and practical guide to ECA divided into two parts – internal ECA and external ECA. Analysis is not based on the conventional distinction between accounting information for internal and external stakeholders. Internal is taken to mean actual environment-related expenditure, while external is taken to mean calculated estimates of externalities that would be needed to reduce business environmental impacts to a socially acceptable level (Howes, 2002 p. 27).

Another example also illustrates the problems that exist with basic terminological issues. UN DSD (2001 p. 5) suggests that cost accounting is also called management accounting, is the central tool for internal management decisions, yet is based on data obtained from financial accounting and the UN DSD acknowledges that financial accounting is mainly designed for meeting the needs of external rather than internal stakeholders. In contrast, Ansari et al. (1997 p. 19) suggest that environmental costs should be measured from the perspective of quality management – based on prevention, appraisal, internal and external failure categories. No recognition is given to the possible impact of financial accounting, through external cost accounting rules (or standards), on the resulting figures. Finally, Schaltegger and Burritt (2000 pp. 107/109) suggest that ECA should be a core component of EMA, while recognising that financial accounting practice, through the imposition of arbitrary rules in cost accounting, can adversely influence management accounting information.

In summary, there is progress in understanding the links between EMA, management accounting and financial accounting. However, links between ECA and EMA remain confusing and open to further clarification through research into the internal/external classification of EMA information use.

7. Performance management

Performance measurement and appraisal systems are described by Gray and Bebbington (2001 p. 59) as the point at which, if the organisation is serious about environmental impact environment, flow into all procedures and policies of a business:

Most critically environmental issues must become a core factor in the design and operation of the financial system and the system of performance appraisal, incentives and rewards.

Gray and Bebbington (2001 p. 59) observe that there has been a great deal of empty rhetoric in this area.

Performance appraisal that does not include environment-related impacts of individuals and organisational units (profit centres or cost objects) is unlikely to produce the behaviour desired by a committed top management. This area clearly deserves further research work. Use of environmental indicators in performance appraisal systems remains at an early stage of development.

8. Should business try to assess externalities?

A gap continues to exist between the theory of full cost accounting (e.g. Bebbington et al., 2001) and the practice whereby business does not commit to identifying externalities.

Slow adoption of full cost accounting for externalities is linked to the competitive process. For example, Ontario Hydro, an energy provider, was cited as an exemplar of an organisation that identified and accounted for externalities in its planning and investment decisions (Boone and Howes, 1996, Epstein, 1996, Mathews and Lockhart, 2001). These full costs were seen as the cost of doing business, but corporatisation and competition mean that consideration of externalities becomes a luxury.

A number of ways of encouraging business to include externalities in their decision-making have been suggested (Bebbington et al., 2001 p. 16, Gray, 2001 pp. 12-14), but lack of adoption in a competitive situation means that non-voluntary approaches are likely to be needed.

One question raised is whether EMA is a voluntary management tool designed to help managers, or a tool of social policy where government imposes its sway. In the USA cost accounting standards, specific measurement rules, were introduced to stop adverse payouts to companies that used accounting fiction when claiming money for government contracts – yet management accounting was still portrayed as a voluntary initiative. Involvement of various groups in the promotion of EMA could be because of the desire for externalities to be internalised when they otherwise would not, hence, if voluntary suasion does not work, full cost accounting rules of engagement for corporations are likely to be introduced as part of the fluid regulatory mix and enforcement pyramid. Interplay between the various stakeholders in the drive for socially desirable outcomes from corporate existence is another challenge for EMA. The debate between those who feel corporations should operate free of government intervention once market rules have been established (e.g. the establishment of tradable property rights), and those who recognise the environmental damage already perpetrated on society by this system will continue.

Tier 4 'societal' costs appear to be assessed by only a very small number of organisations. The lack of voluntary interest in externalities costing (Tier 4 societal costs) by business has received renewed academic attention and a call for action and further government initiatives (Mathews and Lockhart, 2001, Bebbington et al., 2001). The argument put forward is that the internalisation of externalities and its reflection in environmental accounts is too important to be left to managers. Their focus is on what EMA information is of use only to themselves – increased productivity, profitability and continuing legitimacy of the business (Ditz et al., 1995 p. 21).

9. Costing

Academics have long considered the problems of cost allocation. Direct costs are traced to cost objects, whereas indirect costs have to be allocated. Thomas (1974) terms allocations 'incorrigible', that is to say, no theoretical justification can be provided for dividing the common cost of a single input to two outputs. For example, linking the cost of electricity for powering the production of joint products with individual units of output can only be based on an arbitrary rule of thumb. Zimmerman (1979), in contrast, suggests that cost allocations can usefully serve as a proxy for such costs, and that cost allocation helps make managers aware that such costs exist when they might otherwise be ignored in decision-making. Burritt (1997) argues for the use of cost allocation to make managers aware of indirect environmental costs, with the intention that such costs will be better managed as a result of the allocation.

The US General Accounting Office (1992) recognised the problem that conventional management accounting systems did not allocate indirect environmental costs to specific production processes, instead including them as part of general overhead to be absorbed by all production.

When environmental costs are large and such costs are allocated through a general absorption rate to all production processes, the result can be under-costing (and cross-subsidization) of relatively dirty production processes (Hamner and Stinson, 1995). Allocation, or preferably direct tracing through improved measurement, of environmental costs to processes, rather than hiding them in general overhead charges is one way of encouraging cleaner production. Kreuze and Newell (1994 p. 38) applied similar thinking to the encouragement of 'cleaner' products. Revised cost allocation procedures are seen as one way to promote clean products and reduce the sale of dirty products. Kreutze and Newell (1994) illustrate their argument using activitybased costing and life cycle costing.

Although separation of a common indirect cost (e.g. depreciation of integrated production technology) into environmental and commercial elements will always be arbitrary it is becoming the norm that where environmental costs form a significant part of total operating costs an attempt should be made to separate them from general overheads and trace or allocate them to products (US EPA, 1995). Activity-based costing is often suggested as a way of avoiding arbitrary cost allocations, but, in practice, because costs directly traced to activities are then linked with units of product, allocation remains a part of the costing process. The introduction of Integrated Product Policy is likely to exacerbate this tendency as a larger number of costs from upstream are linked to final output.

5 COMMENT

To achieve broad dissemination to a wide range of organizations EMA systems need to be relevant to the issues at hand, available at low cost, provide simple integration with existing management accounting systems, or environmental management systems and be reliable. Some challenges with EMA can be linked directly back to problems of conventional management accounting, for example the pervasive nature of cost allocation in a situation of joint products, over-costing of certain products, etc. Other challenges are added through the incremental adaptation of conventional EMA for environmental issues, for example, the issue of how environmental costs should be defined. Progress in addressing these challenges continues.

NOTES

1 http://www.emawebsite.org/about_emaric.htm.
2 Available at the Department of Environment and Heritage web site http://www.deh.gov.au/industry/finance/publications/project.html.
3 Available by contacting the United Nations Expert Working Group through http://www.un.org/esa/sustdev/sdissues/technology/estema1.htm.
4 The ecological footprint of a business represents the impact or "load" imposed by the business on the Earth measured in terms of bio-productive area (Chambers and Lewis, 2001, Wackernagel and Rees, 1996). Footprints are useful because they: provide a single measure of environmental performance; represent a bottom-up indicator of sustainability; and can be linked with other performance measures, such as eco-efficiency. However, as with all indicators of environmental performance: poor data quality is a problem; boundaries to life cycle analysis are arbitrary; the focus is on resource consumption rather than pollution.
Disaggregate information may be more useful (e.g. when assessing a renewable energy proposal).
5 Recall that an ecological rucksack is the material input used to obtain a product (service) minus the weight of the product itself. The material input is defined as the life cycle wide total quantity (in kg) of natural material moved (physically displaced) by humans in order to generate a product or service (EEA, 1999). The rucksack identifies hidden material movement. For example, in order to make one ton of aluminium it takes about 4.8 tons of bauxite. In order to extract one ton of bauxite, however, some 0.6 tons of topsoil must typically be removed. So far, this makes for a "rucksack" of (4.8 x 1.6) -1 = 6.8 tons of moved material per ton of aluminium. To make the aluminium, however, various other materials are also required as auxiliary inputs. The total "rucksack", counting these materials but not the materials moved to provide energy for the processes, has been estimated by Wuppertal Institute researchers at some 8.6 tons per ton of aluminium. The rucksack must be identified prior to any costing process or competitive advantage.
6 http://sasems.port.se
7 http://www.epa.vic.gov.au/eco-footprint/paint_factory.asp
8 http://www.sylvatica.com/ptlaser.htm
9 http://www.earthshift.com/tcace.htm

REFERENCES

Adams, C.A. (2000), Ethical Reporting Past and Future, *Management Accounting*, February: 48-51.

Adams, R. (2002), *Management accounting and the environment Student Accountant*, ACCA, 4 April (at http://www.accaglobal.com/publications/studentaccountant/405369).

Ansari, S., Bell, J., Klammer, T. and Lawrence, C. (1997), *Management Accounting. A Strategic Focus: Measuring and Managing Environmental Costs*. Columbus (OH): McGraw-Hill.

Barrett, J. and Scott, A. (2001), The Ecological Footprint: A Metric for Corporate Sustainability. *Corporate Environmental Strategy* 8 (4): 316-325.

Bartolomeo, M., Bennett, M., Bouma, J.J., Heydkamp, P., James, P. and Wolters, T. (2000), Environmental Management in Europe: Current Practice and Further Potential, *The European Accounting Review*, 9 (1): 31-52.

Bebbington, J. (2001), *An overview of accounting for environmental externalities*, Advances in Environmental Accounting. Proceedings of the ACCA/Environment Agency Seminar, May. London: Certified Accountants Educational Trust.

Bebbington, J., Gray, R., Hibbitt, C. and Kirk, E. (2001), *Full Cost Accounting: An Agenda for Action*. London: Certified Accountants Educational Trust.

Bennett, M., Bouma, J.J. and Wolters, T. (eds.) (2002a), *Environmental Management Accounting: Informational and Institutional Developments*. Dordrecht/Boston/London: Kluwer Academic Publishers.

Bennett, M., Bouma, J.J. and Wolters, T. (2002b), The Development of Environmental Management Accounting: General Introduction and Critical Review. In: Bennett, M., Bouma, J.J. and Wolters, T. (eds.) *Environmental Management Accounting: Informational and Institutional Developments*. Dordrecht/Boston/London: Kluwer Academic Publishers, pp. 1-18.

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

Bennett, M. and James, P. (1998), Environment Related Management Accounting: Current Practice and Future Trends. In: Bennett, M. and James, P. (eds.) *The Green Bottom Line: Current Practice and Future Trends in Environmental Management Accountin*g. Sheffield: Greenleaf Publishing, pp. 30-60.

Bennett, M. and James, P. (eds.) (1998b), *The Green Bottom Line: Current Practice and Future Trends in Environmental Management Accounting*. Sheffield: Greenleaf Publishing.

Bennett, M. and James, P. (1998c), *Environment Under the Spotlight – Current Practice and Future Trends in Environment-Related Performance Measurement for Business*, Research Report 55, London: Association of Chartered Certified Accountants.

Bennett, M. and James, P. (1998d), The Cost of Waste at Zeneca. In: Bennett, M. and James, P. (eds.) *The Green Bottom Line: Current Practice and Future Trends in Environmental Management Accounting*. Sheffield: Greenleaf Publishing, pp. 362-373.

Bennett, M. and James, P. (1998e), Life-cycle costing and Packaging at Xerox Ltd. In: Bennett, M. and James, P. (eds.) *The Green Bottom Line: Current Practice and Future Trends in Environmental Management Accountin*g. Sheffield: Greenleaf Publishing.

Bennett, M., Rikhardsson, P.M and Schaltegger, S. (eds.) (2003), *Environmental Management Accounting – Purpose and Progress*. Dordrecht/Boston/London: Kluwer Academic Publishers.

Bouma, J.J. and van der Veen, M. (2002), Wanted: A Theory for Environmental Management Accounting. In Bennett, M., Bouma, J.J. and Wolters, T. (eds.) *Environmental Management Accounting: Informational and Institutional Developments*. Dordrecht/Boston/London: Kluwer Academic Publishers, pp. 279-290.

Bouma, J.J. and Wolters, T. (1998), *Management Accounting and Environmental Management: A Survey among 84 European Companies*, Zoetermeer: EIM and Erasmus University.

Boone, C. and Howes, H. (1996), Accounting for the Environment. *CMA Magazine*, June.

Burritt, R.L. (1997), Corporate Environmental Performance Indicators: Cost Allocation — Boon or Bane? *Greener Management International*, 17, (Spring): 89-100.

Burritt, R.L. and Cummings, L. (2002), Accounting for Biological Assets – The Experience of an Australian Conservation Company'. *Asian Review of Accounting* 10 (2): 17-42.

Burritt, R.L., Hahn, T. and Schaltegger, S. (2002), Towards a Comprehensive Framework for Environmental Management Accounting – Links Between Business Actors and EMA Tools, *Australian Accounting Review* 12 (2): 39-50.

Burritt, R.L., Schaltegger, S., Kokubu, K. and Wagner, M. (2003), Environmental Management Accounting for Staff Appraisal: Evidence from Australia, Germany and Japan. In: Bennett, M., Rikhardsson, P.M. and Schaltegger, S. (eds.) *Environmental Management Accounting – Purpose and Progress*. Dordrecht/Boston/London: Kluwer Academic Publishers, pp. 151-188.

Chambers, N. and Lewis, K. (2001), *Ecological Footprint Analysis: Towards a Sustainability Indicator for Business*. London: Certified Accountants Educational Trust.

Chambers, R. (1986), *Financial Management*. Sydney, Australia: The Law Book Company.

Deegan, C. (2002), Introduction. The Legitimising Effect of Social and Environmental Disclosures – a Theoretical Foundation. *Accounting, Auditing and Accountability Journal,* 15 (39): 282-311.

Ditz, D., Ranganathan, J. and Banks, R.D. (1995), *Green Ledgers: Case Studies in Corporate Environmental Accounting*. Washington, DC: World Resources Institute.

EC (2001) *Green Paper on Integrated Product Policy.* Brussels: Commission of the European Communities. COM(2001)68 final.

Eco-effizienz (2002), *Why material reporting?* Eco-effizienz Newsletter 05-02.

ECOMAC, (1996), *Synreport: Eco-Management Accounting as a Tool of Environmental Management (the Ecomac project)*, EIM Small Business Research and Consultancy, http://www.eim.nl/uk/nl/ecomac.html.

EEA (1999), *Making Sustainability Accountable: Eco-Efficiency, Resource Productivity and Innovation*. Topic report. European Environment Agency. No 11/1999.

Epstein, M.J. (1996), *Measuring Corporate Environmental performance. Best Practices for Costing and Managing and Effective Environmental Strategy*, Chicago: Irwin Professional Publishing.

Gago, S. (2002), Management Information for Ecologically-Oriented Decision-Making. A Case Study of the Introduction of Co-Generation in Eleven Spanish Companies, *Accounting Forum* 26 (2): 191-218.

GEMI (1994), *Finding Cost-Effective Pollution Prevention Initiatives: Incorporating Environmental Costs into Business decision making. A Primer.* Washington DC: Global Environmental Management Initiative.

Graff, R.G., Reiskin, E.D. White, A.L. and Bidwell, K. (1998), *Snapshots of Environmental Cost Accounting. A Report to: US EPA Environmental Accounting Project*, May. Boston: Tellus Institute.

Gray, R.H. (2001), *Environmental Accounting: Setting the Scene Advances in Environmental Accounting*, Proceedings of the ACCA/Environment Agency Seminar, May, pp. 9-16.

Gray, R. (2002), Of Messiness, Systems and Sustainability: Towards a more Social and Environmental Finance and Accounting, *British Accounting Review*, 34: 357-386.

Gray, R.H. and Bebbington, J. (2001), *Accounting for the Environment*, 2nd ed. London: Sage Publications.

Gray, R.H., Bebbington, J. and Wolters, D. (1993), *Accounting for the Environment*, London: Chapman Publishing.

Gray, R., Owen, D. and Adams, C. (1996), *Accounting and Accountability. Changes and Challenges in Corporate Social and Environmental Reporting*, London: Prentice-Hall.

Hamner, B. and Stinson, C.H. (1995), Managerial Accounting and Environmental Compliance Costs. *Journal of Cost Management*. (Summer): 4-10.

Hansen, D.R and Mowen, M.M. (2003), *Management Accounting*, 6th ed. Mason, OH: South-Western.

Haveman, M. and Foecke, T. (1998), Applying Environmental Accounting to Electroplating Operations. An in depth analysis. In: Bennett, M. and James. P. (eds.) *The Green Bottom Line: Current Practice and Future Trends in Environmental Management Accounting*. Sheffield: Greenleaf Publishing, pp. 212-236.

Horngren, C.T., Foster, G. and Datar, S.M. (1997), *Cost Accounting – A Managerial Emphasis*, 9th ed. New Jersey: Prentice Hall.

Horngren, C., Datar S.M. and Foster, G. (2003), *Cost Accounting: A Managerial Emphasis,* 11th ed., Upper Saddle River, NJ: Pearson Education.

Howes, J. (2002), *Environmental Cost Accounting. An Introduction and Practical Guide*. London: Chartered Institute of Management Accountants.

IFAC (1998), *Environmental Management in Organizations. The Role of Management Accounting,* Financial and Management Accounting Committee, International Federation of Accountants, Study #6, New York, March.

International Material Data System (IMDS) (2003), http://www.freund-dirks.de/imds/eng/startimds.html accessed on 28 November 2003.

Johnson, H. and Kaplan, R. (1987), *Relevance Lost: The Rise and Fall of Management Accounting*, Cambridge, MA: Harvard Business School Press.

Kaplan, R.S. (1984), The Evolution of Management accounting, *The Accounting Review*, LIX (3): 390-418.

Kaplan, R.S. and Norton, D.P. (1992), The Balanced Scorecard – Measures that Drive Performance, *Harvard Business Review* (January-February): 71-79.

Kaplan, R.S. and Norton, D.P. (1993), Putting the Balanced Scorecard to Work, *Harvard Business Review* (September-October): 134-147.

Kaplan, R.S. and Norton, D. (1996a), *The Balanced Scorecard,* Cambridge, MA: Harvard Business School Press.

Kaplan, R.S. and Norton, D.P. (1996b), *The Balanced Scorecard – Translating Strategy into Action*, Boston, MA: Harvard Business School Press.

Kokubu, K. and Nakajima, M. (2003), The Position of Material Flow Cost Accounting in Environmental Management Accounting, *Kaikei* 2 (164): 123-136, (in Japanese).

Kreuze, J.G. and Newell, G.E. (1994), ABC and Life Cycle Costing for Environmental Expenditures. *Management Accounting*, (February): 38-42.

Lee, B.-W., Jung, S.-E. and Chun, Y.-O. (2002), Environmental Accounting in Korea: Cases and Policy Recommendations. In: Bennett, M., Bouma, J.J. and Wolters, T. (eds.) *Environmental Manage-ment Accounting: Informational and Institutional Developments*. Dordrecht/Boston/London: Kluwer Academic Publishers, pp. 175-186.

Li, L. (2001), Encouraging Environmental Accounting: A Survey of Government Policies and Instruments. *Corporate Environmental Strategy* 8 (1): 55-64.

Lippmann, S. (2001), Supply Chain Environmental Management. *Environmental Quality Management* 11 (2): 11-14.

Mathews, M.R. (1997), Twenty-five Years of Social and Environmental Accounting Research: Is there a Silver Jubilee to Celebrate? *Accounting Auditing and Accountability Journal,* 10(4): 481-531.

Mathews, M.R. (2003), *A History of Social and Environmental Accounting Through the Research Literature*, paper presented at the Accounting and Finance Association of Australia and New Zealand Annual Conference, Brisbane, Australia, July.

Mathews, M.R. and Lockhart, J.A. (2001), *The Use of an Environmental Equity Account to Internalise Externalities*. RP0104. Birmingham, UK: Aston Business School Research Institute.

McDaniel, J.S. (2000), *The Lean and Green Supply Chain: A Practical Guide for Material Managers and Supply Chain Managers to Reduce Costs and Improve Environmental Performance*, EPA 742-R-00-001 US EPA Washington, DC.

METI (2002), *Environmental Management Accounting Tools Workbook*, Ministry of Economy, Trade and Industry, Japan.

Miakisz, J. (1992), *Developing a Composite Index for Measuring and Communicating Environmental Performance*. GEMI Conference Proceedings on Corporate Quality/ Environmental Management II, pp.189-193.

Osborn, D., Savage, D., Reyes, M.F. and Muradyan, T. (2002), *Images of Effectiveness, Equity and Efficiency in the Diffusion of Environmental Management Accounting*. Green Measures: Hawker, Australia: Green Measures, pp. 56.

Otley, D.T, (2001), Extending the Boundaries of Management Accounting Research: Developing Systems for Management Performance, *British Accounting Review* 33: 243-261.

Parker, L. (2000), *Environmental Costing. An Exploratory Examination,* Australian Society of Certified Practising Accountants, Melbourne, February.

Pierce, B. (2001), Management Accounting Without Accountants, *Accountancy Ireland* 33(3).

PwC (2002), End of Life Vehicle Directive, *PricewaterhouseCoopers*, September, 1-14.

Schaltegger, S. (1996), *Corporate Environmental Accounting*, London: John Wiley, with contribution by K. Müller and H. Hindrichsen.

Schaltegger, S. and Burritt, R.L. (2000), *Contemporary Environmental Accounting — Issues, Concepts and Practice*, Sheffield, UK: Greenleaf Publishing.

Schaltegger, S. and Muller, K. (1998), Calculating the True Profitability of Pollution Prevention. In: Bennett, M. and James, P. (eds.) *The Green Bottom Line: Current Practice and Future Trends in Environmental Management Accounting*. Sheffield: Greenleaf Publishing, pp. 86-100.

Schaltegger, S., Hahn, T. and Burritt, R.L, (2002), EMA: Links to Management Systems and Stakeholders' Part II. In: *Environmental Management Accounting, Policies and Linkages*. New York: United Nations, pp. 87-274.

Shank, J.K. and Govindarajan, V. (1992), Strategic Cost Analysis of Technological Investments. *Sloan Management Review* (Fall): 39-51.

Solomons, D. (1965), *Divisional Performance. Measurement and Control*. Homewood, IL: Richard D. Irwin.

Stone, D. (1995), No Longer at the End of the Pipe, but still a Long Way from Sustainability: A Look at Management Accounting for the Environment and Sustainable Development in the United States. *Accounting Forum* 19 (2/3): 95-110.

Stroebel, S. and Redman, C. (2002), Flow Cost Accounting, an Accounting Approach Based on the Actual Flow of Materials. In: Bennett, M., Bouma, J.J. and Wolters, T. (eds.) *Environmental Management Accounting: Informational and Institutional Developments*. Dordrecht/ Boston/ London: Kluwer Academic Publishers, pp. 67-82.

Tellus Institute (2003), EMA for supply chain management details of a current project at http://www.tellus.org/b&s/EMA_sp.html, accessed 28 November 2003.

Thomas, A. (1974), *The Allocation Problem. Part II. Studies in Accounting Research*. Sarasota, FL: American Accounting Association.

UN DSD (2001), *Environmental Management Accounting. Procedures and Principles*. Department of Social and Economic Affairs. New York: United Nations Division for Sustainable Development.

UN DSD (2003), United Nations Division on Sustainable Development. Technology Initiatives at http://www.un.org/esa/sustdev/estema1.htm (accessed on 17 December 2002).

UN DSD (2002), *Proceedings of the United Nations Experts Working Group on Environmental Management Accounting* held in Bristol, UK 13-15 February 2002.

US EPA (1989), *Pollution Prevention Benefits Manual*, Washington DC: United States Environmental Protection Agency.

US EPA (1995), *An Introduction to Environmental Accounting as a Business Tool: Key Concepts and Terms*. Office of Pollution Prevention and Toxics. Washington DC: United States Environmental Protection Agency.

US EPA (1995b), *Incorporating Environmental Costs and Considerations into decision making: Review of Available Tools and Software*, September, Washington DC: United States Environmental Protection Agency.

US EPA (1995c), *Case Studies in Environmental Accounting: Green Accounting at AT&T.* Washington DC: United States Environmental Protection Agency.

US EPA (1996), *Valuing Potential Environmental Liabilities for Managerial decision making: A Review of Available Techniques*. Washington DC: US EPA, December.

US General Accounting Office (1992), *Waste Minimization: Major problems of Data Reliability and Validity Identified*. Washington DC: United States General Accounting Office.

VictoriaEPA (2002) EPA Victoria and eco-footprint (at http://www.epa.vic.gov.au/eco-footprint/default.asp).

Votta, T., Broe, R., Johnson, J.K. and White, A. (1998), Using Environmental Accounting to Green Chemical Supplier Contracts, *Pollution Prevention Review*, Spring, pp. 67-78.

Wackernagel, M. and Rees, W.E. (1996), *Our Ecological Footprint: Reducing Human Impact on the Earth*, New Society, Gabriola Island, BC, Canada.

Whaley, D. and Johnson, J.K. (2001), Optimising the Chemical Supply Chain: the Trend Towards Chemical management Services, EnviroNews: http://www.environews.com/Features/chemical_supply_chain.htm. Accessed 2. July. 2004 New England's Environment, 7 (3).

White, A.L, and Savage, D.E. (1995), Budgeting for Environmental Projects: A Survey, *Management Accounting*, October: 48-54.

Wilmshurst, T and Frost, G. (2001), The Role of Accounting and the Accountant in the Environmental Management System. *Business Strategy and the Environment* 10: 135-147.

Zimmerman, J.L. (1979), The Costs and Benefits of Cost Allocations *The Accounting Review*, (July): 504-521.

CHAPTER 3

CURRENT TRENDS IN ENVIRONMENTAL COST ACCOUNTING – AND ITS INTERACTION WITH ECO-EFFICIENCY PERFORMANCE MEASUREMENT AND INDICATORS

STEFAN SCHALTEGGER AND MARCUS WAGNER

Centre for Sustainability Management, University of Lueneburg, Germany

schaltegger@uni-lueneburg.de, mwagner@uni-lueneburg.de

Abstract. This paper provides an overview of current trends, state of the art and best-practice in environmental cost accounting as well as a discussion of how it complements environmental performance and eco-efficiency indicators. It addresses a number of current approaches to ECA. Amongst others, these will refer to the evolution of and experiences with ECA in companies, such as activity-based costing, process costing and target costing. The trend in cost accounting towards relating costs to material flows and related environmental impacts calls for indicators of integrated economic and environmental performance measurement, so-called eco-efficiency performance measurement.
The complementarity of ECA with environmental performance indicators (in particular eco-efficiency indicators) and environmental performance measurement also needs to take into account the integration of ECA and performance measurement into controlling and operations. Therefore, the paper will also discuss how ECA and environmental performance indicators can be integrated into decision-making. The paper will conclude with comments on the suitability of different ECA and performance measurement approaches for decision-making under different firm-level operating conditions.

1 INTRODUCTION

Environmental management activities at the firm level can cause costs, can help to avoid costs and can create benefits. Environmental management accounting (EMA)

P.M. Rikhardsson et al. (eds.), Implementing Environmental Management Accounting, 45-62

analyses precisely these aspects. Its sub-discipline of environmental cost accounting focuses on the cost side of these activities in terms of both costs created and costs avoided. However, it does not directly address the (monetarised or non-monetarised, i.e. physical) benefits from improved environmental performance. This aspect on measuring improvements in environmental performance (i.e. the physical benefits of environmental management activities, which can also be subsequently monetarised, e.g. based on an estimation or calculation of external costs related with specific aspects of environmental performance) is the focus of another newly emerging sub-discipline of EMA, that of environmental performance measurement (see e.g. Bennett and James, 1997).

By initially carrying out a comprehensive review of different approaches of ECA, this chapter intends to shed light on the way in which ECA addresses the benefits from environmental performance improvements. It will become clear from this review that ECA only does so in a relatively limited way, e.g. in addressing opportunity costs when accounting for the costs of material and energy flows. This review shows a clear trend in cost accounting towards relating costs to material flows and related environmental impacts. This trend calls for indicators of integrated economic and environmental performance measurement, so-called eco-efficiency performance measurement. Thus, eco-efficiency indicators are a potentially valuable complement to ECA. The remainder of the text will therefore focus on introducing such indicators and discussing if they, together with ECA, can relate to decision-making. The chapter concludes with an analysis of the suitability of the different approaches under different framework conditions.

In terms of the approaches covered, the focus of this paper is on approaches to ECA and environmental performance measurement in German-speaking countries (i.e. Austria, Switzerland and Germany). Where appropriate, reference is also made to approaches in other countries, especially the United States and to approaches pursued or proposed by international bodies.

2 OVERVIEW OF CURRENT METHODS OF ENVIRONMENTAL COST ACCOUNTING

Environmental cost accounting is described by IFAC as part of the core of environmental management accounting (IFAC, 1998, see also Hummel and Männel, 1993). Current methods of ECA can be distinguished according to the definition used for environmental costs and the cost accounting method pursued. Table 1 below provides an overview of current methods of ECA.

A particular cost analysis can vary depending on the definition of the subject matter, as different costs are required for different purposes (Clark, 1923). Environmental costs can either be viewed as costs of environmental protection or as costs related to material and energy flows that could be reduced through an increased level of environmental protection. From a conventional perspective environmental costs are defined as costs of environmental protection activities and end-of-pipe, environmental technologies with the result that any kind of environmental measures by definition cause costs and do not create any economic benefit. However, this is in fact not the case. Advanced environmental management activities reduce costs of material and energy use.

In contrast to the conventional perspective, environmental costs can be defined as the sum of all costs that are directly and indirectly related to material and energy use and their resulting environmental impacts. These environmentally-induced costs include all occurring costs, including fees, fines, material purchase, administrative costs caused by environmental regulations and (contingent) liabilities as long as material and energy flows are not reduced (Fichter et al., 1997, Schaltegger and Burritt, 2000 p. 101). This change of perspective from calculating costs of environmental protection to calculating costs of material and energy flows creating environmental impacts has substantial consequences for cost accounting as is discussed in Section 3.4.

Opportunity costs of unrealised environmental protection occur if the Net Present Value of pollution prevention measures is positive. These opportunity costs are included in the latter view of costs related to material and energy flows which thus include the costs of unrealised pollution prevention. Another line along which environmental costs can be distinguished is whether approaches consider past and present costs, or if they also include future costs. To date, five methods have been proposed to deal with environmental costs (see the first column of Table 1). Some of these methods have been designed to produce separate calculations, not integrated into established company management-accounting systems. Other methods proposed are designed to form an integral part of management-accounting systems and include full cost accounting, direct costing, process costing, and target costing. Only very recently have process and target costing-based approaches been used in practice in a few companies (Herbst, 2001, Seidel and Herbst, 2001).

***Table 1**. Overview of current environmental costing methods (based on Fichter et al., 1997)*

	Costs of environmental protection		*Costs of material and energy flows*	
	Past/present costs	*Future costs*	*Past/present costs*	*Future costs*
Stand alone calculations	Emission reduction costs (VDI 1979, UstatG 1974)	Environmental budgeting (Wagner and Janzen 1991)		
Full cost accounting	Full costs of environmental reduction (Fleischmann and Paudke 1977, Stölzle 1990, Haasis 1992, Wicke 1992, CICA 1997)	Consideration of the costs of environmental risks (Neumann-Szyszka 1994, Harding 1998)	Costs of remaining material (Fischer and Blasius 1995, BMU and UBA 1996)	
Direct costing	Environmentally-oriented direct costing (Roth 1992, Kloock 1990, 1993, 1995) Multi-stage direct costing (Schreiner 1988)	Costing of future environmental costs (Freese and Kloock 1989, Roth 1992, Kloock 1993, 1995)		
Process costing	Activity-based costing (Ditz et al. 1995, Heller and Shields 1995) Environmentally-oriented process costing (Herbst 2001, Seidel and Herbst 2001, Letmathe 1998)	Activity-based budgeting (Borjesson 1997)	Material and energy flow-oriented costing (Fichter et al. 1997, Kunert 1995, Spengler et al. 1998, Fischer and Blasius 1995) Material flow oriented activity-based costing (Schaltegger et al. 1996a, Schaltegger and Müller 1998)	Material and energy flow oriented activity-based budgeting (Schaltegger and Burritt 2000)
Target costing		Environmentally-oriented target costing (Seidel and Herbst 2001, Herbst 2001)		

3 FROM SEPARATE ENVIRONMENTAL COSTING TO PROCESS COSTING-BASED APPROACHES

3.1 Separate recording of environmental costs

One of the advantages of calculating the costs of end-of-pipe devices separately is that it entails no change to the existing management accounting system (Fichter et al., 1997). For example, this costing approach is in line with requirements of the German federal law on protection against emissions (Bundesimmissionsschutzgesetz (BImSchG), see Scherer (1997) for details). It provides a direct comparison of the costs of various end-of-pipe technologies in different industries (which was one of the most important aims of and motivations for VDI, 1979). However, the approach also has its problems because it does not lend itself easily to taking into account integrated technologies (e.g. new, less waste creating production systems) or the costs incurred when environmental protection is neglected. In addition, the approach is reactive, as it only has a focus on additional costs caused by environmental regulations. Although costs of end-of-pipe devices can be allocated to cost centres and cost objects, environmental protection is not integrated into management accounting and no clear indication is provided about how to treat costs from integrated technologies and integrated environmental protection. The approach to separately record environmental costs is still developed further today, for example in Japan, where, the Japanese Environment Agency (JEA) has initiated a joint initiative by government, research institutes and industry to develop a "Guideline for Introducing an Environmental Accounting System EAS". The aim of the project is to calculate "efficiency ratios" for Japanese firms and industry sectors, based on monetary data and non-monetary information on environmental impacts. The information gathered in this project is to be used by firms internally to steer resource allocation and costs and also to form a basis for environmental policy making by government and environmental agencies (JEA, 2000). In the longer term, JEA aims to achieve a high level of standardisation in data collection in order to ensure comparability of results. In order to support this objective, JEA provides a free software (to date only in Japanese) to Japanese firms, which should assist them in recording environmental costs and should help the firms in reporting their environmental costs to JEA. Such data will subsequently be used as benchmarks and should therefore be published in aggregated form (JEA, 2000). Based on the general definition of environmental costs as costs intended to protect the environment, some authors propose that potential or future costs (second column to the left in Table 1) be assessed, too. Wagner and Janzen (1991) designed a separate costing system along these lines.

3.2 Full cost environmental management accounting

Full cost accounting is the conventional method of cost accounting that traces direct costs and allocates indirect costs to a product, product line, process, service, or activity (see e.g. White and Becker, 1992). IFAC (1998) views full cost accounting and ECA as the same – "…the identification, evaluation, and allocation of conventional costs, environmental costs, and social costs to processes, products, activities or budgets (pp. 23-25)." A key element of this definition is the recognition that to obtain full costs of an object, costs must be allocated to that object because they cannot be directly traced.

The term full cost pricing is also sometimes used as a synonym for full cost accounting, but there are differences between the two as the provision of full cost accounting information for decision-making does not require a company to adopt full cost pricing. Full cost accounting is merely a necessary means to the introduction of full cost pricing. Not everyone uses the term "full cost accounting" in the same way. Some applications only include the internal costs of a company, i.e. those costs that affect the company's financial bottom line (White and Becker, 1992), while others include the full range of costs throughout the life cycle of the product, from raw material extraction to product disposal. Some of these full costs do not show up directly or even indirectly in the company's "bottom line". The term "full cost accounting" can therefore be misleading and has to be used with caution as it may or may not be seen to include environmental externalities (external costs). Different cost accounting approaches have, of course, various strengths and weaknesses which are dealt with in depth elsewhere (see, e.g. Burritt and Luckett, 1982, Coenenberg, 1993, Freidank, 1991, Garrison and Noreen, 2000, Hansen and Mowen, 2000, Horngren and Foster, 2000, Kilger, 1992, Kosiol, 1979). Therefore, discussion of these approaches is kept rather brief (also see Fichter et al., 1997). One of the first approaches to full cost environmental management accounting was developed by Fleischmann and Paudtke (1977), but was limited, however, mainly to environmental investments. Their approach was expanded to environmental running costs by Stölzle (1990), Haasis (1992) and Wicke (1992). Because of the differentiated recording of environmental protection costs in both, cost centre accounting and cost type accounting (i.e. classification of costs by the nature of the resource on which they are incurred e.g. total cost of staff, of materials, etc.) in these approaches, it was possible to integrate them succesfully into the existing management accounting systems of firms.

Integration of future costs of environmental protection using full cost accounting has been discussed by Neumann-Szyska (1994). In principle, the assessment of future costs, especially when related to environmental issues, is very important indeed. Neumann-Szyszka's approach (1994) deals with the identification of the costs of environmentally-related risks based on full cost accounting. Beyond the direct environmental costs, costs for environmental liabilities are included in her approach. This extension is based on the observation that a considerable proportion of environmental costs do not result from environmental protection activities, but from e.g. legal bases for claims resulting from environmental liability laws.

Traditionally, full cost accounting is the dominant approach of cost accounting in general, for example, in Australia direct costing is not permitted for financial accounting purposes, thereby putting pressure on management accountants to ignore the approach. The advantages of applying full cost accounting to environmentally-induced costs includes the possibility of allocating these costs on the basis of the activities that cause the costs – they're cost drivers. Central to cost allocation is the management process of establishing what the cost objects and cost centres are in an organization and who is responsible (accountable) for them. As a result, environmental protection is seen as part of daily business, a spur the search for potential savings, a market opportunity.

Among the flaws of the full cost accounting approach are the fact that environmental protection is generally regarded as a cost to business rather than an opportunity and the emphasis is mostly on end-of-pipe devices. Information on the pollution abatement costs of specific production processes and products is often not seen as being useful because end-of-pipe technologies largely cause fixed costs independent of the level of production so that the costs of end-of-pipe technology per product unit strongly fluctuate depending on capacity utilization. Allocation of fixed costs to units of product may be an inappropriate procedure in management accounting in some instances. For example, when environmental costs are treated as general overhead costs to be allocated, this will reduce the transparency of environmental costs so necessary for environmental cost management. It will also result in distorted costs for decision-making if no specific mechanism for the linking of environmental costs to products is defined. Viewing environmental protection as a cost-adding factor may, moreover, lead to a negative attitude towards pollution prevention. Furthermore, the opportunity costs incurred through the neglect of corporate environmental protection are not taken into account either. Hence, on grounds of faulty decision-making and poor accountability, full cost accounting can be criticized if it does not try to identify costs that are specifically related to cost objects.

3.3 Environmental direct costing

The main advantage of environmental direct costing is the emphasis placed on the possibility of tracing environmental costs to products based on economically plausible causal relationships (Burritt and Luckett, 1982). Moreover, direct costing allows fixed and variable costs to be considered separately and, therefore, for a distinction to be made between information relevant to the short and the long term. Schreiner's (1988) multistage direct costing proposal suggests identification of environmental cost centres which can be used to pinpoint the localization of potential savings from environmental protection. Schreiner also raises the issue that the costs of material and energy flows will have to be considered, too. Schreiner (1988) analyses the effects of environmental protection activities on the profitability targets of a company and tries to reveal synergistic relationships between the firms' financial and environmental targets. He points out that these synergistic relationships can only be exploited, if ECA is incorporated into the existing management accounting system of the firm. In order to achieve this, Schreiner develops a system running from cost type accounting via cost centre accounting through to cost object accounting, which also incorporates the internalisation of external effects.

The practical problem with the direct costing approach is the necessity to separate environmental from other costs, and the fact that no authors have provided clear criteria to help managers with this process. It thus remains unclear, for example, how the costs of integrated technologies should be tracked and traced. Apart from Schreiner's approach, the other methods proposed for considering past and present costs of environmental protection do not take costs of neglected pollution prevention into account and are therefore only of limited practical relevance.

Conventional management accounting has also been criticized for being far too oriented towards past instead of towards present and (most importantly) future activities (see e.g. Johnson and Kaplan, 1987a, 1987b) since an important use of management accounting information is to assist planning for the future. Extending direct costing-based approaches to include future costs of environmental protection would therefore be desirable. However, none of the approaches incorporating future costs (Freese and Kloock, 1989, Kloock, 1993, 1995, Roth, 1992) have, as yet, been implemented. Apart from the pros and cons mentioned above, any consideration of future costs faces quite substantial problems when trying to estimate future costs. Estimation of the future costs of pollution prevention and environmental liabilities is particularly difficult as neither future technology nor future demands of stakeholder groups are known.

3.4 Process costing-based approaches to environmental cost accounting

Overall, the generally held view is that the conventional (full costing and direct costing-based) approaches to ECA are often too shortsighted, since their understanding of corporate environmental protection is that of a mere cost driver. In addition to this, they tend to promote additive environmental protection activities rather than integrated activities based on clean technology or cleaner production. Because of these caveats, the full or direct costing-based approaches discussed so far are only of limited use for eco-control.

Environmental cost accounting therefore needs to be extended in two directions. Firstly, it is necessary to include process stages upstream and downstream of the actual production process (which was so far the focus of ECA) into the analysis. Secondly, it is necessary to incorporate those environmental costs, which arise during the use and disposal phases of the product. Extending ECA into such a life-cycle perspective puts the focus of analysis mainly on consumer benefits and competitiveness.

Therefore the logical next steps in the development of ECA would be the development of new methods based on activity-based costing and process costing as well as the development of approaches for environmental target costing.

One of the main advantages of using activity-based costing or process costing to assess environmental costs – apart from the advantages which have been mentioned concerning environmental full cost accounting – is the integration of ECA into the strategic management process and its linking to management objectives and activities. In general, an accounting system, such as activity-based costing or process costing, that encourages managers to try and trace environmental costs to products responsible for those costs is to be supported. Also, conventional approaches, such as direct costing, are less decision oriented than activity-based costing and process costing, because it concentrates on calculating the costs of specific business activities using volume as a cost driver, rather than the richer set of cost drivers used in activity-based costing. However, as the experience gained in American companies shows (Ditz et al., 1995), the introduction of activity-based costing (process-based costing) can be quite expensive for most companies. In addition, as with all other approaches discussed so far, future environmental costs are not taken into account in practical applications, despite this being possible.

Two of the more advanced and somewhat similar environmental process costing approaches are Letmathe (1998) and Seidel and Herbst (2001). The approach developed by Letmathe (1998) is introduced briefly at this stage. It goes beyond full cost or direct cost-based approaches in that it records systematically the environmental impacts and that it tries to influence (and reduce) these impacts through the use of transfer prices and volume management. Letmathe distinguishes direct impacts from indirect impacts. Direct environmental impacts originate from production and products directly whereas indirect impacts originate from upstream (supply chain) or downstream processing (further production, consumption, disposal, etc.) of the products. All direct and indirect environmental impacts are recorded on the basis of material and energy flow balances in physical units (usually kilograms). In a next step the transfer prices for a specific environmental impact category (such as the contribution to the greenhouse effect, etc.) are calculated as the sum of all costs related to the impact category including the direct costs, treatment costs, costs of logistics, costs for inducing change in the behaviour of stakeholder groups, ecological (external) costs and cost surcharges for control activities. The transfer prices are subsequently used in modified form for cost type accounting, cost centre accounting and cost object accounting in order to achieve an allocation which is fair according to the inputs involved. In order to record the environmental impacts, Letmathe proposes to carry out physical volume accounting in order to enable a differentiated analysis of deviations in consumption of different inputs. His approach is decision-oriented from the viewpoint of an ecologically-oriented control or eco-control in that it not only analyses the costs of environmental protection, but also incorporates the opportunities and benefits of environmental protection activities into the analysis. However, it still fails to incorporate the costs of product or process-integrated environmental protection activities (e.g. based on clean technology, cleaner production or design for environment) into the analysis due to the difficulties in definition attached to the costs of such activities (i.e. which part of the costs of process-integrated environmental protection activities is to be regarded as environmental costs and which part as "normal" production costs). One possibility to mitigate this weakness is by expanding the definition of environmental costs to incorporate all costs of material and energy flows which have an impact on the environment.

The clear trend in cost accounting towards accounting for the costs of material and energy flows causing environmental problems requires a tight link between material flow information and cost information. However, one aspect not fully addressed by ECA is that of benefits of environmental management activities in terms of improved environmental performance of firms. This is where the newly developing field of environmental performance measurement and environmental performance indicators (EPIs) and eco-efficiency indicators plays in and relates to the current trends in ECA. This new field is therefore described in the following, and it is discussed how it can possibly complement ECA for improved eco-efficiency performance measurement.

4 ENVIRONMENTAL PERFORMANCE MEASUREMENT AND ECO-EFFICIENCY INDICATORS

4.1 Environmental performance indicators and environmental performance measurement

In general terms, environmental performance has been defined as the "results of an organization's management of its environmental aspects" (ISO, 1999). An environmental performance indicator (EPI) has been defined as a "specific expression that provides information about an organization's environmental performance" (ISO, 1999). Parallel to this, environmental performance measurement has been defined as the measurement of the interaction between business and the environment (Bennett, 1997). We feel that all three definitions provided are fairly vague, partly due to the consensus-oriented definition process (in the case of ISO), partly due to the broad field to be defined (in the case of environmental performance measurement). Therefore the following definition of environmental performance is proposed:

> Environmental performance is the change of a firm's environmental impact over time.

Here, environmental performance can be understood as an absolute descriptive (e.g. absolute emissions), a relative descriptive (e.g. emissions relative to turnover or physical production output) or as a normative (e.g. an environmental improvement target of a company for a specified period of time), which could refer to an absolute or a relative descriptive, i.e. there are four possible combinations.

Several stakeholder interests have driven the development of environmental performance measurement (Schaltegger and Burritt, 2000). Another set of driving forces for environmental performance results from its final objectives. In this respect the question is whether environmental performance measurement should be business-linked or solely oriented towards environmental improvement, and related to that, if it should be oriented towards sustainability or towards more short-term, incremental improvements. This aspect in turn points to the question if environmental performance measurement should take a life-cycle approach or a more practical management-oriented one. Next to these questions, there is the issue if environmental performance measurement should be more externally focused or internally oriented, i.e. whether it needs to be more geared towards external or towards internal stakeholders of the company. Finally the relationship of environmental performance measurement and environmental accounting needs to be clarified (Gijtenberg et al., 1996).

4.2 Eco-efficiency indicators

The concept of eco-efficiency was initially developed as "ecological-economic efficiency" by Schaltegger and Sturm (1994). Based on this Schaltegger and Burritt (2000) developed a more general framework of EPIs. They state that, in order to measure corporate eco-efficiency, the set of economic and ecological information available has to be transformed into eco-efficiency information. By this is understood that economic numbers (measured in monetary terms) and environmental figures (measured in ecological terms) as indicators of efficiency have to be integrated. The integration of economic (numerator) with ecological (denominator) performance indicators provides a combined measure, a ratio for measuring economic-ecological efficiency (eco-efficiency), thereby allowing environmental issues to be incorporated with economic factors in decision-making and accountability processes (an eco-efficiency indicator defined in this way basically has the reciprocal value of an EPI based on the ISO 14031 or GRI guidelines). Depending on the aggregation level of the economic and environmental indicators used, the measure for eco-efficiency performance will vary in its level of specificity – aggregate information will tend to reflect greater generality. This in turn means that also the cost and material information needed from accounting to calculate the indicators has to match these requirements of generality (or specification). General indicators show the overall performance of a company, while specific indicators provide detailed process, product and site information about operations. The first row in Figure 1 shows economic performance figures for different levels of aggregation, whereas the last row provides examples of environmental figures for the different levels of aggregation (from general to specific). Possible links for deriving eco-efficiency indicators are indicated in Figure 1 by the arrows in the middle row. Mathematically, an unlimited number of combinations of economic and environmental figures are possible, reflecting the fact that eco-efficiency is a multidimensional concept which has to be related to each specific context analysed. However, as indicated by the width of the arrows in Figure 1, combination of figures at the same or similar aggregation levels will usually make most sense in practice (wider arrows show higher plausibility that combinations will produce useful indicators).

The most general, aggregate eco-efficiency indicator (see link 1 in Figure 1) is the ratio of short run income to environmental impact added for a specific accounting period, or the ratio of shareholder value to net present environmental impact added as a long-term indicator. As the net present environmental impact added (NPEIA) is closely linked with the net present value and residual income as a measure of shareholder value, it can be used as the equivalent environmental figure for defining long-term eco-efficiency indicators. The net present environmental impact added (NPEIA) is the discounted aggregate future environmental impact added representing a long-term indicator accounting for future environmental impacts.

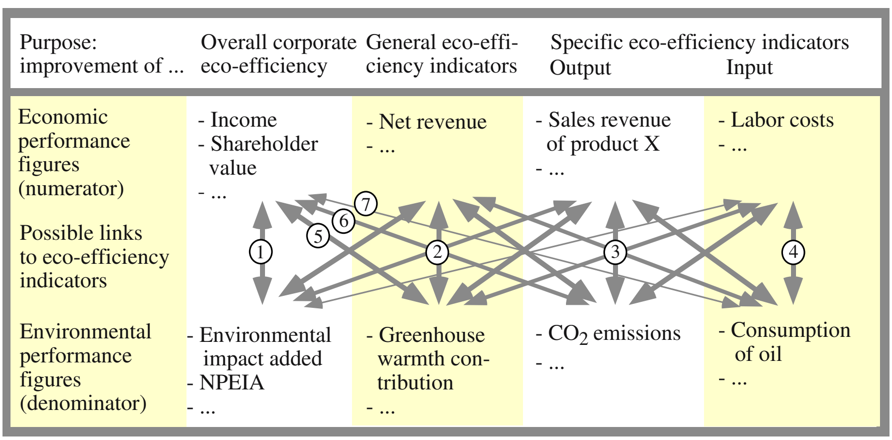


Figure 1. *Systematic collection of eco-efficiency information (examples of absolute figures, NPEIA = net present environmental impact added), Source: Schaltegger and Burritt (2000 p. 362)*

Other fairly general indicators (see link 2 in Figure 1) combine economic performance figures, such as net revenue and free cash flow, with environmental performance figures, such as the contribution to greenhouse warming, ozone depletion potential, and the contribution to photo-chemical smog. Free cash flow, and a product's net revenue, can be directly influenced by the financial consequences of specific environmental problems that affect a specific cost object.

Examples of specific eco-efficiency indicators include indicators based on material-flow outputs such as revenue per kilogram of CO_2 emitted (link 3), and input-related indicators (link 4) such as the labour costs incurred per litre oil consumed. Whereas for the more general indicators (e.g. links 1 and 2), it is relatively straightforward to understand them as a normative, providing a direction towards which the indicators should develop; this is less so for the more specific indicators (e.g. links 3 and 4), which should be understood as (relative) descriptives. The more specific indicators therefore are more likely to draw their significance from a larger (performance measurement) framework in which they are embedded.

To communicate with different levels of management and employees, it may nevertheless be valuable to use indicators combining different levels of aggregated economic and environmental figures. Given emerging knowledge about the links between financial consequences of environmental problems and different energy and material inputs, many stakeholders will become interested in such 'cross-level indicators'. Investors, for example, may want to calculate indicators such as the shareholder value per unit of contribution to the greenhouse effect (link 5), the shareholder value per unit of CO_2 emitted (link 6), or the shareholder value per kilogram of oil consumed (link 7). Such indicators may enable investors to assess the relative financial susceptibility of a firm to the possible internalisation of external greenhouse effect costs, or rising oil prices caused by an energy tax related to the greenhouse effect.

Of critical importance is that eco-efficiency indicators must be unambiguously defined in such a way that the economic and environmental dimensions measured are comparable and focused on the activities of concern to specific stakeholders (Table 2 below). For instance, for any shareholder communication that adopts a long-term view, a long-term economic indicator such as the shareholder value (SHV) must be related to a long-term indicator of environmental impact such as net present environmental impact added (NPEIA). For short-term analysis, a combination of return on equity with environmental impact added may be useful. Or if the impacts of a company on society as a whole are the object of attention, a necessary eco-efficiency measure would be value added (VA) per unit of environmental impact added (EIA).

By definition, internal and external stakeholders have different views and are interested in different indicators. Divisional management may, for example, need to focus on the economic and environmental impacts of strategic business units or sites. Middle and lower levels of management focus on product groups, product units, sites, and production steps. As indicators are used to guide management control and strategic planning activities, indicators must be defined with care and must take the specific circumstances of a company into account.

Table 2. *Examples of eco-efficiency indicators*

Stakeholder group	*Eco-efficiency indicators (examples)*	*Focus*
Shareholders	$\frac{\text{SHV}}{\text{NPEIA}}$	Assessment of financial investment
Government, Top management	$\frac{\text{VA}}{\text{EIA}}$	Assessment of impacts on society as a whole
Government, Top management	$\frac{\text{Corp. taxes}}{\text{EIA}}$	Assessment of impacts relevant for the government and the tax agency
Top management	$\frac{\text{Income}}{\text{EIA}}$	Assessment of annual performance
Site management	$\frac{\text{ROCE}}{\text{EIA}}$	Assessment of site
Project management	$\frac{\text{NPV}}{\text{NPEIA}}$	Assessment of capital investment project
Divisional management	$\frac{\text{CM}}{\text{EIA}}$	Assessment of product group
Product management	$\frac{\text{CM}}{\text{EIA}}$	Assessment of product
...	...	...

SHV = shareholder value, VA = value added, ROCE = return on capital employed, NPV = net present value, CM = contribution margin, Cor = Corporate, NPEIA = net present environmental impact added, EIA = environmental impact added

For most actors, economic, environmental, and eco-efficiency indicators only start to make sense if they are related to objects within their own sphere of control; i.e., objects they intend to influence, actually can influence, have an incentive to influence and for which they are rewarded for influencing. Thus, depending on the main interest of a stakeholder, an eco-efficiency indicator has to be related to standards for comparison that are controllable and relevant at the level of concern (e.g. the division, site, process, or activity). Possible denominators for comparison are dollars invested (for investors), product units (for product management), and machine hours (for engineers controlling a production process).

Furthermore, to support eco-integrated investment decision-making, project-related financial and environmental information is necessary. Examples of indicators for pollution prevention measures include net costs or revenues per kilogram of reduced throughput, costs of scrubbers per cubic meter of polluted air, and costs of sewage plant per cubic meter of sewage caused. Establishment of eco-efficiency indicators provides one major practical aspect of eco-control. A second aspect relates to the benchmarks, targets, or level of predictions that must be made if some comparison is to be made between expected and actual eco-efficiency. Suitable indicators can provide relevant time series (over time) and cross sectional (comparisons at a point in time) information about the current state of eco-efficiency and potential for its improvement. However, at present, the use of eco-efficiency indicators is limited for a number of reasons.

First, eco-efficiency indicators can only support decisions and improves accountability relationships if the figures they are based on are reliable (information quality) and if they are calculated the same way (consistency in the accounting approach). As no generally accepted standards of physical environmental accounting exist, application is mostly limited to internal comparisons between strategic business units, production sites, and other internal responsibility centres, as well as to internal comparisons made over time (i.e. intra-firm benchmarking and performance management).

Second, even if the data quality were perfect, eco-efficiency indicators would have to be used with some care. Indicators and figures can be imprecise, either too narrow or too broad for a particular decision and, therefore, can provide an inadequate representation of the situation. Hence, any definition of indicators must be compiled with great care. Furthermore, in most cases eco-efficiency figures cannot take all aspects of a decision into account and, as they are necessary but not sufficient information for decision-making and accountability purposes, they must be complemented by other quantitative and qualitative information and considerations.

5 SUMMARY AND CONCLUSIONS

For the last decade, corporate environmental accounting has gained increased importance in practice, of which cost accounting receives most attention. This paper gives an overview of the numerous approaches and trends in ECA. The increasing number of methods makes it difficult for managers to choose the appropriate method or combination of methods. At the same time, management often finds it difficult to adequately apply these tools. In addition to this, resource requirements are not always trivial.

This is why recently environmental performance indicators have received more attention, and it is discussed whether they could substitute environmental accounting (For an overview of different types of environmental performance indicators see Schaltegger et al., 2003 as well as Wehrmeyer and Wagner, 2001). However, this discussion neglects the fact that both concepts are complementary and rely on each other. Environmental accounting, and in particular ECA provides crucial data, which is required to successfully calculate and work with environmental indicators. Eco-efficiency indicators are in turn a logical further step of working with the economic and environmental indicators provided by modern cost accounting approaches which link cost information tightly with material and energy flow information. A consistent system of environmental indicators furthermore provides a focus for environmental accounting to successfully and efficiently compile the strategically necessary data. Environmental indicators, when based on a consistent environmental accounting framework, allow aggregation of and focus on data into meaningful information for managerial, decision-making processes. Therefore the debate about environmental accounting and environmental indicators should focus on the efficient and effective integration of both.

REFERENCES

Bennett, M. and James, P. (1997), *Environment-Related Performance Measurement: Current Practice and Trends*. Ashridge: Ashridge Management College.

BMU and UBA (1996), *Handbuch Umweltkostenrechnung*. Berlin: Federal Environmental Agency (available only in German).

Borjesson, S. (1997), A Case Study on Activity-Based Budgeting. *Journal of Cost Management* 10 (4): 7.

Burritt, R.L. and Luckett, P.F. (1982), Direct Costing-Is It Allocation Free? *Management International Review* 4: 34-44.

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

Clark, J.M. (1923), *The Incidence of Overhead Costs*. Melbourne/Australia: University of Chicago Press/Accountants Publishing Company Ltd.

Coenenberg, A. (1993), *Kostenrechnung und Kostenanalyse*. Landsberg am Lech: Moderne Industrie (available only in German).

Ditz, D., Ranganathan, J. and Banks, R. (1995), *Green Ledgers. Case Studies in Corporate Environmental Accounting*. Baltimore, World Resources Institute.

Fichter, K., Loew, T. and Seidel, E. (1997), *Betriebliche Umweltkostenrechnung*. Berlin: Springer.

Fischer, H. and Blasius, R. (1995), Umweltkostenrechnung. In: *BMU and UBA Handbuch Umweltcontrolling*. München: Vahlen, pp. 439-457 (available only in German).

Fleischmann, E. and Paudke, H. (1977), Rechnungswesen. Kosten des Umweltschutzes. In: Vogl, J., Heigl, A. and Schäfer, K. (eds.) *Handbuch des Umweltschutzes*. Landsberg am Lech.: Moderne Industrie Grundwerk Teil M/III (available only in German).

Freese, E. and Kloock, J. (1989), Internes Rechnungswesen und Organisation aus der Sicht des Umweltschutzes. *Betriebswirtschaftliche Forschung und Praxis* 41 (2): 1-29 (available only in German).

Freidank, C. (1991), *Kostenrechnung. Einführung in die begrifflichen, theoretischen, verfahrens-technischen sowie planungs- und kontrollorientierten Grundlagen des innerbetrieblichen Rechnungswesens* München: Campus (available only in German).

Garrison, R.H. and Noreen, E.W. (2000), *Managerial Accounting*. Boston, MA: Irwin McGraw-Hill.

Haasis, H. (1992), Umweltschutzkosten in der betrieblichen Vollkostenrechnung. *Wirtschaftsstudium* 3: 118-122 (available only in German).

Hansen, D.R. and Mowen, M.M. (2000), *Cost Management. Accounting and Control*. Cincinnati OH: South Western College Publishing.

Harding, R. (1998), *Environmental decision making, the Roles of Scientists, Engineers and the Public*. Sydney/Australia: The Federation Press

Heller, M., Shields, D. et al. (1995), Environmental Case Study: Amoco Yorktown Refinery. In: Ditz D., Ranganathan J. and Banks R. (eds.) *Green ledgers*. Baltimore: World Resources Institute, pp. 47-81.

Herbst, S. (2001), *Umweltorientiertes Kostenmanagement durch Target Costing und Prozesskosten-rechnung in der Automobilindustrie*. Lohmar (available only in German).

Horngren, C.T. and Foster, G. (2000), *Cost Accounting. A Managerial Emphasis*. New Jersey: Prentice Hall International Inc.

Hummel, S. and Männel, W. (1993), *Kostenrechnung – Moderne Verfahren und Systeme*. Wiesbaden: Gabler (available only in German).

IFAC (1998), Environmental Management in Organizations. The Role of Management Accounting New York: Financial and Management Accounting Committee of the International Federation of Accountants.

ISO (1999), *Environmental management – Environmental performance evaluation – Guidelines (ISO 14031:1999)*. Brussels: European Committee for Standardization/International Standards Organisation.

JEA (2000), *Developing an Environmental Accounting System. Year 2000 Report*. Tokyo/Japan: Environment Agency.

Johnson, H. and Kaplan, R. (1987a), *Relevance Lost: The Rise and Fall of Management Accounting*. Cambridge, MA: Harvard Business School Press.

Johnson, H. and Kaplan, R. (1987b), The Rise and Fall of Management Accounting. Management Accounting Information is Too Late, Too Aggregated, and Too Distorted to be Relevant. *Management Accounting* January: 22-29.

Kilger, W. (1992), *Einführung in die Kostenrechnung*. Wiesbaden, Gabler (available only in German).

Kloock, J. (1990), Umweltkostenrechnung. In: Scheer, E. (ed.) *Rechnungswesen und EDV*. Heidelberg 129-156 (available only in German).

Kloock, J. (1993), Neuere Entwicklungen betrieblicher Umweltkostenrechnungen. In: Wagner, G.R. (ed.) *Betriebswirtschaft und Umweltschutz*. Stuttgart: Vahlen, pp. 179-206 (available only in German).

Kloock, J. (1995), Umweltkostenrechnung. In: Junkernheinrich, M., Klemmer, P. and Wagner, G.R. (eds.) *Handbuch zur Umwelökonomie*. Berlin: Springer, pp. 295-301 (available only in German).

Kosiol, E. (1979), *Kosten- und Leistungsrechnung. Grundlagen, Verfahren und Anwendungen*. Berlin: Springer (available only in German).

Kunert (1995), *Modellprojekt Umweltkostenmanagement*. Immenstadt/Augsburg: Kunert AG/IMU (available only in German).

Letmathe, P. (1998), *Betriebliche Umweltkostenrechnung*. München: Vahlen (available only in German).

Neumann-Szyszka, J. (1994), *Kostenrechnung und umweltorientiertes Controlling. Möglichkeiten und Grenzen des Einsatzes eines traditionellen Controllinginstruments im umweltorientierten Controlling*. Wiesbaden: Deutscher Universitätsverlag (available only in German).

Roth, U. (1992), *Umweltkostenrechnung. Grundlagen und Konzeption aus betriebswirtschaftlicher Sicht*. Wiesbaden: Deutscher Universitätsverlag (available only in German).

Schaltegger S. and Burritt R. (2000), *Contemporary Environmental Accounting – Issues. Concepts and Practice*. Sheffield: Greenleaf.

Schaltegger, S., Burritt, R. and Petersen, H. (2003), *An Introduction to Corporate Environmental Management*. Sheffield: Greenleaf.

Schaltegger, S. and Müller, K. (1998), Calculating the True Profitability of Pollution Prevention. In: Bennett, M. and James, P. (eds.) *The Green Bottom Line*. Sheffield: Greenleaf, pp. 86-99.

Schaltegger, S., Müller, K. and Hindrichsen, H. (1996), *Corporate Environmental Accounting*. London: John Wiley & Sons.

Schaltegger, S. and Sturm, A. (1994), *Ökologieorientierte Entscheidungen in Unternehmen. Ökologisches Rechnungswesen statt Ökobilanzierung. Notwendigkeit, Kriterien, Konzepte*. Berne: Haupt (available only in German).

Scherer, J. (1997), Environmental Regulation in the Federal Republic of Germany. In: Handler, T. (ed.) *Regulating the European Environment* (2nd ed.) Chichester & New York: John Wiley, pp. 89-112.

Schreiner, M. (1988), *Umweltmanagement in 22 Lektionen. Ein ökonomischer Weg in eine ökologische Wirtschaft*. Wiesbaden: Gabler (available only in German).

Seidel, E. and Herbst, S. (2001), Neuere Entwicklungen zum kostenorientierten Umweltmanagement. In: Kramer, M. and Brauweiler, J. (eds.) *Umweltorientierte Unternehmensführung und ökologische Steuerreform*. Wiesbaden: Gabler (available only in German).

Spengler, T and Hähre, S. (1998), Stoffflußbasierte Umweltkostenrechnung zur Bewertung industrieller Kreislaufwirtschafskonzepte. *Zeitschrift für Betriebswirtschaft* 2: pp. 147-174 (available only in German).

Stölzle, W. (1990), Ansätze zur Erfassung von Umweltschutzkosten in der betriebswirtschaftlichen Kostenrechnung. *Zeitschrift für Umweltpolitik und Umweltrecht* 4: 379-412 (available only in German).

UstatG (1974), *Gesetz über Umweltstatistiken vom 15.08.1974*. Bonn: Bundesanzeiger (available only in German).

VDI (1979), *VDI-Richtlinie 3800. Kostenermittlung für Anlagen und Maßnahmen zur Emissionsminderung*. Düsseldorf: Verein Deutscher Ingenieure (available only in German).

Wagner, G.R. and Janzen, H. (1991), Ökologisches Controlling – Mehr als ein Schlagwort? *Controlling* 3 (3): 120-129 (available only in German).

Wehrmeyer, W. and Wagner, M. (2001), Environmental Performance indicators. In: Berkhout, F., Hertin, J., Tyteca, D., Carlens, J., Olsthoorn, X., van Druinen, M., van der Woerd, F., Azzone, G., Noci, G., Jasch, C., Wehrmeyer, W., Wagner, M., Gameson T., Wolf, O., Eames, M. (eds.) *Appendix II of MEPI – Measuring Environmental Performance of Industry, Final Report and Appendices* submitted to European Commission (DG XII), Brussels.

White, A. and Becker, B. (1992), Total Cost Assessment. Catalyzing Corporate Self Interest in Pollution Prevention. *New Solutions* (Winter): 34-38.

Wicke, L. (1992), *Betriebliche Umweltökonomie. Eine praxisorientierte Einführung*. München,: Vahlen (available only in German).

CHAPTER 4

ENVIRONMENTAL ACCOUNTING DIMENSIONS: PROS AND CONS OF TRAJECTORY CONVERGENCE AND INCREASED EFFICIENCY

PONTUS CERIN AND STAFFAN LAESTADIUS

Royal Institute of Technology (KTH)
Dept. of Industrial Economy and Management, Sweden

pontus.cerin@indek.kth.se, staffan.laestadius@indek.kth.se

Abstract. Three dimensions of physically based environmental accounting are indicated – regional, company and product accounting – these have developed along different paths. In the globalised and highly specialised economy of today, company activities and their services are multinational and are to a decreasing degree to be seen as a subset of regions. Consequently, these accounting practices intersect each other, on three dimensions, from micro to macro levels. Even though they are all based on physical and energy input/output (I/O) analysis the differences in terminology, structure and evaluation methods make it difficult to exchange data and use them efficiently. This paper explores several aspects of these three environmental accounting dimensions such as the control engineering tradition, the lack of adequate data and the resource consuming work as well as incompatibility, overlapping scopes and aims. The conclusion is that the three accounting dimensions are similar in construction in spite of a development in independent paths. The differences are not primarily the three-letter acronyms of the tools but the objectives and control scope used in studies. If adopting a common framework and a global all-dimensional nomenclature there are great potentials for increasing the work efficiency, making the tools towards sustainability more sustainable.

P.M. Rikhardsson et al. (eds.), Implementing Environmental Management Accounting, 63-80

1 INTRODUCTION

The early phase of an innovation process is characterised by several different streams – or development paths. Ideas flourish, providing the foundation for new technologies, methods, products, firms and institutions. As time goes by these new phenomena stabilise into what may be called a dominant design and the number of actors – and technical solutions – are dramatically reduced (cf. Utterback, 1996).

The innovation of environmental management accounting (EMA) seems not to be an exception to this general model although there may be differences in the details. Just a short glimpse into the rapidly growing amount of texts (books, papers published in journals or presented at international conferences) provides a good picture of the growth of varieties within the families of environmental systems, management and standards. Analysing them in more detail – although from a friendly critical point of view – you may get the impression that this flourishing of new environmental management systems and dimensions has developed along paths which are challenging in the short run for those of us who are concerned with long-term sustainability and eco-efficiency.

The aim of this paper is to capture the variety on the flourishing meadow of the accounting part of green management and analyse the problems and challenges facing these tools in which many academics and consultants – of which the authors of this paper are no exception – have vested interests. In this paper the authors argue that the innovative diversity which characterises the present fluid phase in environmental management – and which is propelled by an environmentally friendly business climate in general – has hitherto developed a set of complex and resource-consuming tools which threaten the long-term sustainability of environmental management. The authors also argue that the ambition to feed all these environmental management systems with data will not only demand large resources but may – due to their inert and centralised character – also create fundamental problems regarding industrial dynamics.

The paper handles the problematique identified above as follows. In section 2, three dimensions of environmental accounting practices, and accompanying management fields, are identified: regional, company and product. The practical use of the three dimensions is illustrated and analysed – i.e. the lack of data, the border areas of dimensions and their resource-consuming work – in section 3. A concluding discussion on the lacking compatibility between these systems follows in section 4, which also suggests why and how to integrate essential parts of the diverting dimensions.

2 THREE DIMENSIONS OF ENVIRONMENTAL ACCOUNTING AND MANAGEMENT

The development of environmental management and accounting – accompanied by a large family of systems, methods and standards – follows several different paths which differ significantly from the general direction of practices for management and accounting. Are we here witnessing the development of highly complex and incompatible systems? In the corporate world environmental management systems often seem to be detached from existing activities due to isomorphism where external pressure make organisations adopt these tools, letting integration with its own activities come second (DiMaggio and Powell, 1983). Cerin and Laestadius (2000, 2003) and Wagner et al. (2001) have found that in firms environmental accounting and management may not be well incorporated into the day-to-day work. This is consistent with what Burström and Lindqvist-Östblom (2001) have found regarding how municipalities deal with environmental issues and analyses. Cerin and Laestadius (2000, 2003) and Schaltegger and Burritt (2000) are concerned about the considerable resources these tools consume. In the long run these downsides utter threats against the sustainability of these tools, as well as against the environmental agenda, if improvements are not achieved. Let us now identify such areas in environmental accounting.

First of all one a regional dimension of environmental management may be identified, or rather a family of approaches, primarily focusing on intra- and inter-regional material flows. This school has obvious similarities with the regional input-output models which were popular among economists in the decades around 1950-60 although the economic models were concerned with economic data rather than physical entities/material flows. (see Leontief, 1936, Isard and Kuenne, 1953, Dorfman et al., 1958). In this EMA dimension the region is typically the unit of analysis and the aim is to measure the environmental conditions inside and outside the system and the exchange across the border. Here the authors see three major discourses: 1) judicial (municipal/country) accounting, 2) Hinterland accounting and 3) Metaland accounting.

Secondly the authors identify a company dimension in environmental management and accounting, i.e., where the company is the typical unit of analysis – or parts of it such as sites (plants) and/or subsidiaries depending on the corporate structure. In some analyses the services of these units may be superimposed. Major readings in the company environmental accounting field are Gray et al. (1993) and Schaltegger and Burritt (2000) that also adopt a more comprehensive decision-policy picture. Basically the aim of corporate environmental accounting is to provide some kind of measure on the environmental impact of corporate activities on various levels of aggregation. The authors see two major discourses here: 1) judicial (company) accounting and 2) value chain accounting.

Thirdly there is the product dimension in environmental accounting/management. The dominant management system in this area is life cycle assessment (LCA) and related methods that follow the impacts associated to the product during all, or chosen, life-cycle phases (value chain) included in the scope of the study. The typical unit is the function performed by the product or service.

These three dimensions, or families of tools, may be combined with different foci on how to capture the environmental impact, i.e. what data to collect and analyse. In fact both the material accounting focus and the economic accounting focus have shortcomings in estimating sustainability, in particular, but also eco-efficiency. None of these foci are well suited to analyse ecological phenomena such as biodiversity. In our taxonomy it seems that the material and substance flow I/O analysis (/accounting) focus is dominant in the regional (Material Flow Analysis – MFA[1]) and product (Life Cycle Inventory – LCI) approaches while economic data primarily are in focus in the company approach. The assessment of environmental impacts is also core to the product dimension, based upon the I/O LCI. There are thus elements of I/O accounting in all three dimensions.

Input-output analysis has often been associated with material (and energy) flows entering and exiting the system boundary (e.g. site, process, company or product) being studied (Jasch, 1999, cf. Rikhardsson, 1999). Within economics Input-Output Analysis (IOA) has for over a half a century been used for national (regional) accounting of sectors (see Leontief, 1936). In fact Leontief (1970) introduced environmental aspects to these accounts. Materials based input/output analyses have also been carried out for quite some time (see Berthouex and Rudd, 1977).

The taxonomy suggested here is, of course, not the only one possible. CHAINET (1998) made efforts to place analytical tools for environmental aspects into a socio-political framework. This is done in three product group case studies where it is determined what tools are needed for retrieving relevant environmental information in each case. Numerous authors (Tukker, 1999, Moberg, 1999, Burström and Frostell 2000) have carried out systematic categorisations of Environmental Analysis (EA) tools; each of them differently though. Tukker (1999) created a map over the relations between system definitions used in environmental evaluation tools. The top dichotomy is functional (LCA and functional SFA) and regional (regional SFA, hybrid LCA/SFA, MAF, EIA and RA) approaches; tools in both approaches are then divided into descending size order. Finnveden and Moberg (2001) are another example, categorising EA tools into five objectives, four focuses and two perspectives. To a high degree these studies serve as a disposition and enumeration of environmental evaluation methods and are not positioned to illuminate the possibilities for increased efficiency by finding potentials for streamlining their frameworks and nomenclatures. In Kleijn and van der Voet (2001) analytical tools that can be used in environmental decision-making are divided into specific environmental risks, analysis at the micro-level (products and services) and analysis at the macro-level (countries, cities, sectors of industry). In their corporate study Cerin and Ramírez (2000) emphasise that the system boundaries and environmental aspects of study may be as important as the methodology chosen. Sinclair et al. (2001) focus on LCA as a tool for integration (in waste management) of data collection and presentation. They divide the analytical tools into physical and non-physical metric ones. Schaltegger and Burritt (2000) in contrast promote environmental company site accounting, which is then aggregated to retrieve data for the life cycle of products (or firms). This concept is introduced by Schaltegger (1997a) as site specific LCA, but only presupposing aggregations of global impact on a global level (Schaltegger, 1997b). In Udo de Haes (2001) environmental information tools are divided into two groups that provide information on environmental consequences based on physical data and financial costs of environmental consequences. The design of various taxonomic frameworks and displacement of tools in their respective framework – as done in the papers mentioned in this paragraph – may very well be discussed in detail, but this is certainly a topic for further research and future articles.

3 THE BARRIERS TO INTRA AND INTER-ENVIRONMENTAL ACCOUNTING

Utterback (1996) divides the innovation process into an early phase (the fluid phase), characterised by many development paths (of methods, tools and data), followed by a maturing phase in which these new phenomena stabilise into what may be called a dominant design, and where the number of actors – and technical solutions – is dramatically reduced. Environmental accounting is still in a fluid phase. Before stabilising into a dominant design, this is the time – perhaps tardily – to point out the weaknesses, and indicate what may be changed. This is also the time to consider how far reaching and detailed our management and information systems should be. The extent of control to facilitate the development towards sustainability? And what kind of control?

It seems possible to identify a control culture and even control discourse more or less independent of our traditional understanding of political ideology (cf. Levin, 2000). The role of the visible hand and the role of control in long-term industrial development has for instance been analysed by Chandler (1977) and Beniger, (1986). Historically engineering culture and engineering management have to a large extent consisted of controlling industrial and technical processes in their detail. The vision of perfect technical rationality and optimal allocation of resources through the control of details may be illustrated by the Taylor system. The Taylorist vision, applied on the micro level of the industrial system – the plant – was to collect extremely detailed information on the labour process, to analyse it ”scientifically” and to organise, control and optimise the system in the most resource efficient way (cf. Laestadius, 1992). There is a strong intellectual heritage in engineering culture which favours centralised, control-oriented strategies to solve complex industrial problems. This appears in much engineering management literature (Meima and Welford, 1997, Emerson et al., 1997), in the discourse around the Taylorist methods (cf. Laestadius, 1992 for further references) and in the scarce research on the ideology of control (cf.

Levin, 2000). The mirror image of this was, of course, also the development of accounting systems.

There is a vast literature on the advantages and disadvantages of this heritage. Changing to probabilistic methods solved some of the problems. As regards accounting, the most well-known reaction against the self-propelled growth of accounting data collection was formulated by Johnson and Kaplan (1987).

Also Soviet planning, to depart from another angle, was based on the vision of collecting enormous amounts of data, controlling, analysing and optimising the system. The means for this macro-level planning was ambitious material balance matrices on inter and intra-sector material flows connected into an enormous input-output system (cf. Wilczynski, 1970). As is well known these models for control encompassed severe shortcomings in promoting flexibility, creativity and dynamics on the micro as well as on the macro level of industry.

It may be argued that there is a family resemblance between the mentioned models for control and several of today's approaches in environmental management. The material flow-based model on the industrial metabolism has similarities to the material balances of the Soviet planning system, for instance. It may even be argued that the focus on molecules in some of the resource models of today will make the analytical system still more complex (cf. Burström, 2000). As tools for understanding models like these may be useful; the fundamental problem is whether it is possible to manage complex systems like these .

3.1 The continuous lack of adequate data

One of the consequences of the control ambitions connected to the present growth of environmental management is a lack of adequate data. The conclusion and complaint regarding shortage of data is considerable in the literature related to all environmental accounting dimensions (cf. Cerin, 2000, Danius and Burström, 2001, Cerin and Laestadius, 2003, Ljungdahl, 1999). The issue is not only to face a question of whether to allocate more resources to data collection in general but of identification and selection of what kind of information to focus on. In this computerised world, where enormous amounts of data can be stored and handled, it is more important than ever to base our information gathering on a sound theory or at least good hypotheses as regards the data necessary to control the sustainability problem reasonably well.

Is it really necessary to gather data on everything at the policy level of municipalities and companies? What is the necessary and/or sufficient strategic information which can be transformed to knowledge on the important environmental parameters and which can direct general policy decisions? For municipalities Burström and Lindqvist-Östblom (2001) pointed out the need to identify the very basis for environmental information management before developing a monitoring system. So far, few municipalities seem to be aware of why they are collecting the information that they in fact do collect.

Quite a large proportion of environmental accounting work today is related to shovelling data back and forth. In the case of LCAs estimations also show that the handling of I/O data in the LCI stage represents a great part of the total time spent on a complete assessment (cf. Cerin and Laestadius, 2000, 2003, cf. Östermark et al., 2000). Within the regional environmental accounting dimension, assessments and classification of environmental impacts are rarely made, but like the other tools the data-handling phase is immense, consuming considerable resources. Moreover, when someone shovels the data back and forth without having a good picture (deficient transparency) of other works (sometimes in other trajectories), someone else may already have done the job (cf. Zobel et al., 2002), a problem that may also arise within large organisations (cf. Cerin and Laestadius, 2003).

3.2 The incompatibility of accounting dimensions

The regional approach, the company approach and the product approach only partly intersect as regards their goals, the target groups of their analytical work and consequently their need for data. As mentioned, company-based information may only be relevant for regional analysis as a matter of coincidence, a problem which is enforced by the fact that there may be significant material movements across regional borders without being captured by environmental control authorities. In fact this phenomenon increases as world trade is liberalised, which will probably continue along with the creation of continental trade blocks around the world, such as the EU. And it is not necessarily possible to break down product-based data – obtained in LCA activities – to the company or regional level.

As a result there is a great variations in the scope of the three identified accounting dimensions. On top of this there are also differences in time aspect. The time aspects, however, also vary within each dimension between the different tools, and a thorough analysis of the time problem certainly merits a research paper of its own. The same can also be said for modes of analysis such as impact assessment. Moreover, there are great differences within and between the accounting dimensions, regarding average versus marginal studies, objectives of studies and types of impacts considered. Some of the differences above can also be seen within individual tools. Another division within tools is applicable pro and retro perspectives, e.g. on LCAs and LCCs (cf. Finnveden and Moberg, 2001). A chosen perspective may have impacts on the delimitation in space and time of the object studied (cf. Tillman, 1999).

From a strong control point of view one immediate reaction to this incompatibility problem is to create elementary information systems. It is possible, in theory at least, to imagine databases, where material information is broken down to elementary units (cf. ISO, 2001) which are supposed to be useful for aggregation to all environmental management systems and all levels of analyses on all dimensions. To enable such exchange between the various accounting dimensions and multidimensional aggregation, the nomenclature and units of measurement for the I/O data must be the same. This is a task of key importance that still, today, is a problem in ordinary Management Control Systems (and probably will still be in the future). The lack of common economic nomenclature is an obstacle for implementing corporate-wide environmental accounting systems, especially after the merger of different corporate cultures. Immense costs arose, for example, following the merger of Astra and Zeneca when creating a common economic accounting system even though they had the very same enterprise resource planning system, SAP R/3[2]

3.3 The overlapping delimitations of the various accounting dimensions

Even though the environmental accounting tools in for instance industry and municipalities show family resemblance (based on I/O-analysis) and provide bases for chain analysis (Udo de Haes et al., 1998). These tools differ since they set out to answer different questions (cf. Burström, 1999, Finnveden and Moberg, 2001). There are, of course, areas in environmental accounting where different analytical tools are applied to similar problems and delimitations. See for instance table 1 on scope and degree of control.

Data handling corresponds to the lion's share of the working time spent in accounting (as described in section 3.2). Despite the need for data there are at present cultural and linguistic barriers between the different accounting dimensions, disabling interchange. In Lindeijer's (2000) review on land use impact categories he indicates the lack of data as one major obstacle that has to be dealt with, as LCA practitioners cannot solve this problem by themselves. In Vogtländer et al. (2002) a class model is tested and found applicable for both EIA and LCA. Municipalities and the corporate world are working with similar I/O analyses, unfortunately without co-ordination of data and database structure. In the corporate world some firms have chosen to merge different system boundaries (scopes and even different dimensions) of accounting. At Ericsson, the database structure, from storing unit process data up to how to present the aggregated results, has been combined into one single database structure and terminology. This database structure includes e.g. products, company sites and geographic areas[3] which can be applied for the entire global corporation. Ericsson maintains these approaches within the same I/O database which is also used for aggregations (however aggregated in different flow directions) and impact assessments. The work is denominated Environmental Aspects but prior to 1998 the designation was LCA (cf. Ericsson, 2001, 2002[4]). The database follows the data modelling process described in ISO 14048 (cf. ISO, 2001).

There are international, environmental studies describing land use, as for instance the one by Lindeijer (2000), and agrarian production (e.g. Brentrup et al., 2001), these studies are based on I/O inventories. Hence, data collected in these unit processes (smallest portion of a studied system[5]) may very well, to our minds, fit under the descriptions of regional MFAs. The distinguished groups of LCA in Lindeijer (2000) are for instance functional and land use classes (i.e. natural, modified and cultivated systems) while groups of (regional) MFA in Burström (1999) are regional or functional. The inventory part of the Brentrup et al. (2001) LCA dealing with agricultural production focuses on nitrogen flows, as do Lindeijer and Burström,.and Joosten et al.'s study (1999) of flows through society, not an LCA, is structured in its chain analysis much like an ordinary LCA into tables of supply and use – based on material production, material processing, assembly, consumption and waste processing. The European Commission supported a meso-scale LCA study (Sarigiannis and Triacchini, 2000) of environmental policy impacts on a region, if implemented – an impact assessment method that is not far from ordinary regional MFA boundaries.

MFA may be interpreted as 1) a tool for analysing regional metabolism (Burström, 1998) but may also 2) be used in a functional approach (cf. Burström, 1999). Examples of functional approaches are for instance an MFA on sludge management plants (cf. Ramírez, 2000), an LCA-based agricultural study (Mattsson et al., 2000) and an MFA-based agricultural study (Viglizzo et al., 2001) which deals not only with N (and P and K) flows but also with the changing of functions. An LCA-like study by Smith Cooper (2001) conducts a product-targeted MFA on fuel cell design concepts, with connections to national level implications and incorporating linkages to LCA principles. As Cerin and Ramírez (2000) argue there are great similarities between MFA and the life cycle inventory (LCI) process which is by far the most time consuming part when conducting an LCA, merely distinguished by the goal and scopes commonly chosen and cultural differences such as grade of standardisation and actors conducting the studies. Authorities usually perform MFAs, while LCIs are mostly employed by industry, which may have influenced the development of the tools.

Despite the similarities shown (also indicated by Burström, 1999) and overlappings (e.g. in corporate management analysis dimensions indicated by White et al., 1995) cultural divides between for instance company judicial and product accounting, can be indicated. Schaltegger and Burritt (2000) criticise life-cycle assessments as being "… of poor quality and … of little value for decision making and accountability purposes." To indicate the gap between different dimensions of environmental studies, in this case between judicial company environmental accounting and product-based analysis, opposite views do exist such as Hedblom's[6] (1998) explanation that LCA enables companies "to obtain scientifically defensible descriptions of good and bad interrelationships between industrial product systems, the human society, and the external environment. … that most often reflect the negative impact of industry or society's activities."

According to Schuster (2000) corporate environmental accounting and reporting in Scandinavian countries seem to a larger extent to address external stakeholders while e.g. German companies focus more on internal groups. Jasch (2000) has done an outline of the EU-EMAS site delimited EMS, which in commonly used in Germany, and the more holistic scope of ISO 14001/ISO 14031 (ISO, 1996: 2000a). Both reporting focuses, however, use I/O analysis. The former is delimited by a company's geographical sites (compare with regional accounting delimitations) and the latter by LCA on all products manufactured by the company. Contrary to this division, Caduff (1998), Frei and Wüest (1997), Schlatter (1998) and Schlatter and Züst (1998) have earlier recognised the key importance of corporate environmental information systems that not only cover the I/O of a production unit but also the product fluxes as well as the product design units.

Carlson and Pålsson (2001) also belong to the group[7] that indicate similarities in information need on describing environmental aspects in EMS and LCI. These authors consider the scope (components and boundaries) and flows (in- and outflows) depending on the responsibility of management. Consequently, the managed system consists of sub-systems which are aggregated in different flow directions. Udo de Haes et al. (2000) describe tools for analysing environmental impacts i.e. MFA, SFA and LCA as all being based on fixed input-output relations characterized by the nature of their flow objects. They moreover come to the conclusion that distinguishing the modes of analysis – region (MFA) and function (LCA) – strengthens the idea of a coherent family of tools for environmental systems analysis.

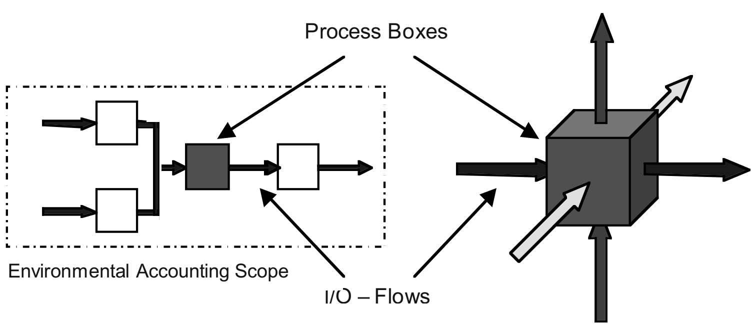


Figure 1. *Input and output flows to and from the process box of one- and three-dimensional environmental accounting scopes*

Figure 1 shows that the essential differentiation of the three dimensions is chosen scopes and further indicates the actual similarities in data and process handling. The boxes in figure 1 represents the core component in any environmental accounting, namely the process box with input and output flows to and from the process (see data modelling process in ISO 2001). The arrows in the figure are in- and outflows from the box where the direction depends on the accounting dimension chosen – depending on the responsibility of management chosen. The one-dimensional box on the left hand side of figure 1 could represent the LCI of an LCA (or any other accounting dimension) and all other I/O arrows in that accounting scope would be horizontal – following the value chain (VC) of the product studied. If using the very same process box in other dimensions as shown in the three-dimensional box on the right hand side, the other I/O arrows used for accounting other dimensions may (in general) only follow that process box of the VC and follow other scopes relevant to the companies or regions studied.

The development of ISO 14048 (2001) has followed the idea of adopting one single database structure for several methods of environmental accounting (as was the case at Ericsson, see above in this section), moving from being solely a Life cycle assessment data documentation format (ISO, 2000b, cf. Carlson et al., 2001) to a more general data documentation format today. This makes it applicable for other environmental accounting tools as well. Some of the forerunners in this work (Carlson and Pålsson, 2001, Carlson et al., 2001) have stated the importance of data structure, data storage, and transparency between system modules. They also stress that besides the current lack of data, there is the even greater lack in documentation of data. The lack of this meta data means reduced transparency as well as credibility. The precision is hard to estimate, affecting the overall reliability as well as the relevance (cf. Pålsson, 1999). Gathering meta data is resource demanding and therefore often avoided – by practitioners. This phenomenon, however, makes quality control, review and of course exchange of information more difficult and less attractive, opposing the needs set in Schaltegger (1997b) and Carlson et al. (2001).

The authors have therefore made a basic model – see Figure 2 – constructed into three phases. The model should consist of a common database structure for input/output data, meta data and process data, which is aggregated in flows suitable for the study's accounting scope and dimension. Then communication of impact assessment and visualisation must be coherently performable – how depends on the scope and objectives such as total mass flows or into environmental impact categories. This schematic description, moreover, holds true for the environmental aspect database structure at Ericsson described above in this section, which is employed for environmental analysis regarding life-cycles of products, judicial corporation and community-site interaction. The database and its structure have evolved from woring with local databases and paper sheets, requiring resource-demanding exchanges of data – often concerning material declarations and LCIs (How resource consuming some analysis have been – e.g. noticeably affecting company segment revenue negatively – is shown in Cerin and Laestadius, 2003, cf. also Cerin and Ramíres, 2000)[8].

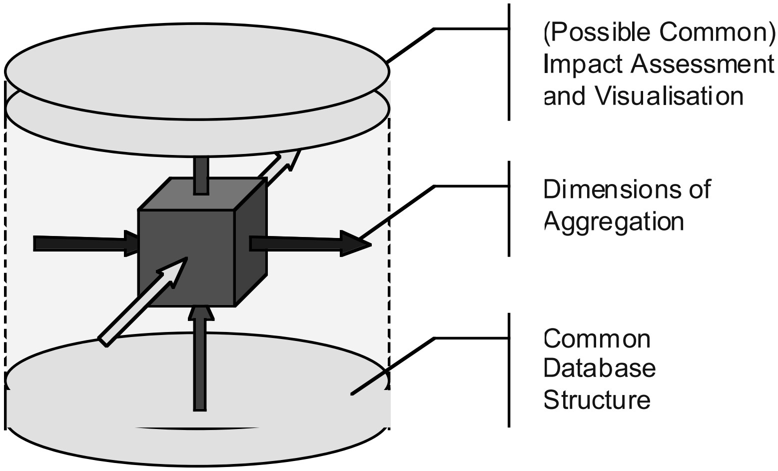


Figure 2*. A simplistic environmental accounting model showing three phases of information aggregation from a common database structure, dimensions of aggregations and to impact assessment and visualisations. Impact assessment and visualisation may be independently chosen for desired purposes. The model is based on our empirical analysis of how Ericsson works with different dimensions of accounting.*

Table 1 shows the relationships between different accounting dimensions as primarily being scopes depending on responsibility of management chosen rather than being widely different tools for environmental analyses. The degree of responsibility cuts through the different accounting dimensions in the table. The control-based responsibility goes for the company and regional dimensions, the influence-based responsibility goes for all dimensions while the attention-based responsibility goes only for the regional dimension. The table indicates that company accounting that is based on a possibility to change (influence based) has more in common in terms of scope (value chain) with the life cycle of products than with company controlled-based accounting that strictly follows the judicial borders of the studied organisation. If a common framework for the different dimensions of environmental accounting existed, which congregated the different paths, it would also increase the possibilities of putting products into a larger societal context.

***Table 1**. Relationship between different environmental analyses and their scope versus the degree of control*

Accounting Dimension	*Control Based*	*Influence Based*	*Attention Based*
Product Life Cycle		a	
Company Judicial	a		
Company Value Chain		a	
Regional Jurisdiction	a		
Regional Hinterland		a	
Regional Metaland			a

4 CONCLUDING DISCUSSION

In this paper the authors on the one hand focus on the internal incompatibility of the present development of environmental management accounting systems along three dimensions: regional, company and product. These developments have been more or less inconsistent even within the identified dimensions. In addition, the authors argue that the present development of environmental accounting systems is dominated by a control paradigm which – although well intended – may be looked upon as searching for an engineering solution of the sustainability problem. Hence, inadequate efforts are put into the economic efficiency of these systems.

The objective of this paper has not been to suggest detailed alternatives to the present modes for environmental management and accounting. Neither has the intention been to select among the existing ones or develop them further. The abbreviations used for the accounting tools are not the primary gap between them, but the choice of scope (influence) used in studies is which depends on the object of study. The authors do recognise that it is possible to streamline the I/O analyses of the three dimensions of environmental accounting as regards for instance common structure and all-dimensional global nomenclature for data storage. By doing this it will be possible, to a higher degree, for environmental accounting tools and their practitioners to use the same databases reusing the data and processes already stored, thus cutting down the time and costs for data handling. The streamlining of I/O analyses would enable cutting costs for the most resource-consuming part of these studies. Although the problems of using environmental impact categories in assessments should not be underestimated, the authors do also see that an increased usage in the various assessment paths may be useful and could contribute to compatibility between the various dimensions of environmental accounting in estimating potential environmental impact. A common framework for the different dimensions of environmental accounting, which would congregate the different paths, would also increase the possibilities of placing products into a larger societal context.

According to the authors, the phenomena discussed above taken together may promote the development of complicated and resource-consuming tools for environmental management, which are not sustainable in themselves. The growing awareness on the enormous environmental problems ahead of us has created a climate which in general is very positive towards the greening of industry and municipalities and the development of sustainable technologies and industrial systems. Involved actors do, however, have to look into the efficiency and similarities of these accounting tools as well as their differences in objectives in order to avoid a major future backlash, bridging over spurious barriers due to tradition and historical trajectories of tools. In other words: it must be ensured that the tools intended to contribute to sustainability are themselves sustainable.

5 ACKNOWLEDGEMENTS

Pontus Cerin would like to acknowledge the generous financial support received twice from: (1) King Carl XVI Gustav of Sweden through his foundation dedicated to science, technology and the environment, (2) the Data and Telecommunication company Ericsson, (3) the Swedish Council for Planning and Coordination of Research, and (4) the Department of Industrial Economics and Management at the Royal Institute of Technology in Stockholm.

NOTES

1 Sometimes substance flow analysis (SFA) is used instead of MFA, but denotes as a specific analytical tool.

2 Presentation by SAP R/3 sales staff in Stockholm, 2000.

3 For example data for a Stockholm suburb combined together with data from other actors such as the telecom operator Telia, public transportation, the gas company Statoil, an office area, a housing area and the Royal Institute of Technology, among others (internal Ericsson information).

4 However, mostly based upon internal Ericsson information.

5 For a more thorough example on system structures turn to the ISO 14040-series (cf. ISO, 1997).

6 Dr. Mats-Olov Hedblom is the Environmental Manager of Ericsson whose holistic product-value-chain view incorporated into company management has gained positive attention from Dow Jones Sustainability Index in 2001 by selecting Ericsson as the sustainability leader in its industry.

7 The group at Chalmers University [http://www.cpm.chalmers.se] also provides an LCI database containing substances and materials used by some of Sweden's largest firms.

8 The information regarding database development is retrieved not only from these case studies, but also by working for a number of years at Ericsson with environmental analyses and corporate environmental reports.

REFERENCES

Beniger, J. (1986), *The Control Revolution: Technological and Economic Origins of the Information Society*. Cambridge, MA: Harvard University Press.

Berthouex, M. and Rudd, D. (1977), *Strategy of Pollution Control*. New York, NY: John Wiley & Sons.

Brentrup, F., Küsters, J., Kuhlmann, H. and Lammel, J. (2001), Application of the Life Cycle Assessment methodology to agricultural production: an example of sugar beet production with different forms of nitrogen fertilisers. *European Journal of Agronomy*, 14: 221-233.

Burström, F. (1998), *Municipal Materials Accounting and Environmental Management*. Licentiate Thesis. Division of Industrial Ecology, Department of Chemistry, Royal Institute of Technology (KTH), Stockholm, Sweden.

Burström, F. (1999), Materials Accounting and Environmental Management in Municipalities. *Journal of Environmental Assessment Policy and Management* 1 (3): 297-327.

Burström, F. (2000), *Environment and Municipalities: Towards a theory on municipal environmental management*. Division of Industrial Ecology, Department of Chemistry, Royal Institute of Technology (KTH), Stockholm, Sweden.

Burström, F. and Frostell, B. (eds.) (2000), *Miljösystemanalys och miljöledning*. Unit of Industrial Ecology, Department of Chemical Engineering and Technology, Royal Institute of Technology (KTH), Stockholm, Sweden (available only in Swedish).

Burström, F. and Lindqvist-Östblom, A. (2002), On Information and Environmental Management in Municipalities. *Local Environment* 7 (2): 189-201.

Caduff, G. (1998), Beschreibung und Beurteilung der umweltorientierten Leistung. In: Züst, R. and Schlatter, A. (eds.) *Eco-Performance: Beiträge zum betrieblichen Umweltmanagement*. Zürich: Verlag Eco-Performance and PricewaterhouseCoopers (available on in German).

Carlson, R., Erixon, M., Forsberg, P. and Pålsson, A.-C. (2001), System for integrated business environmental information management. *Advances in Environmental Research* 5: 369-375.

Carlson, R. and Pålsson, A.-C. (2001), Industrial environmental information management for technical systems. *Journal of Cleaner Production* 9: 429-435.

Cerin, P. (2000), *Corporate Environmental Reporting: An Innovation of Accounting?* Working Paper. Department of Industrial Economics and Management, Royal Institute of Technology (KTH), Stockholm, Sweden.

Cerin, P. and Laestadius, S. (2000), *The Efficiency of Becoming Eco-Efficient*. The 2000 Eco-Management and Auditing Conference Proceedings. Manchester, UK. pp. 44-53.

Cerin, P. and Laestadius, S. (2003), The Efficiency of Becoming Eco-Efficient. *Management of Environmental Quality: An International Journal* 14 (2): 221-241.

Cerin, P. and Ramirez, J.-I. (2000), Present Use and Need for Environmental Analyses at Ericsson Corporate and Site levels. In: Burström, F. and Frostell, B. (eds.). *Miljösystemanalys och miljöledning*. Unit of Industrial Ecology, Department of Chemical Engineering and Technology, Royal Institute of Technology (KTH), Stockholm, Sweden, pp. 45-82.

Chandler, A. (1977), *The Visible Hand: The Managerial Revolution in American Business*, Cambridge, MA: Belknap.

CHAINET (European Network on Chain Analysis for Environmental Decision Support) (1998), CHAINET Definition Document: Final version. Leiden: CML, Leiden University.

Danius, L. and Burström, F. (2001), *Regional material flow analysis and data uncertainties: Can the results be trusted?* Sustainability in the Information Society: Environmental Informatics 2001, 15th International Symposium, Informatics for Environmental Protection. Royal Institute of Technology (KTH), Stockholm, Sweden.

DiMaggio, P. and Powell, W. (1983), The Iron Cage Revisited: Institutional Isomorphism and Collective Rationality. In: Powell, W. and DiMaggio, P. (eds.) *The New Institutionalism in Organizational Analysis*. Chicago: University of Chicago Press, pp. 63-82.

Dorfman, R., Samuelson, P. and Solow, R. (1958), *Linear Programming and Economic Analysis*. New York, NY: McGraw-Hill.

Emerson, T., Meima, R., Tansley, R. and Welford, R. (1997), Human Resource Management, Strategic Organizational Capabilities and Sustainable Development. In: Welford, R. (ed.) *Corporate Environmental Management 2: Culture and Organisations*. London: Earthscan Publications Ltd.

Ericsson. (2002), *Ericsson Sustainability Report 2001*. Stockholm, Sweden.

Ericsson. (2001), *Ericsson Environmental Report 2000*. Stockholm, Sweden.

Finnveden G. and Moberg Å. (2001), *Environmental Systems Analysis Tools – An Overview*. LCM 2001 Copenhagen. Life Cycle Management – A bridge to sustainable products. 1st International Conference on Life Cycle Management, Copenhagen, August 27-29,. pp. 117-120.

Frei, M. and Wüest, G. (1997), Klare Aussagen – Umweltinformtionssystem am Beispiel Geberit (Clear Evidence – The Case of Environmental Information Systems at Geberit [Own translation from German]). *Umweltfokus*. (Focus on the Environment [Own translation from German]). (3): pp. 24-29.

Gray, R., Bebbington, J. and Walters D. (1993), *Accounting for the Environment*. London: Markus Wiener Publishers, Princeton, NJ, and Chapman Publishing Ltd.

Hedblom, M.-O. (1998), Environment, for better or worse. Ericsson Review: *The Telecommunications Technology Journal*. No. 3-4 1997; and No. 1 1998, Stockholm, Sweden.

Isard, W. and Kuenne, R. (1953), The Impact of Steel upon the Greater New York – Philadelphia Industrial Region, *Review of Economics and Statistics* 35: 289-301.

ISO (1996), *ISO 14001 – Environmental Management – Specifications with Guidance for Use*. International Organization for Standardization: Technical Committee ISO/TC 207, Geneva.

ISO (1997), *ISO 14040: Environmental Management – Life Cycle Assessment – LCA – Principles and Framework*. International Organization for Standardization: Technical Committee ISO/TC 207, Geneva.

ISO (2000a), *ISO 14031: Environmental Management – Environmental Performance Evaluation – Guidelines*. International Organization for Standards, Technical Committee ISO/TC 207, Geneva.

ISO (2000b), *International Standards of the ISO 14000 series*. International Organization for Standards, Technical Committee ISO/TC 207, Geneva [2000-02-25].

ISO (2001), *ISO 14048: Environmental Management – Life Cycle Assessment – Data documentation format – Technical Specification*. International Organization for Standardization: Technical Committee ISO/TC 207, Geneva.

Jasch, C. (1999), Ecobalancing in Austria – Its Use in SMEs and for Benchmarketing. In: Bennett, M. and James, P. (eds.) *Sustainable Measures: Evaluation and Reporting of Environmental and Social Performance*. Sheffield: Greenleaf, pp. 151-170.

Jasch, C. (2000), Environmental performance evaluation and indicators. *Journal of Cleaner Production* 8: 79-88.

Johnson, T. and Kaplan, R. (1987), *Relevance Lost: The Rise and Fall of Management Accounting*, Boston, MA: Harvard Business School Press.

Joosten, L., Hekkert, M., Worrell, E. and Turkenburg, W. (1999), STREAMS: a new method for analysing material flows through society. *Resources, Conservation and Recycling* 27: 249-266.

Kleijn, R. and van der Voet, E. (2001), *Material Flow Accounting*. 4th NTVA Industrial Ecology Seminar and Workshop: Industrial Ecology – Methodology and practical challenges in industry. Norwegian University of Science and Technology, Trondheim, 14-15 June.

Laestadius, S. (1992), *Arbetsdelningens dynamik*. Lund: Arkiv bokförlag (available only in Swedish).

Leontief, W. (1936), Quantitative Input and Output Relations in the Economic System of the United States. *Review of Economic Statistics* 18 (3): 105-125.

Leontief, W. (1970), Environmental Repercussions and the Economic Structure – An Input-Output Approach. *The Review of Economics and Statistics* 52 (3): .261-271.

Levin, M. (ed.) (2000), Cultures of Control. Amsterdam: Harwood Academic Publishers.

Lindeijer, E. (2000), Review of land use impact methodologies. *Journal of Cleaner Production* 8: 273-281.

Ljungdahl, F. (1999), *Utvecklingen av miljöredovisningen i svenska börsbolag – praxis, begrepp, orsaker*. Lund: Lund University Press (available only in Swedish).

Mattsson, B., Cederberg, C. and Blix, L. (2000), Agricultural land use in life cycle assessment (LCA): case studies of three vegetable oil crops. *Journal of Cleaner Production* 8: 283-292.

Meima, R. and Welford, R, (1997), The Ecological Challenge in Organization Theory and Organizational Behaviour. In: Welford, R. (ed.) 1997), *Corporate Environmental Management 2: Culture and Organisations*. London: Earthscan Publications Ltd.

Moberg, Å. (1999), *Environmental Systems Analysis Tools – differences and similarities*. Master Thesis, Department of Ecology Systems, Stockholm: Stockholm University.

Östermark, U., Andrae, A. and Lenell, L. (2000), *Life Cycle Assessment of MD 110*. Ericsson Enterprise Systems and CIT Ekologik, Stockholm.

Pålsson, A-C. (1999), I*ntroduction and guide to LCA data documentation using the CPM data documentation criteria and the SPINE format*. CPM report 1999:1, Gothenburg: Chalmers University of Technology.

Ramírez, J. (2000), *A Systems Approach Evaluation of Sludge Management Strategies. Case study: Sludge Management in Valparaíso and Aconcagua, Chile*. Licentiate Thesis. Dept. of Industrial Ecology. Royal Institute of Technology, Stockholm.

Rikhardsson, P. (1999), Information Systems for Corporate Environmental Management Accounting and Performance Measurement. In: Bennett, M. and James, P. (eds.) *Sustainable Measures: Evaluation and Reporting of Environmental and Social Performance,* pp. 132-152.. Sheffield: Greenleaf Publishing.

Sarigiannis, D. and Triacchini, G. (2000), Meso-Scale Life-Cycle Impact Assessment of Novel Technology Policies: The Case of Renewable Energy. *Journal of Hazardous Materials* 78: 145-171.

Schaltegger, S. (1997a), Economics of Life Cycle Assessment: Inefficiency of the Present Approach. *Business Strategy and the Environment* 6 (1): 1-8.

Schaltegger, S. (1997b), Information Costs, Quality of Information and Stakeholder Involvement – the Necessity of International Standards of Ecological Accounting. *Eco-Management and Management* 4 (3): 87-97.

Schaltegger, S. and Burritt, R. (2000), *Contemporary Environmental Accounting: Issues, Concepts and Practice*. Sheffield: Greenleaf Publishing.

Schlatter, A. (1998), Erfolgskriterien bei der Erstellung eines Umwelt-Informationssystems. (Success Criteria for Creating an Environmental Information System [Own translation from German]). In: Züst, R. and Schlatter, A. (eds.) *Eco-Performance: Beiträge zum betrieblichen Umweltmanagement* (Eco-Performance: Contributions to Operational Environmental Management [Own translation from German]). Zürich: Verlag Eco-Performance and PriceWaterhouseCoopers.

Schlatter, A. and Züst, R. (1998), Aufbau betrieblicher Umweltinformationssysteme: Ein Beitrag zur Konzeption und Realiserung (Structure of Operational Environmental Information Systems: A Contribution to Concept and Realisation [Own translation from German]). In: Bullinger, H.-J., Hilty, L., Rautenstrauch, C., Rey, U. and Weller, A. (eds.) *Betribliche Umweltinformationssysteme in Produktion und Logistik* (Operational Environmental Information Systems in Production and Logistics [Own translation from German]). Marburg: Metropolis, pp. 31-53.

Sinclair, P., Cowell, S., Löfstedt, R. and Clift, R. (2001), *The Integration of Tools: Lessons from a Participatory Case Study in Waste Management*. LCM 2001 Copenhagen. Life Cycle Management – A bridge to sustainable products. 1st International Conference on Life Cycle Management, Copenhagen, August 27-29, pp. 121-123.

Smith Cooper, J. (2001), *Materials Flow Analysis of Emerging Technologies: A Study of Emerging Fuel Cell Design Concepts*. LCM 2001 Copenhagen. Life Cycle Management – A bridge to sustainable products. 1st International Conference on Life Cycle Management, Copenhagen, August 27-29, pp. 125-128.

Tillman, A.-M. (1999), Significance of Decision-Making for LCA Methodology. *Environmental Impact Assessment Review* 20: 113-123.

Tukker, A. (1999), *The relation between environmental evaluation tools*. Delft: TNO Institute of Strategy, Technology and Policy (TNO-STP).

Udo de Haes, H. (2001), *The Combined Use of Analytical Tools: Results from the CHAINET Program*. LCM 2001 Copenhagen. Life Cycle Management – A bridge to sustainable products. 1st International Conference on Life Cycle Management, Copenhagen, August 27-29, pp. 113-116.

Udo de Haes, H., Heijungs, R., Huppes, G., van der Voet, E. and Hettelingh, J.-P. (2000), Full Mode and Attribution Mode in Environmental Analysis. *Journal of Industrial Ecology* 4 (1): 45-56.

Udo de Haes, H., Huppes, G. and de Snoo, G. (1998), Analytical Tools for Chain Management. In: Vellinga, P., Berkhout, F. and Gupta, J. (eds.). *Managing a Material World: Perspectives in Industrial Ecology*. Dordrecht: Kluwer Academic Publishers.

Utterback, J.M. (1996), *Mastering the Dynamics of Innovation*. Boston, MA: Harvard Business School Press.

Viglizzo, E., Lértora, F., Pordomingo, A., Bernardos, J., Roberto, Z. and Del Valle, H. (2001), Ecological Lessons and Applications from one Century of Low External-Input Farming in the Pampas of Argentina. *Agriculture, Ecosystems and Environment* 83: 65-81.

Vogtländer, J., Lindeijer, E., Witte, J.-P. and Hendriks, C. (2004), Characterizing the Change of Land-Use Based on Flora: Application for EIA and LCA. *Journal of Cleaner Production* 12 (1), pp. 47-57

Wagner, M,, Wehrmeyer, W. and Carlens, J. (2001), *The Relationship between Environmental and Economic Performance of Firms and the Influence of ISO 14001 and EMAS Analysis*. The 2001 Eco-Management and Auditing Conference. 21-22 June, Nijmegen School of Management.

Whit,e P., de Smet, B., Owens, J. and Hindle, P. (1995), Environmental Management in an International Consumer Goods Company. Resources, *Conservation and Recycling* 14, pp. 171-184.

Wilczynski, J. (1970), *The Economics of Socialism*. London: Allan & Unwin.

Zobel, T., Almroth, C., Bresky, J. and Burman, J.-O. (2002), Identification and Assessment of Environmental Aspects in an EMS Context: An Approach to a New Reproducible Method Based on LCA Methodology. *Journal of Cleaner Production* 10 (4), pp. 381–396.

CHAPTER 5

PROCESS AND CONTENT: VISUALIZING THE POLICY CHALLENGES OF ENVIRONMENTAL MANAGEMENT ACCOUNTING

DICK OSBORN

Green Measures, Australia

greenmeasures@osborn.net

Abstract. This chapter argues the policy challenge of environmental management accounting is getting decision-makers to understand they are dealing with a mess: a situation where disagreement and uncertainty exists. Finding shape and structure in messy situations is a pre-condition to designing and implementing effective policy. Visualising communication processes between policy makers and takers, and the content transmitted between them, supports the search for shape and structure. A series of images on process and content aspects of environmental management accounting are presented. Five images place secondary data into theoretical constructs of classical diffusion theory. Collectively, the images on communication processes and their consequences show that relying on top-down innovation through mass media distribution of advisories is ineffective in achieving widespread pro-environmental behaviour. Two images are then presented in a search to place environmental management accounting within a mapping on the causes and effects of management accounting. A tenuous link with research on how environmental uncertainty affects accounting policy choice is identified. But mainstream accounting and management conventions with respect to environmental uncertainty typically focus on environmental matters that exclude nature. Hence process and content images on environmental management accounting presented here illustrate the disagreement and uncertainty characteristics of a mess. Forming and implementing effective policy is not possible in a messy situation.

P.M. Rikhardsson et al. (eds.), Implementing Environmental Management Accounting, 81-101

1 INTRODUCTION

A common intent in forming and implementing policy is to achieve outcomes more effective, efficient, or equitable, than the *status quo*. Implementing policy therefore seeks change within a target population from one behavioural state to another. How such transitions occur will depend on the communication channels linking policy-makers to policy-takers (process), and what information is transmitted between them (content). Researchers will influence design and implementation since their ideas and analyses contribute to policy advice. These generalisations apply whether policy-makers operate within public or private sectors.

Perceptions by policy-makers and their advisers on undertaking the task ahead will affect choosing the information transmitted to target populations. Pidd (1996) builds on a history of dealing with complexity in policy formation and organisational management (e.g. Ackoff, 1979, Rittel and Webber, 1973, Warfield, 1976) to order such perceptions. Those seeking outcomes beyond the status quo may see the task ahead reflected in one of three situations:

- "Puzzles: situations where it is clear what needs to be done and also, in broad terms, how it should be done. A puzzle solution can be found by applying known methods.
- Problems: situations where it is clear what needs to be done, but not obvious how to do it. The problem is well defined or well structured, but considerable ingenuity and expertise may be needed to find an acceptable, let alone optimal solution.
- Messes: unstructured situations where there is disagreement about what needs to be done and why; therefore it is impossible to say how it should be done. The mess must be structured and shaped before any solution, should such exist, can be found." (Pidd et al., 2003).

Knowledge workers establish solutions to *puzzles* through experiments and case studies. A tradition among many policy-makers sees disseminating results *en masse* as necessary and sufficient for achieving behavioural change. Phelan and Basinger (1993) identify engineering solutions to puzzles disseminated during the beginnings of US soil conservation policy. They note an early example where farmers reading the US Yearbook of Agriculture were informed of means to prevent accelerated soil erosion (Hartley, 1903). Other early examples where public policy assumes a linear process of information⇒awareness⇒behaviour can be identified. Psychologists first developed puzzle solutions to prevent tobacco use among young people in the 1950s. Solutions were applied in the following decade (Aarø et al., 1998). The linear process where mass dissemination of scientific knowledge is the primary means for promoting widespread behavioural change is labelled the 'information deficit model'.

Evaluation studies soon found the information deficit model to be ineffective as an instrument for implementing public health policy (e.g. Thompson, 1978, Goodstat, 1978, as cited by Aarø et al., 1998). Policy advisers working in environmental fields (e.g. Baker, 2001, Kollmuss and Agyeman, 2002, Napier and Napier, 2002, Scott and Gough, 2003) similarly present evaluation studies and other arguments to show the information deficit model is generally ineffective in achieving pro-environmental behaviour.

Marks and Godfrey (2001) summarise the challenge where policy implementation rests on disseminating researchers' perceptions of rational behaviour thus: "One cannot conceive of a linear relationship between research evidence and its implementation in practice. Implementation is a function of the relationships between the nature of the evidence, the organisational, professional and social and resource context in which changes are to be implemented and the facilitation of change processes. Tailored action plans are required that offer consideration of these different aspects."

Nevertheless, key top-down initiatives of recent past for promoting adoption of environmental management accounting (EMA) practice identify the information deficit model as a key element in action agendas (e.g. Office of Pollution Prevention and Toxics, 1994). More recently Savage et al. (2002) studied eighteen cases of EMA promotion by government agencies at local, regional, national, and supranational scales. Their findings show mass dissemination to be the only policy instrument common to all cases. More than three quarters of guidance documents listed in the EMA Research & Information Center (EMARIC) library catalogue circa early 2004 were funded by central government agencies. A project facilitated by the UN's Division for Sustainable Development, funded by the governments of the US, the UK, Germany and Austria, and managed by the International Federation of Accountants, should see another application of the information deficit model to EMA promotion in 2004. The international accounting community will be the policy target (Savage, 2004).

Pidd's 1996 consideration of decision support system (DSS) tools, and their selection according to categories of puzzles, *problems*, or messes, sees problems as well-defined and structured situations where ingenuity and skill should be sufficient to provide a solution. Is EMA practice a well-defined and structured situation?

One possible meaning of the phrase 'environmental management' is to have power or control over surrounding conditions. The prospect of managers having dominion over nature (Passmore, 1974), and other environments, seems irrational in today's world of turbulent societies, chaos, and climate change. Castree (2002) signals the futility of differentiating between environmental, cultural, economic and social issues, and their respective policy domains. Kolk and Mauser (2002) offer reasons why academics are shifting their search for describing the environmental aspects of business behaviour from 'environmental management' to 'environmental performance evaluation'. Lambe (2002) describes the agenda to be faced by the accounting profession in dealing with risk, uncertainty, and intangibles. He provides useful distinctions between the comfort zone of ‘counting’ favoured by accountants, and the profession’s need to join others skilled in ‘giving an account’ through ways meaningful to markets and managers. Burritt (2004) signals the frustrations in trying to define what is and what isn’t EMA practice, advocating a shift from ‘learning by learning’ to ‘learning by doing’ as a way forward in promoting its adoption.

Forming and implementing EMA policy cannot therefore be seen as a well-defined, stable and structured situation where applying ingenuity and skill will lead inevitably to the outcomes sought. Should today’s EMA policy-makers and their advisors act as if the situations they face are puzzles or problems, then the literature scan conducted so far suggests the behavioural changes they seek are unlikely.

Within Pidd’s (1996) categorisation, the challenge in forming and implementing effective EMA policy seems to be getting makers and takers to recognise they are dealing with a *mess*: a situation characterised by disagreement as to what needs to be done and why, and where designers have to find shape and structure before they can devise worthwhile solutions. Baker (2001), Glasser (1998), Lachapelle et al. (2003), Reid et al. (1996), and Salwasser (2002) represent many researchers and practitioners recognising design and implementation of environmental policies means dealing with a mess. Gray (2002) similarly identifies discourse on social and environmental finance and accounting practice at the enterprise level as a mess, requiring systems thinking to share and improve understanding of fundamental issues.

But are words sufficient for communicating ideas on complex policy and management tasks when confronting messes? Horn (2001) joins Pidd (1996) by also acknowledging and building on the work of other scholars advocating machine/human interfaces to create shape and structure in the social messes of public policy and organisational management. He does so through creating a visual language combining text, shapes, and images (Horn, 1999). Tufte (1992, 1997) publishes scholarly examples on using visualisations to deal with complexity, including how to improve giving an account to decision-makers. Tegarden (1999), with Dull and Tegarden (1999), reviews a scant research literature considering the impact of visualisation techniques on accounting practice, and reports some experiments. Campbell (1998) also reports an experiment on using graphic tools to communicate environmental risk to decision-makers. A practical innovation built by Engel (undated) uses visualisation to support the efforts of small to medium sized enterprises (SMEs) implementing environmental management systems.

The balance of this chapter continues a search begun through a series of working papers (Osborn et al., 2002, Osborn, 2003a, 2003b) for giving shape and structure to the mess of promoting EMA. It does so in two main sections. Shapes to reflect the *process* of diffusing EMA are next presented at various levels of policy implementation. Shapes to reflect *content* relationships between EMA and related branches of accounting and other management practice are then offered. Their presentation should aid understanding key perspectives on forming and implementing EMA policy at jurisdictional and enterprise scales. A summary concludes this chapter by urging readers to confront the challenge of shifting EMA policy from messy situation to solvable problem.

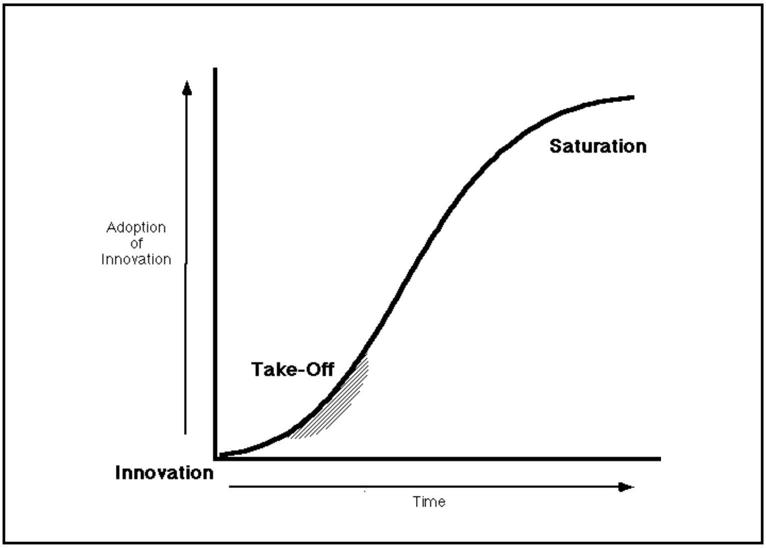
2 SHAPES REFLECTING THE PROCESS OF DIFFUSING EMA

At jurisdictional and enterprise levels the formation and implementation of EMA policy can be considered as the process where makers and takers negotiate a dialogue on diffusing, adopting, and implementing, an innovation: "*an idea, object, or practice that is perceived as new by the individual or other unit of adoption*" (Rogers, 2003 p. 12). Now in its fifth edition, the work by Rogers (2003) is used here as the standard reference to theoretical developments in, and empirical studies on, diffusion of innovations. Theoretical constructs for visualizing the process and consequences of communicating on innovation diffusion are applied here to EMA policy and practice in four ways. Examples build on secondary data from the public record, combined with some personal observations from working with Australian local governments.

2.1 Reaching Critical Mass Along an Innovation Adoption Curve

"The critical mass occurs at the point (on an innovation adoption curve) at which enough individuals in a system have adopted an innovation so that the innovation'*s* further rate of adoption becomes self-sustaining." (Rogers, 2003 p. 344).

The innovation adoption curve typically follows an S-shaped, or sigmoid, path over time (Figure 1). The curve has been demonstrated subsequently in thousands of empirical studies on innovation diffusion across diverse research fields in developed and developing countries. Policy-makers, and their advisors, generally, should be able to translate the outcomes sought from a target population, and the instruments chosen to achieve those outcomes, into milestones along its distance. Judging and testing which instruments are likely to most effective and efficient in reaching take-off (1st inflection, critical mass, tipping) point should be key elements in any policy design.



Osborn et al. (2002) identify five key points along the classical innovation adoption curve of Figure 1, using desktop analysis to measure progress in implementing EMA promotional policies at global scale. The five points are:

1) The origin of the Innovation Adoption Curve as the point in time of policy implementation.
2) A lag will occur between public policy implementation and the flow through of behavioural change required in target organisations by, say, promoting pro-environmental behaviour through EMA. Monitoring policy performance can, or should, include periodic surveys tracking growth in the number of innovators, and begin as close to the point of policy implementation as possible.
3) A second observation point should be used to estimate an annual rate of adoption by units within the target population.
4) Classical theory and empirical studies (Gladwell, 2001) suggest the take-off interval identified in Figure 1 will occur when the innovation under consideration has been adopted by 10-20 percent of the target population. A critical mass point of 15 percent seems appropriate.
5) Estimating the size of the target population at saturation can lead therefore to estimating the size of the policy target.

A visualisation adapting the classical innovation adoption curve to enhance understanding of diffusion and adoption of EMA practice at global scale is provided in

Figure 2 as an example of this approach to policy analysis. Placing promotional efforts and opportunities into the curve can provide shape and context to the mess of EMA policy with relatively little resource allocation.

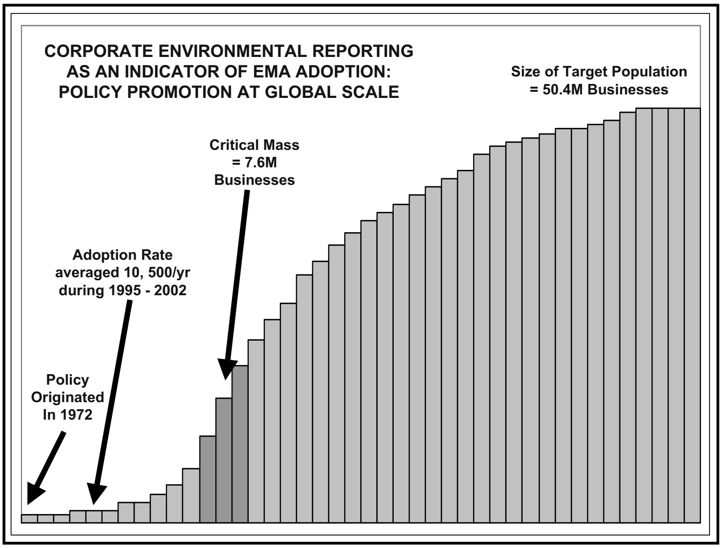


Figure 2. *Applying the Classical Curve to EMA Promotional Policy, Source: Osborn (2003b)*

Policy commitments to promote what is now known as EMA can be identified in the UN's 1972 Action Plan for the Human Environment. Opportunities to adopt this innovation by following advice disseminated en masse in the accounting literature were provided in the mid-1970s (Mathews, 1997). Counts on the number of businesses participating in various corporate environmental reporting (CER) schemes were first available in the public record from the 1960s and 1970s through Pollution Release and Transfer Registers. However, Osborn et al. (2002) used the onset in 1995 of ISO 14001 and other CER schemes as their first point on the interval for estimating an adoption rate.

By 2002 the cumulative total of adopting units engaged in CER activities indicative of EMA practice reached some 85,000 businesses at global scale: *equivalent to 0.2 percent of the critical mass target*. Results thus contribute to the body of evidence cited previously in this chapter as to the ineffectiveness of the information deficit model as a policy instrument for behavioural change.

2.2 Accelerating Adoption Rates Through Authority and Contingent Innovation-Decisions

"We distinguish between three main types of innovation-decisions: (1) optional innovation-decisions*, choices to adopt or reject that are made by an individual independent of the other members of the system,* (2) collective innovation-decisions, *choices to adopt or reject made by consensus among the members of a system,* (3) authority innovation-decisions*, choices to adopt or reject an innovation that are made by relatively few individuals in a system who possess power, status, or technical expertise. A fourth category consists of a sequential combination of two or more of these three types of innovation-decisions.* Contingent innovation-decisions *are choices to adopt or reject that are made after a prior innovation-decision."* (Rogers, 2003 p. 38).

Key stakeholders at global scale consider past, present, and future trends in environmental governance (World Resources Institute, 2003). They see greater efforts in balancing the application of policy instruments as necessary for healthier citizens and healthier ecosystems, including a return to applying the command-and-control instruments of the 1970s. A visualisation contrasting the diffusion consequences where innovation decisions are policy instruments for environmental governance is offered here. This example uses secondary data from Australia to compare adoption rates for two 'soft' environmentally sound technologies by contrasting between optional and contingent innovation-decisions.

Osborn et al. (2002) differentiate CER practices by businesses from their engagement in statistical environmental reporting (SER). There are two main differences between CER and SER to consider from a diffusion of innovation perspective. One of the former involves disclosure of identity. The latter does not, thus making identification of possible lead innovators or product champions difficult. The other is that the extent of engagement by businesses in SER is likely to be much greater than occurs in CER. The two forms of engagement are similar in many other respects. Business engagement in CER can be expected to provide evident improvements in environmental performance. Similar outcomes are also possible by entities applying their skills from SER (Osborn, 2001).

The adoption and implementation by a business of, say, ISO 14001 standards is an optional innovation decision. The International Standards Organisation conducts and publishes surveys annually on issue and non-renewal of ISO 14001 certificates. Information then available enables researchers and others to track the diffusion of this innovation through social systems: be they nations, industries, or firms of similar size. Growth in the number of entities adopting ISO 14001 illustrates an optional innovation decision in this example.

In 1995/96 a small number of Australian local governments began estimating their environment protection expenditures in pilot studies conducted by the Australian Bureau of Statistics (ABS) (Savage, 2002). In that same year the first Australian business gained an ISO 14001 certificate. The pilot studies showed compiling estimates on environment protection expenses and revenues under activity classifications agreed to by the international community to be a relatively easy task. The ABS was encouraged therefore by some local authorities to make future collections mandatory for significant proportions of the industry, thus ensuring regular collection and publication of continuous, comparable, and credible environmental information. By shifting from an optional innovation-decision to an authority innovation-decision, the diffusion of SER through the Australian local government sector represents a contingent innovation-decision.

Figure 3 is offered as another visualization yielding shape and structure to the mess of EMA policy. Contingent or authority innovation-decisions can be an efficient means of reaching the critical mass point along an innovation adoption curve. They can also be effective in raising environmental performance and improving ecosystem condition, if takers of the authority decision are supported by capacity building initiatives. Figure 3 assumes all ISO 14001 Certificates held in Australia have been issued to manufacturing establishments. While untrue, the assumption seems reasonable for illustrative purposes.

2.3 Positive Adoption Decisions Are Made Primarily Through Interpersonal Communication

*"*Mass media channels *are means of communicating messages that involve a mass medium, such as radio, television, newspapers, and so on, which enables a source of one or a few individuals to reach an audience of many…*Interpersonal channels *involve a face-to-face exchange between two or more individuals. Mass media channels are relatively more important at the knowledge stage, and interpersonal channels are relatively more important at the persuasion stage of the innovation process."* (Rogers, 2003 p. 205).

Much of the discourse on design and implementation of EMA practice considers manufacturing businesses within the northern hemisphere. Analysis of EMA practice tends also to be limited to individual entities. The discipline and constructs of classical innovation theory necessarily take a holistic perspective, and considers diffusion and adoption of ideas, objects, or practices through a social system.

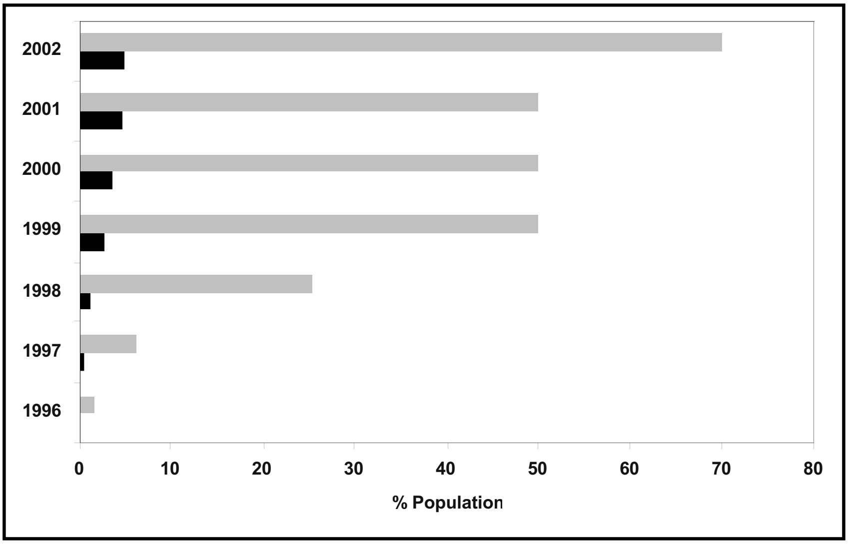


Figure 3. *Consequences of Optional and Contingent Innovation Decisions: Australian Manufacturing and Local Government Establishments. :Source: OECD (2001), Meadows et al. (1999) and ABS (2002)*

The Community Innovation Surveys (CIS) conducted among developed nations similarly take a systems view, using well-tested methods to publish robust inferences on outcomes from diffusion and adoption processes for systems and sub-systems of, say, business establishments operating in manufacturing and service sectors. Results from CIS2 conducted within the European Economic Area during 1996-97 provide useful insights into the challenge of designing policies to promote adoption of EMA practice. The shapes and words provided through Figure 4 offer a first layer of visualisations from CIS2 into the policy challenge of EMA in the European manufacturing sector. The size of sub-bars is in all cases relative to the size of total population of manufacturing establishments.

Roughly half of near 185,000 businesses making up the system of European manufacturing identified themselves as innovators during the 1996-97 survey period, and were split almost evenly between those undertaking product innovations and those making process innovations. The proportion of manufacturing businesses citing economic objectives (such as reducing labour costs) as very important drivers of innovative behaviour is roughly three to four times greater than a comparable measure where environmental objectives (such as reducing environmental damage, material and energy consumption) are seen as very important. Identifying this gap adds another dimension in structuring the messy challenge of EMA policy.

The generalisations of classical diffusion theory state interpersonal communication is more relevant to the adoption decision than mass dissemination. CIS2 results support classical theory. Note particularly at the foot of Figure 4 the differences between information sources as drivers of innovation. Again a result supporting those who see public policy relying on the information deficit model as ineffective in achieving behavioural change.

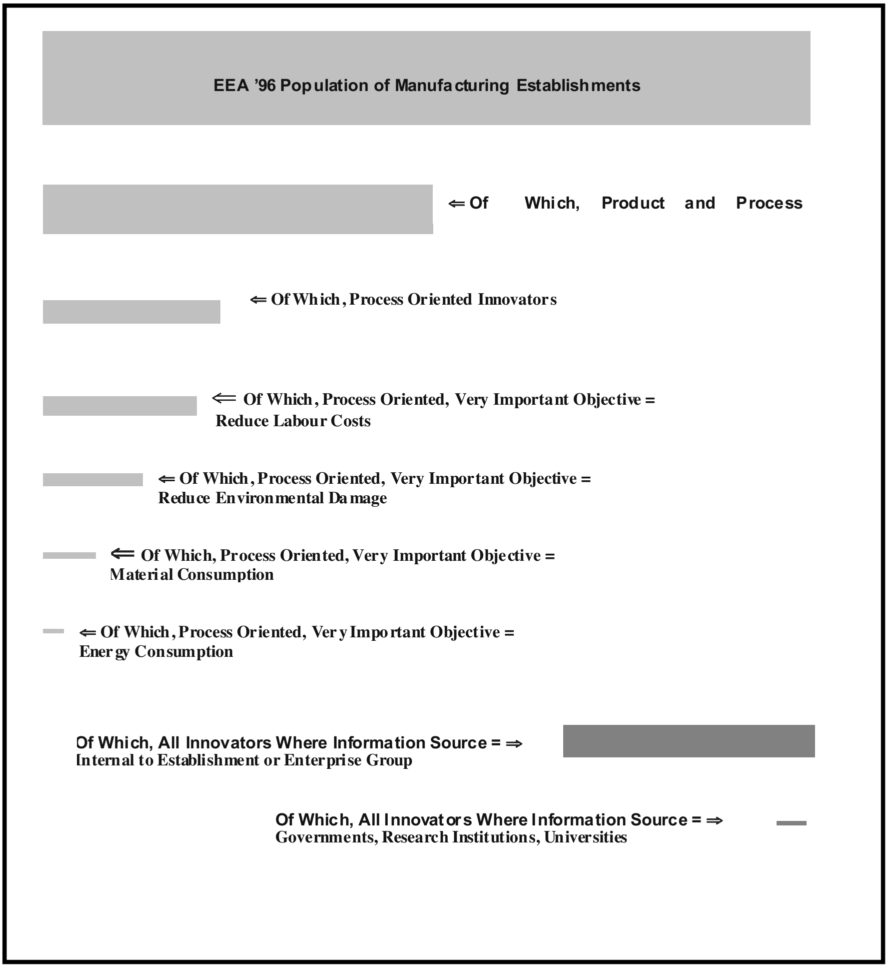


Figure 4. *Visual Insights into EMA Innovations in European Manufacturing.. Data Source: European Communities (2001)*

2.4 Implementing Organisational Innovation: The Decision Episode Framework

"In deciding whether or not to adopt or reject an innovation, individuals depend mainly on the communicated experience of others much like themselves who have already adopted a new idea. The subjective evaluations of an innovation flow mainly through interpersonal networks. So we must understand the nature of networks in order to understand the diffusion process." Rogers, 2003 p. 331. "Agenda-setting occurs in the innovation process when a general organizational problem that may create a perceived need for an innovation is defined…Both the innovation and the organization usually change during the innovation process." Rogers (2003 p. 434).

Swan et al. (2000) apply a decision episode framework to understand the communication networking necessary for the process of diffusing, adopting, and implementing organisational innovations. The framework connects three key elements:

1) A pool of organisational innovations;
2) A group of external stakeholders with some knowledge of their application; and
3) Those in a potential adopting organisation who will consider the fit of possible innovations to their own agendas.

Through mass media channels of communication, potential users within an organisation will have, at best, a fuzzy image of the innovations likely to be relevant to their needs. Employees thus span beyond their organisation's boundaries to network with other individuals holding skills and experiences similar to their own. Consequences of boundary spanning with change agents and other external stakeholders include better understanding as to the intent and design of innovations within the pool, and of those possibly relevant to an organisation's needs. Through interpersonal communication with change agents and others, the adopting organisation imports innovations from the pool across its boundaries.

An innovation is by definition an idea, practice, or object that is new to a potential adopter. Its newness means that its adoption, implementation, and usage will always be accompanied by some degree of uncertainty (Rogers, 2003 p. 6). The decision episode framework acknowledges the presence of uncertainty in the process of diffusion, implementation and usage internal to the firm. It does so by visualising episodes of negotiation and transition in personal or team agendas where relationships may be complementary or competitive.

Section 1 of this chapter argued for accepting the EMA policy challenge as a mess: a situation where disagreement is widespread as to what is and is not EMA practice. Figure 5 adapts the visualisation of the decision episode framework drawn by Swan et al., 2000 by placing an illustrative set of process innovations into a pool considered by the Eurobodalla Shire Council as it adopted environmental accounting.

Selection for this example is based in part on an EMA case study (Osborn, 2001), and partly from the author's direct observation.

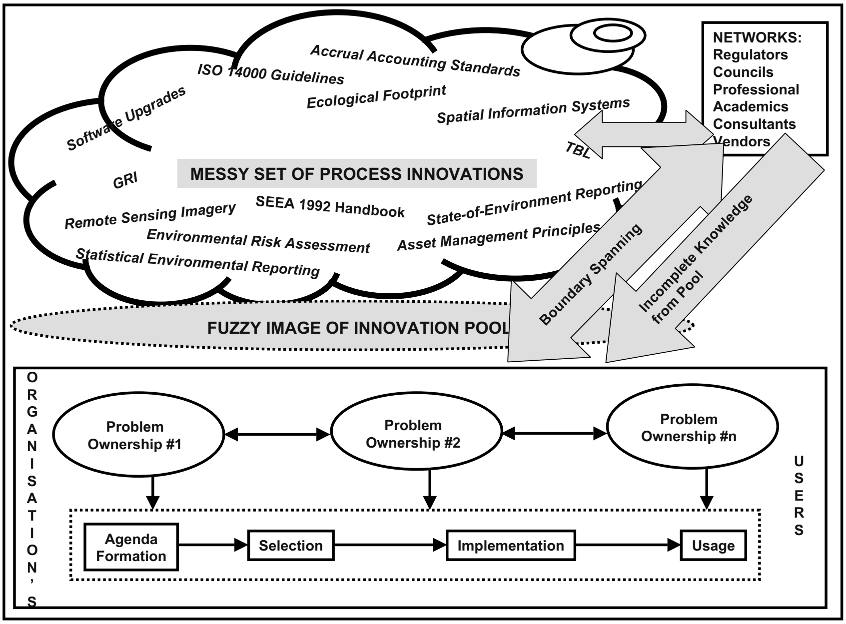


Figure 5. *Eurobodalla Council's EMA Decision Episode Framework – late 1990s: Adapted from Swan et al. (2000)*

Collaborative research studies are underway in many places to design and diffuse toolboxes where relatively large sets of process innovations (instruments, tools) are given shape and structure. Some examples include a set of some 46 concepts and instruments for sustainable organisation development (Schaltegger et al., 2002); a set of some 50 communication and information tools for public participation in European river basin management (Maurel, 2003); and a set of some 60 tools for engaging citizens in managing Australia's coastal zone (Coastal CRC, undated).

Among many offering authoritative definitions, the Business and Sustainability Group of the Tellus Institute identifies EMA as a collection of practices (or set of tools): *"How organizations identify, collect, estimate, analyze, and report materials and energy flow information, environmental cost information, and other cost information for internal decision-making is a key driver in shaping their environmental performance. These practices – collectively known as Environmental Management Accounting (EMA) – help both business and government organizations identify* *operating inefficiencies and opportunities for management and technology improvements as well as cost reduction. In addition to assisting in internal decision-making, EMA also provides a more accurate and comprehensive set of information for measuring and reporting company performance to external stakeholders such as customers, finance providers, government, the local community, and others."* (Tellus Institute undated). An authoritative specification as to the contents of an EMA toolbox as elements in an innovation pool could yield shape and structure: the pre-condition for shifting the formation and implementation of EMA policy from mess to problem.

3 SHAPES REFLECTING THE STRUCTURAL CONTEXT OF EMA

Does EMA adoption by an organization as a process innovation require radical or incremental change? Is it embedded and well distributed through the system of mainstream management accounting practice, or isolated? Visualisations can provide some answers to such questions.

Luft and Shields (2003) provide another example of using shapes to comprehend and communicate complex situations. They do so by using graphics to map the causes and effects of management accounting. Their review of six journals yields some 270 articles providing theory-based evidence, making visualisations of relationships between more than 500 variables possible. Of these variables, only one – Environmental Uncertainty (EU) – seems to be to what can be distinctively labelled as an EMA variable. EU appears as a contingency theory variable in four of nine thematic maps presented by Luft and Shields (2003). In their work around half of the links between EU and another variable are direct, the balance are indirect, arriving at their final connection through a branch. EU appears marginal therefore in its influence on causes and effects in management accounting practice. EU segments from each of the four thematic maps have been extracted from Luft and Shields (2002), and appear here as interconnected quadrants in Figure 6.

The sampling and analytical methods used by Luft and Shields (2003) suggest, at best, those engaged in the empirical studies they reviewed do not perceive environmental uncertainty as a significant element in a comprehensive and systemic mapping of management accounting. The next, and final, step in this search for shape and structure in the messy challenge of EMA policy takes a closer look at the possible meanings of EU. Which among the many surrounding conditions considered by management accounting practitioners and interested researchers are recognised as influencing accounting policy choice, and therefore its practice? Two examples from accounting literature, and two from management, provide information sufficient for closing this chapter's argument.

Gerhardy (2002) builds on visual frameworks from prior research to develop an extended contingency model for analysing the relationship between accounting and the environment within which it is practiced. He identifies five primary classes of environmental variables influencing the development of accounting systems within nations. Garratt (2001) is an advocate for action learning within business organisations, and sees a company's board of directors as responsible for policy learning. In doing so they must identify changes occurring within six primary classes of environmental variables. Morrison (1992) describes environmental scanning as a method enabling decision-makers both to understand the external environment and the interconnections of its various sectors to an institution's planning and decision-making processes. The scanning method proposed for planning an institution's future typically relies on three primary classes of environmental variables. Harrison (2003) reviews the accounting and other literature prior to demonstrating the validity of measuring perceived environmental uncertainty, and sees two primary classes of environmental variables.

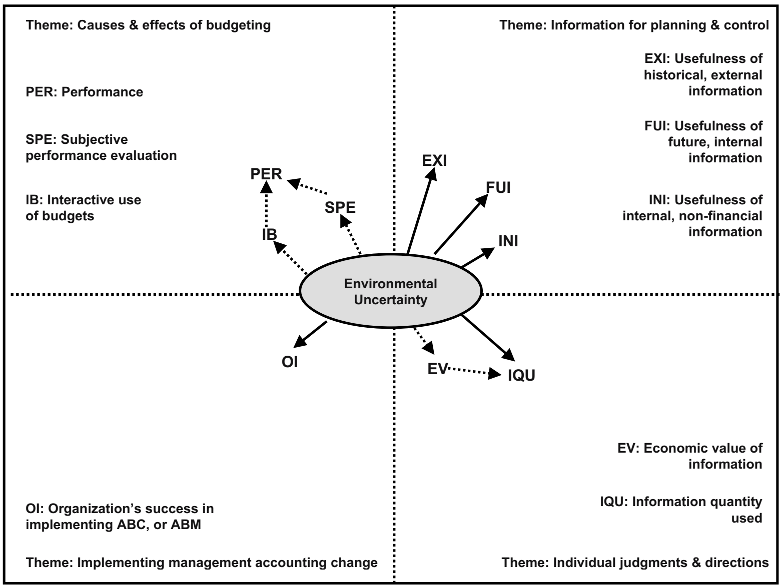


Figure 6. *Relationships between Environmental Uncertainty and other management accounting variables: interpreted by author from Luft and Shields (2002)*

These examples seem collectively to identify a set of environmental variables commonly found to, or believed to, affect accounting and other policy choices for informing decision-making. The set so derived is reflected in Figure 7, extending into the secondary classifications. Results suggest concerns as to a firm's impact on ecosystems are unlikely to compete effectively against other environmental variables affecting accounting policy and practice. From what appear to be a few isolated experiments Lewis and Harvey (2002), and Ozanne and Mengue (2000) provide contrary evidence to suggest researchers can sample around, say, 150 manufacturing firms, and find examples where managerial concerns over ecosystems are sufficient to affect accounting and other behaviours.

4 SUMMARY

This chapter argues the situation of forming and implementing EMA policy at jurisdictional and enterprise levels is neither puzzle (for which formula-based solutions are sufficient), nor problem (where ingenuity and skill may eventually provide a solution), but a mess (where searching for shape and structure is a pre-condition to finding solutions). A visual language combining text, images, and shapes through readily available computing technologies can provide shape and structure to social messes of policy design and organisational management. Sections 2 and 3 offer seven visualisations on process and content aspects to the messy challenge of EMA policy. The visualisations yield the following insights into policies for diffusing EMA practice between and within organisations:

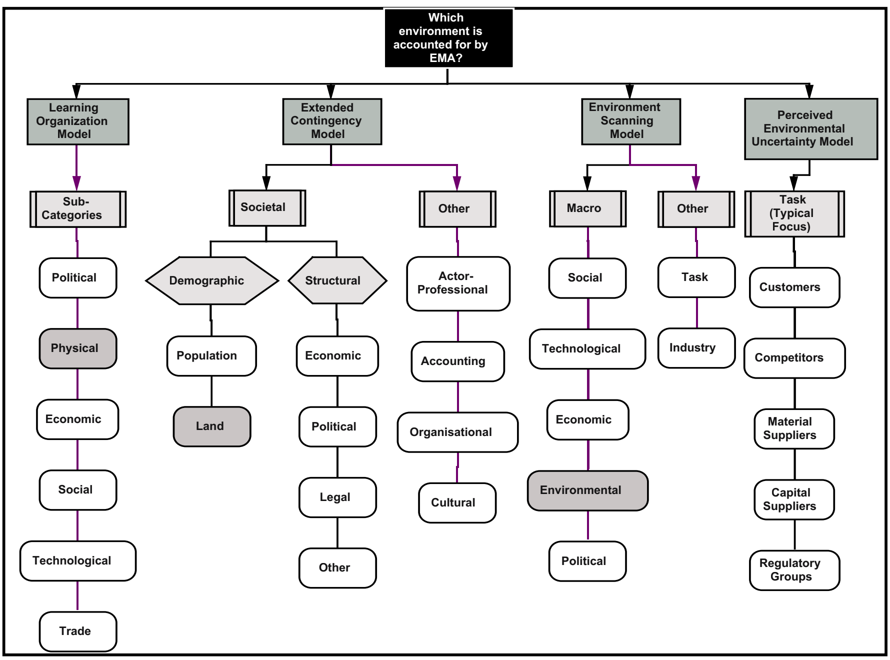


Figure 7. *Classes of Environmental Variables Affecting Accounting Policy Choice: Adapted from Gerhady (2002), Garratt (2001), Morrison (1992), Harrison (2003)*

- The innovation adoption curve of classical diffusion theory can be a useful device for analysing secondary data on cumulative totals of businesses engaging in activities indicative of EMA practice. The device is illustrated using EMA promotional policies and innovation diffusion opportunities starting at global scale in the early 1970s. Engagements by businesses and other organisations in CER are used as an indicator to evaluate policy performance. The performance indicators show a gap at global scale (possibly some 7.5M businesses) between adoption progress to date and critical mass policy target that cannot be closed by using ineffective policy instruments. Results support other evidence showing the information deficit model to be ineffective as an instrument for behavioural change.

- Classical diffusion theory identifies three types of innovation-decision. Of these, the authority innovation-decision will clearly diffuse an idea, practice, or object through a social system at rates much faster than can be obtained through optional or collective innovation-decisions. Differences between policy instruments in terms of their impact on adoption rates are illustrated in this chapter with examples from Australia's manufacturing and local government industries.

- Effective dialogue between maker and taker yields good policy outcomes. Effective dialogue between a potential adopter with another person of similar skills and experience, and some knowledge of the innovation being considered, will yield higher rates of adoption than can be achieved using mass media communication. An illustration is provided using mid-1990s data from Europe's manufacturing industry. The European Community Innovation Survey may well be an important source of data in future considerations on designing EMA policy.

- EMA practice is both a process innovation and an organisational innovation. Empirical studies in European manufacturing industry have led to the construction of a decision episode framework for understanding and illustrating the process of organisational innovation. The framework connects three key elements: an innovation pool likely to be too complex for any individual to understand; change agents with some knowledge of some elements in the pool; and a person able to span the boundaries between his or her organisation by networking with change agents. An illustration based on a case study and personal experience of the author applies the decision episode framework to the process of an EMA innovation pool considered by the Eurobodalla Shire Council of New South Wales.

The visualisations in this chapter also consider the contextual structure of mainstream management accounting practice, and illustrate the search for structure and shape to EMA in two ways:

- A systemic mapping on causes and effects of management accounting by Luft and Shields (2002) shows connections across some 500 variables identified through a review of theory-based evidence. Of these variables, only one – Environmental Uncertainty (EU) – seems related to EMA practice. Shapes showing the limited number of connections between EU and other management accounting variables are presented against four of the thematic maps created by Luft and Shields (2002). The analysis illustrates the probability of very weak connections between mainstream accounting practice and EMA.

- A key belief behind the development of EMA practice, and of public policies promoting its adoption, is that raising the environmental performance of organisations will improve eco-system condition. Research to establish which among many possible EU variables may affect accounting policy choice has necessarily led to attempts in taxonomy. Four classifications of environmental variables from within the accounting and management literature are presented. The visualization suggests the already weak connection between EMA and mainstream management accounting variables is diluted further when the many contexts within which EU affects accounting and other policy choices are identified. Few acknowledge or place importance on the nexus between environmental performance and eco-system condition.

Looking at the challenge of forming and implementing EMA policy as a mess requiring shape and structure necessarily leads inquiry beyond the immediate interests and discipline of scholar-practitioners in accounting. Social marketing, social network analysis, grassroots rather than top-down innovation, information and communication tools for informing and engaging publics, the shifting sands of environmental governance, visual language, and above all, using metrics to meet both horizontal comparison and vertical integration functions, are among ways and means for discovering shape and structure in EMA.

REFERENCES

Aarø, L.E., Jøsendal, O. and Bergh, I.H. (1998), Interventions for smoke-free schools. From information deficit to social influence. *Reviews of Health Promotion and Education Online*. [online] [cited 9 July 2004] Available from Internet URL
http://www.rhpeo.org/ijhp-articles/1998/15/index.htm.

Ackoff, R.L. (1979), The future of operational research is past. *Journal of the Operational Research Society 30*: 93-104. [online] [cited 13/7/04] Available from Internet URL
http://www.sociate.com/texts/AckoffFutureofORIsPast.pdf.

Australian Bureau of Statistics (2002), *Environment and Natural Resources Survey,* Catalogue No. 4611.0, Canberra.

Baker, S. (2001), *Environmental Governance in the EU*. School of Social Sciences Working Paper Series 12. Cardiff University. [online] [cited 12/7/04] Available from Internet URL:
http://www.cf.ac.uk/socsi/publications/workingpapers/numeric-list.html.

Burritt, R.L. (2004), Challenges for Environmental Management Accounting. In Rikhardsson P et al. (eds), *Implementing Environmental Management Accounting: Status and Challenges*. pp. 1944. Dordrecht: Kluwer Academic Publishers.

Campbell, K.S. (1998), The Effects of Information Design on Perception of Environmental Risk. *Society for Technical Communication Proceedings*. [online] [cited 11/7/04] Available from Internet URL http://www.stc.org/confproceed/1998/PDFs/00064.PDF.

Castree, N. (2002), Environmental issues: from policy to political economy. *Progress in Human Geography 26*(3):357-365. [online] [cited 9/7/04] Available from Internet URL http://www.strath.ac.uk/Departments/Geography/pdf/castree.pdf.

Coastal Cooperative Research Centre (undated), Citizens Science Toolbox [online] [cited 17/7/04] Available from Internet URL: http://www.coastal.crc.org.au/toolbox/details.asp?id=5.

Dull, R.B. and Tegarden, D.P. (1999), A Comparison of Three Visual Representations of Complex Multidimensional Accounting Information. *Journal of Information Systems 1*3(2). [online] [cited 13/7/04] Available from Internet URL http://aaa-is.byu.edu/Publications/Journal/fall99.htm.

Engel, H.W. (undated), *EcoMapping*. [online] [cited 14/7/04] Available from Internet URL: http://www.ecomapping.org.

European Communities (2001), *Statistics on Innovation in Europe: Data 1996-97*. Luxembourg: Office for Official Publications of the European Communities.

Garratt, B. (2001), *The Learning Organization: Developing Democracy at Wor*k. London: HarperCollinsBusiness.

Gerhardy, P.G. (2002), *An Extended Contingency Model of Environmental Factors Influencing National Accounting and Disclosure Practices*. School of Commerce Research Paper Series. 02-8. Adelaide Finders University. [online] [cited 2/7/04] Available from Internet URL: http://www.ssn.flinders.edu.au/commerce/researchpapers/02-8.pdf.

Gladwell, M. (2001), *The Tipping Point: How little things can make a big difference*. London: Abacus.

Glasser, H. (1998), On the Evaluation of 'Wicked Problems'; Guidelines for Integrating Qualitative and Quantitative Factors in Environmental Policy Analysis. In: Borri, D., Barbanente, A., Khakee, Lichfield, N. and Prat, A. (eds), *Evaluation and Practice and Urban Interplay in Planning*, pp. 229-249. Dordrecht: Kluwer..

Goodstat, M.S. (1978) Alcohol and drug education: models and outcomes. *Health Education Monographs,* 6 (3): 263-279.

Gray, R. (2002), *Of Messiness, Systems and Sustainability: Towards a more social and environmental finance and accounting*. Working Paper Series 2002/6. Department of Accounting and Finance, University of Glasgow. [online] [cited 12/7/04] Available from Internet URL www.accfin.gla.ac.uk/AccFin/UploadedDocuments/ WorkingPapers/2002/ROBG1-2002-6.pdf.

Hartley, C.P. (1903), Means of Preventing Soil Washing. *Yearbook of Agriculture, 1903*, pp. 178-179. Washington, DC: US Department of Agriculture.

Harrison, J.L. (2003), Perceived environmental uncertainty: validation of a measure from the accounting literature. *Australasian Journal of Business and Social Inquiry. 1* (3). [online] [cited 12/7/04] Available from Internet URL: http://www.scu.edu.au/ajbsi/papers/vol1/harrison.pdf.

Horn, R.E. (2001), *Knowledge Mapping for Complex Social Messes*. [online] [cited 11/7/04] Available from Internet URL http://www.stanford.edu/~rhorn/a/recent/SpchPackard.html.

Horn, R.E. (1999), *Visual Language: Global Communication for the 21st Century*.by Macrovu Press.

Kolk, A. and Mauser, A. (2002), The Evolution of Environmental Management: from stage models to performance evaluation. *Business Strategy and the Environment 11:* 14-31. [online] [cited 12/7/04] Available from Internet URL: http://papers.ssrn.com/sol3/papers.cfm?abstract_id=31962.

Kollmuss, A. and Agyeman, J. (2002), Mind the Gap: why do people act environmentally and what are the barriers to pro-environmental behaviour? *Environmental Education Research, 8* (3): 239-260.

Lachapelle, P.R., McCool, S.F. and Patterson, M.E. (2003), Barriers to Effective Natural Resource Planning in a 'Messy' World. *Society and Natural Resources 16* (6): 473-490. [online] [cited 9/7/2004] Available from Internet URL http://taylorandfrancis.metapress.com/app/home/contribution.asp?wasp=h0xf4mvhugdvy.

Lambe, P. (2002), *Accounting for Knowledge Management*, Presentation to 16th World Congress of Accountants. [online] [cited 12/7/04] Available from Internet URL http://www.greenchameleon.com/thoughtpieces/account.pdf.

Lewis, G.J. and Harvey, B. (2002), Perceived Environmental Uncertainty: The Extension of Miller's Scale to the Natural Environment. *Journal of Management Studies 38* (2): 201-234. [online] [cited 15/504] Available from Internet URL: http://www.blackwellpublishing.com/abstract.asp?ref=0022-2380.

Luft, J. and Shields, M.D. (2003), Mapping management Accounting: Graphics and guidelines for theory-consistent empirical research. Accounting, *Organizations and Society 28* (2-3): 169-249.

Maurel, P. (ed). (2003), *Public Participation and the European Water Framework Directive: Role of Information and Communication Tools*. WorkPackage 3 report of the HarmoniCOP project – Harmonising Collaborative Planning.

Marks, L. and Godfrey, M. (2001), *Changing Practice in Line with the Evidence*: Report Four, Nuffield Institute for Health. [online] [cited 7 July 2004] Available from Internet URL http://www.nuffield.leeds.ac.uk/downloads/portfolio/paper4.pdf.

Mathews, M.R. (1997), Twenty-five years of social and environmental accounting research: is there a silver jubilee to celebrate. *Accounting, Auditing & Accountability Journal 10* (4): 481-531.

Meadows, P., Coleman, S. and Palto, M. (1999), *Measuring Environment Related Transactions: Report on a Survey of Local Government Authorities in Australia*. Australian Centre for Local Government Studies Working Paper, Canberra University of Canberra.

Morrison, J.L. (1992), Environmental Scanning. In: Whitley, M.A., Porter, J.D. and Fenske, R.H. (eds). *A primer for new institutional researchers,* pp. 86-99. Tallahassee FL. [online] [cited 31/5/04] Available from Internet URL: <http.horizon.unc.edu/courses/papers/enviroscan/>.

Napier, T.L. and Napier, S.M. (2002), Implementing Soil and Water Conservation Production Systems at the Farm Level, in *International Environmental Modelling and Software Society Proceedings* [online] [cited 23 Dec 2003] Available from Internet URL <:http://www.iemss.org/iemss2002/proceedings/pdf/volume%20tre/421_napier.pdf>.

OECD (2001), *Structural Statistics for Industry and Services*, Paris.

Office of Pollution Prevention and Toxics (1994), *Stakeholders' Action Agenda: A Report of the Workshop on Accounting and Capital Budgeting for Environmental Costs*, (December 5-7, 1993). US Environment Protection Agency, Washington DC. [online] [cited 19/7/04] Available from Internet URL < http://www.emawebsite.org/documents/emaric_107.htm>.

Osborn, D. (2001), *How environmental management accounting supports the 'Good Government, better living' vision of the Eurobodalla Shire Council, New South Wales'* [online] [cited 24/7/04] Available from Internet URL ,http://www.emawebsite.org/documents/emaric_167.pdf>.

Osborn, D., Savage, D., Reyes, M.F. and Muradyan, T. (2002), *Images of effectiveness, equity and efficiency in the diffusion of environmental management accounting*, Canberra: Green Measures Working Paper [online] [cited 11/7/04] Available from Internet URL <:http://www.emawebsite.org/documents/emaric_316.pdf>.

Osborn, D. (2003a), *Prospects for Radical Change in the Diffusion and Adoption of Environmental Management Accounting*, Canberra, Green Measures Working Paper [online] [cited 18 Dec 2003] Available from Internet URL <:http://www.emawebsite.org/documents/emaric_414.pdf>.

Osborn, D. (2003b), *Visualizing the Challenge of Implementing Environmental Management Accounting Policy*. Canberra: Green Measures Working Paper, unpublished.

Ozanne, L.C. and Mengue, B. (2000), *The Influence of Natural Environmental Orientation on Business Performance and Employee Attitudes*. ANZMAC 2000 Proceedings: Visionary Marketing for the 21st Century: facing the Challenge. [online] [cited 12/6/04] Available from Internet URL: <http:130.195.95.71:8081/www/ANZMAC2000/Cdsite/papers/no/Ozanne1.pdf>.

Passmore, J. (1974), *Man's responsibility for nature: ecological problems and Western traditions*. 1st ed.. London: Duckworth.

Phelan, J.T. and Basinger, D.L. (1993), *Engineering in the Soil Conservation Servic*e. Historical Notes #2, Soil Conservation Service, US Department of Agriculture. [online] [cited 7 July 2004] Available from Internet URL < http://www.nrcs.usda.gov/about/history/articles/>.

Pidd, M. (1996) *Tools for thinking: modelling in management science*. Chichester: John Wiley & Sons Ltd.

Pidd, M., Mackenzie, A., Rooksby, J., Sommerville, I., Warren, I. and Westcombe, M. (2003), *Wisdom, Decision Support and Paradigms of Decision Making*, Lancaster University Management School Working Papers, 2003/060. [online] [cited on 7/7/04] Available from Internet URL: http://www.lums.co.uk/publications.

Reid, L.M., Ziemer, R.R., and Lisle, T.E. (1996), Approaching messy problems: strategies for environmental analysis, in *Proceedings, Watershed '96: Moving Ahead Together.* [online] [cited 9 July 2004] Available from Internet URL <http://216.48.27.142/pubs/viewpub.jsp?index=357>

Rittel, H.W.J. and Webber, M. (1973), Dilemmas in a general theory of planning. *Policy Science 4*: 155-169.

Rogers, E.M. (2003), *The Diffusion of Innovations* (5th ed.) New York: Free Press.

Savage, D., Ligon, P., and Lomsek, J. (2002), Policy Pathways for Promoting Environmental Management Accounting (EMA). In: *Environmental Management Accounting Policies and Linkages*. New York: UN Division for Sustainable Development.

Savage, D. (2004), The Work of EMARIC and the UN EMA Expert Working Group. *Advances in Environmental Accounting. Proceedings of the ACCA/Environmental Agency Seminar,* pp.19-23. London: Certified Accountants Environmental Trust.

Salwasser, H. (2002), *Navigating through the wicked messiness of natural resource problems: roles for sciences, coping strategies, and decision analysis*, Sierra Science Symposium, [online] [cited 12 Dec 2003] Available from Internet URL <:http://www.fs.fed.us/r5/snfpa/science/salwasser-wickedproblems.pdf>.

Scott, W.A.H. and Gough, S.R. (2003), *Sustainable Development and Learning: framing the issues*. London/New York: RoutledgeFalmer.

Schaltegger, S., Herzig, C., Kleiber, O. and Müller, J. (2002), *Sustainability Management in Business Enterprises: Concepts and Instruments for Sustainable Organisation Development*. Berlin: Federal Ministry for the Environment, Nature Conservation and Nuclear Safety.

Swan, J., Newell, S. and Robertson, M. (2000), The diffusion, design and social shaping of production information management systems in Europe. *Information Technology and People* 13 (1): 27-45.

Tegarden, D.P. (1999), Business Information Visualization. *Communications of the Association for Information Systems 1* (4). [online] [cited 13/7/04] Available from Internet URL http://www.cob.vt.edu/accounting/faculty/dtegarden/wrk-paper/BusInfoVizTut.pdf.

Tellus Institute (undated), *Environmental Management Accounting Program*. Business and Sustainability Group. [online] [cited 22/7/04] Available from Internet URL: http://www.tellus.org/b&s/index.html.

Thompson, E.L. (1978), Smoking education programs 1960-1976. *American Journal of Public Health 68* (3): 250-257.

Tufte, E. (1992) *The visual display of quantitative information*. Graphics Press.

Tufte, E. (1997) *Visual explanations: images and quantities, evidence and narrative*. Graphics Press.

Warfield, J.N. (1976), *Societal Systems: Planning, Policy and Complexity*. New York: John Wiley & Sons.

World Resources Institute (2003), *World Resources 2002-2004: Decisions for the Earth: Balance, voice, and power.* UN Development Programme, UN Environment Programme, World Bank, World Resources Institute. [online] [cited 4/7/04] Available from Internet URL http://governance.wri.org/pubs_description.cfm?pubID=3764>.

SECTION 2

EXPLORING EMA IMPLEMENTATION ISSUES

CHAPTER 6

ENVIRONMENTAL PERFORMANCE AND THE QUALITY OF CORPORATE ENVIRONMENTAL REPORTS: THE ROLE OF ENVIRONMENTAL MANAGEMENT ACCOUNTING

MARCUS WAGNER

Centre for Sustainability Management, University of Lueneburg, Germany

mwagner@uni-lueneburg.de

Abstract. This article analyses and discusses whether there is an association between environmental performance and corporate environmental reporting in the paper and electricity industries in Germany and the United Kingdom and what the influence of environmental management accounting is on this link. After discussing environmental performance measurement and environmental reporting in general, the chapter introduces a measurement framework for both as the basis of an empirical study. Subsequently, the major empirical findings from a cross-sectional survey of corporate environmental reports and environmental statements as well as environmental performance indicators for air and water emissions in the above industries and countries are reported. These findings suggest that consistency between environmental performance and environmental reporting (operationalised empirically in terms of statistical correlation) is relatively rare, although (as is argued in the article) future credibility of companies will most likely depend on it. The findings also reveal that environmental performance tend to be linked to country location whereas quality of corporate environmental reports tend to be associated to sector membership. The chapter attempts an explanation of this, relating the findings to differences in environmental legislation in both countries. It concludes with implications for the use of environmental reports by third parties as well as a number of recommendations, especially concerning the need for more standardised indicators and reporting procedures.

P.M. Rikhardsson et al. (eds.), Implementing Environmental Management Accounting, 105-122

1 ENVIRONMENTAL PERFORMANCE MEASUREMENT AND CORPORATE ENVIRONMENTAL REPORTS

Environmental performance measurement (EPM) can be defined as the measurement of the interaction between business and the environment (Bennett and James, 1997). The physical environmental performance of a company or site can be defined by its performance with regard to environmental aspects such as mass, energy or pollutant flows through the manufacturing process, which constitute a direct relationship between firms and the environment (ISO, 1996). Environmental performance indicators (EPIs) are frequently used to measure performance defined in this way. EPIs can be quantitative (i.e. measured on a continuous, interval or ordinal scale) or qualitative (i.e. measured on a nominal scale). They are of special importance since they reflect an important link between management performance and environmental conditions. In theory, the firm-internal basis for EPIs and EPM is environmental accounting, which can be used in the contexts of financial or management accounting. In the first context, it addresses an external audience and is aimed at the estimation and public reporting of environmental liabilities and financial material environmental costs (Schaltegger & Burritt, 2000). In the context of management accounting, which uses a broad range of cost and performance data for internal decision making, environmental management accounting incorporates a number of tools, such as eco-controlling, eco-balancing, ecological accounting, life-cycle assessment (LCA) and indicators for sustainable development used in an firm-internal context (Schaltegger and Sturm, 1992, Young and Rikhardsson, 1996, Young and Welford, 1998). The aim of environmental management accounting (EMA) is to provide tools to integrate environmental aspects into cost allocation, capital budgeting and process or product design procedures (EPA, 1995). One specific tool of EMA is eco-balancing (synonymous: internal ecological accounting or ecological bookkeeping) which provides site and company-level information on environmental aspects and impacts (Schaltegger and Burritt, 2000). In this eco-balancing resembles very much a site-specific LCA inventory analysis. An eco balance forms the basis for aggregated environmental performance indicators. Schaltegger and Burritt clarify this by stating:

> "Sometimes, a complete inventory provides enough information to see what the main environmental problems are and where they originate. In such a case, priorities for environmental protection and pollution prevention can be defined using the inventory. However, in most cases, the inventory provides an enormous amount of unassessed, detailed data that cannot be interpreted accurately by management. If this is the case, an impact assessment of the inventory data is clearly necessary." (Schaltegger and Burritt, 2000 p. 275).

EPIs can thus be understood as one way of aggregating inventory data, in doing so providing an impact assessment (with or without utilising weighting procedures). Conceptually therefore, EPIs are an outcome of an eco balance, even though it is not essential to carry out an eco balance in order to arrive at EPIs. Given that eco-balancing is an EMA tool the question arises how environmental performance, environmental reporting and environmental management accounting are related.

Usually, EPIs and environmental performance in general are reported in corporate environmental reports (CERs), based on an environmental reporting process. Given that many external assessments of firms are based on CERs as a whole, the question arises, how the actual environmental performance of a company or site compares to the quality of its environmental reporting process. This is of particular relevance, since work comparing environmental performance and legislation with economic performance is often based on CERs as far as concerns measurement of environmental performance (Hitchens et al., 1998, 2000, Schaltegger and Synnestvedt, 2002). This is the case even though there is no guarantee that good reporting quality and good environmental performance are correlated, if reports are merely "green glossies". The question here is what causation may derive for instance from the use of eco-balancing or other EMA tools, as revealed by reporting of the results of an eco balance in an environmental report.

Corporate environmental reports (CERs) are defined as stand-alone reports issued by companies to disclose environmental information available to the public (Brophy and Starkey, 1996). Site-level and company-level environmental reports are the two main types of CERs used, mostly in the context of voluntary environmental reporting[1]. One of the most widespread voluntary reporting schemes is the EU Eco-Management and Audit Scheme, EMAS (CEC, 1993). EMAS is based on site-level reporting and thus requires only a site-level environmental statement for which dtailed guidelines exist. EMAS requires periodic publication of an environmental statement which has to include, among other things, an assessment of all significant environmental issues of relevance to the company's activities. A summary of figures on pollutant emissions, waste generation, consumption of raw materials, energy and water, noise emissions and other significant environmental aspects of relevance to the company is also required (CEC, 1993, 2001, Skillius and Wennberg, 1998). Full environmental statements under EMAS conforming to these requirements have to be prepared after an initial review (i.e. when an environmental management system according to EMAS is introduced in a firm) or upon completion of a full audit which is required every three years (CEC, 1993, Skillius and Wennberg, 1998). Simplified environmental statements have to be produced annually according to EMAS.

CERs have a variety of potential users (e.g. businesses, financial institutions, consumers, communities and government agencies); this makes different reporting requirements necessary (Bennett and James, 1998). Although CERs have been widely produced for over a decade, empirical research reveals scepticism about the value of companies' environmental reporting. A survey by Bennett and James (1997) among environmental managers finds that less than 50 per cent of the respondents agree that CERs create benefits that more than justify the resources invested in their production. Greater support was found for the statement that site reports create benefits that justify the resources invested in their preparation, a statement with which almost 75 per cent of the respondents agreed.

One explanation for these results can be that site-level information is more suitable to inform stakeholders that are interested in localised environmental impacts of plant operations (Schaltegger and Burritt, 2000). However, shareholders and regulators are likely to be more concerned about corporate environmental performance in total and should therefore prefer company-level CERs. This last argument contradicts empirical findings to some extent as one would expect higher appreciation of CERs. It is possibly explained by the fact that environmental reports are still predominantly used within firms – i.e. by internal stakeholders (Bennett and James, 1997) and by the possibility that the level of aggregation in company-level reports is considered less reliable in terms of informing about the actual environmental performance of firms. Also, regulators still rely much on legislation and statutory reporting which is usually less discretionary than the contents of CERs.

2 RESEARCH QUESTIONS, METHODOLOGY AND SURVEY DESIGN

The evaluation of CERs is based on report quality alone and usually does not include the actual physical environmental performance of a company. However, voluntary or mandatory environmental reporting may benefit the physical environmental performance of a company as it forces companies to measure their environmental aspects (or even impacts) and to communicate these to their stakeholders (Skillius and Wennberg, 1998) which can help identifying weaknesses of firms' environmental management. On the other hand the empirical research reported above suggests disillusionment with the low number of external readers of environmental reports and the comparatively lower reliability of much of the data within these reports (IRRC, 1995). As a result, one could formulate the hypothesis that no association between the quality of CERs and the level of environmental performance will be observable.

The research question addressed in this chapter is therefore whether environmental reporting and a company's actual environmental performance are positively associated. If this were the case, then good environmental reporting and good environmental performance would be linked. On the other hand, if no association exists this would question the external use of CERs, since it would raise doubts regarding their credibility and consistency. To operationally measure environmental performance (according to ISO 14031 as defined in ISO, 1996, 1999) and the quality of environmental reporting (based on criteria mainly developed and proposed by IRRC, 1995, Schaltegger and Burritt, 2000, Skilius and Wennberg, 1998), three groups of variables have been selected (general variables, environmental performance variables and environmental reporting variables) all of which are summarised in Table 1 and for which data was gathered in an empirical survey.

The survey covered the quality of environmental reporting (as measured by the criteria set out in the right column of Table 1) and the environmental performance (middle column) among firms in the electricity and paper industries in the United Kingdom and Germany to analyse possible association between environmental performance and environmental reporting. The two sectors and countries were chosen partly because of the availability of a large number of corporate environmental reports (e.g. under ISO 14001, see Hillary, 2000) and site-level environmental statements under EMAS. Such reports or statements are usually externally validated and therefore guarantee a minimum level of data quality. More importantly however, it was considered of importance to base the research on environmentally intensive sectors as well as on countries operating under a common basic regime (that of the European Community) yet having distinct national characteristics (Gordon, 1994). Additionally both sectors produce fairly homogenous products which allowed a comparison of environmental performance. The sector classification used is based on NACE (Nomenclature generale des Activites économiques dans les Communautées Européennes) codes 21.1 (Paper) and 40.1 (Electricity).

All identifiable companies or sites in the two sectors and countries that produced useable environmental reports or statements were included. Information on companies publishing EMAS statements was gathered from the EMAS Service Desk in Luxembourg and companies publishing non-EMAS environmental reports were identified through internet searches, especially of trade association web sites. Environmental reports were ultimately requested from 56 companies or sites in the paper sector and 35 in the electricity sector. Out of these 34 (Paper) and 27 (Electricity) were used in the analysis. These were partly reports of the same company for different years between 1994 and 1997. Although a higher total number of reports has been received from the paper sector, the quality of reports was generally better in the electricity sector. Whereas in the paper sector the majority of reports analysed were environmental statements prepared under EMAS, the majority of reports in the electricity sector were not published under the EMAS scheme. Generally, the response rate was very high, equalling on average 85 per cent over the whole sample.

***Table 1**. List of variables used in the analysis*

General	*Environmental performance*	*Environmental reporting*
• Firm identifier • Year of publication of report • EMAS verification • Full or part audit • Industry sector • Country • Site- or company level report • Number of employees (firm size) • ISO 9000 certification • ISO 14001 certification • BS 7750 certification • Annual production output in Kilo tonnes or Mega Watt hours (kt or MWh)	• Annual chemical and biological oxygen demand (COD and BOD) loads • Annual nitrogen (N) load • Annual phosphate (P) load • Annual absorbable organic halogen (AOX) load • Annual water input • Annual carbon dioxide (CO_2), sulphur dioxide (SO_2) and nitrogenous oxide (NO_x) loads • Electricity generated from nuclear material as fuel input • Electricity generated from wind energy • Electricity generated from coal as fuel input or oil • Electricity generated from gas • Electricity generated from water energy	• Length of environmental report (number of pages) • Length of environmental policy (number of lines) • Discussion of sustainability in report • Use of the eco-balance method in the report • Number of water indicators used out of the following: BOD, COD, AOX, total suspended solids (TSS), nitrogen (N), phosphate (P), acidity (pH) • No. of air indicators used (CO_2, NO_x, SO_2, carbon monoxide (CO), dust) • Use of time-series (Years emissions are reported back)

3 RESULTS

3.1 Exploratory data analysis of air emissions and quality of environmental reports

Prior to the analysis, all environmental performance variables (measured as total emissions) were standardised with annual production output to arrive at efficiency measures. Based on these measures, the initial exploratory data analysis reported in the following found that the levels for most air emission efficiencies were significantly lower in Germany than in the United Kingdom. The Figures 1 to 3 each show box plots for the three air emission efficiencies analysed. The black bar in each box denotes the median value, whereas the boxes denote the inner two quartiles around the median, i.e. the inter-quartile range containing 50 per cent of the values. The whiskers denote the outer two quartiles around the median, i.e. they extend from the box to the highest and lowest values, respectively, while excluding outlier and extreme values.

The boxplots therefore also show the distribution of the variable in question and thus also to some degree how well the variable conforms to a normal distribution. Outlier values are identified by a circle and extreme values by an asterisk, and the number of the observation the value belongs to in the data set. Significant differences between two boxplots can commonly be identified by missing (or almost missing) overlap of the whiskers of these two boxplots. This is for example the case for the SO_2 emissions per unit of output in Figure 1 below, were the emission efficiencies (i.e. emissions per unit of production output) are significantly lower for the electricity sector in Germany compared to the United Kingdom.

This significant difference was also confirmed (at the 0.05 level) through parametric t-tests as well as non-parametric Mann-Whitney tests (Hair et al., 1998). No significant differences were found between the electricity and paper sectors in Germany or in the United Kingdom. Also, no significant differences could be identified for the paper sector in Germany compared to the United Kingdom. Thus, for SO_2 emission efficiency, only country-related significant differences for one of the two sectors analysed could be identified.

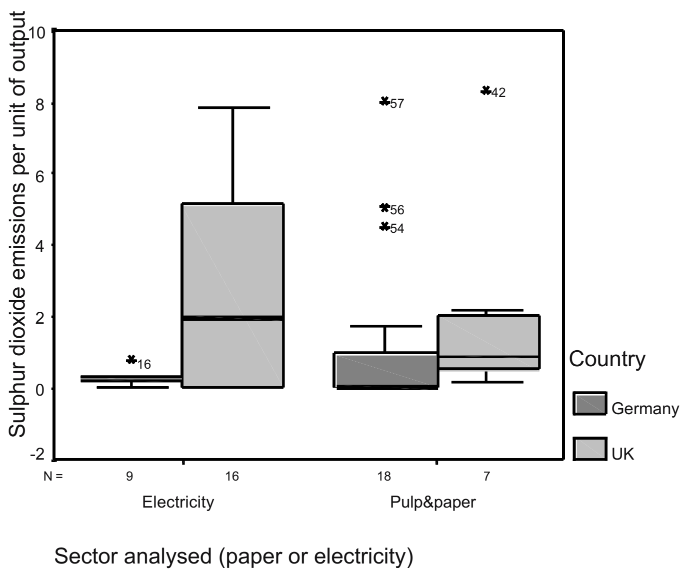


Figure 1. *Boxplots for SO_2 emissions per unit of output by sector (clustered by country)*

Next to SO_2 emissions, the mean CO_2 emissions per unit of output for the electricity sector in the United Kingdom are significantly lower (at the 0.01 level) than in the pulp and paper sector. In addition to that, the mean CO_2 emissions per unit of output were significantly different (at the 0.05 level) in the pulp and paper sector between the United Kingdom and Germany, with the latter having the lower mean.

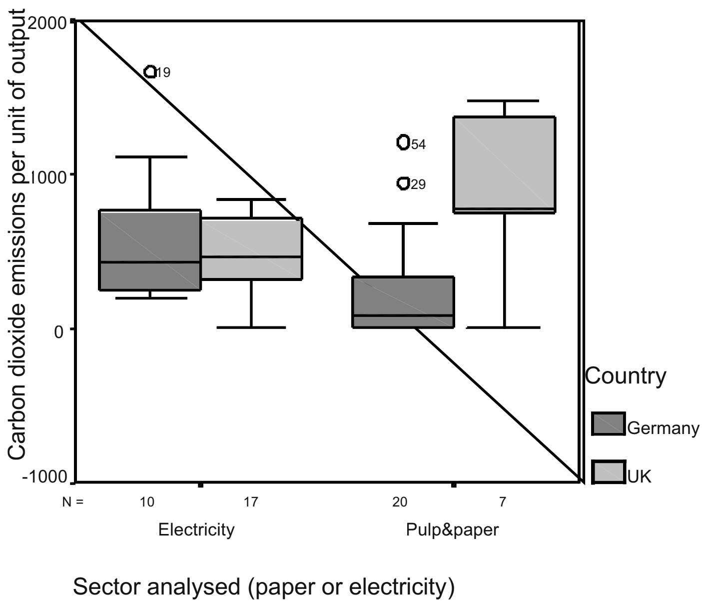


Figure 2. *Boxplots for CO_2 emissions per unit of output by sector (clustered by country)*

For NO_x emissions per unit of output (as can be seen from Figure 3) mean values were significantly lower (at the 0.05 level) for the electricity sector in Germany compared to the United Kingdom. It needs to be noted that these differences do not have any relevance beyond descriptive information as long as the different fuel mixes in both countries (probably leading to different sectoral carbon/sulphur/nitrogenous (di-)oxide emissions in the electricity sector) and different rates of self-generation of electricity in the paper sector (resulting in different emission profiles for this sector in the two countries) are not taken into account in more detail in the interpretation.

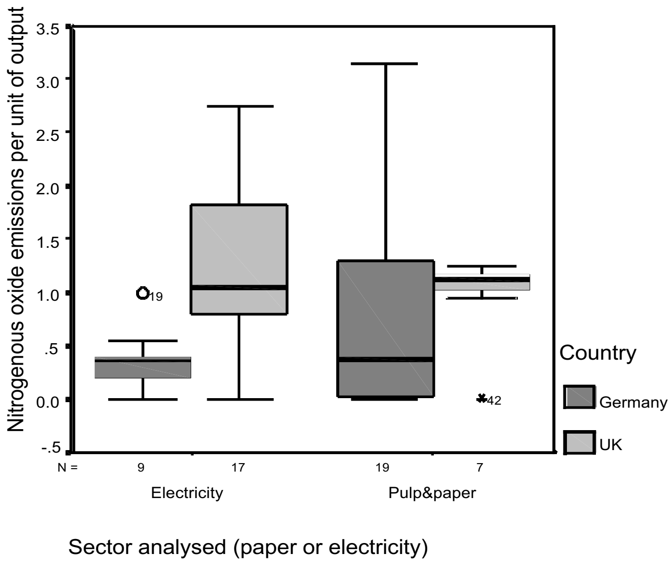


Figure 3. *Boxplots of NO_x emissions per unit of output by sector (clustered by country)*

As was found for Figures 1 to 3, the difference between emission efficiencies was significant for sulphur dioxide (SO_2) emissions in the electricity sector, carbon dioxide (CO_2) emissions in the paper sector and nitrogenous oxide (NO_x) emissions in the electricity sector between the two countries. However, these results have to be put into the fuel mix context of the two countries: if coal was a significantly higher fuel input in the United Kingdom, higher air emissions in Britain would be the result. Consequently, differences in emission efficiencies would to lesser extent be due to differences in the relevant legislation or differences in the quality of environmental management in both countries. However, it was found (based on t-tests) that fossil fuel input (coal, gas and oil) did not have a significantly different share as fuel input for electricity generation between the two countries. Differences in self-generation in the paper sector can, however, not be ruled out completely, but this would only concern CO_2 emission efficiencies).

Given this and that no significant difference in the mean values of emission efficiencies were found (except for CO_2) between the two sectors, it was concluded that differences in emission efficiencies are determined by country rather than by sector membership. This makes legal differences a more probable explanation of the results in that stronger environmental legislation in Germany may be a determining factor for better corporate environmental performance in Germany.[2] Especially the fact that more than one air emission is significantly lower in Germany than in the United

Kingdom supports such an often argued influence of environmental legislation (Gordon, 1994, James, 1997, Peattie and Ringler, 1994). For example, Peattie and Ringler (1994) note that Germany had already in 1991 significantly lower per-capita sulphur dioxide and nitrogenous oxide emissions and also set more ambitious emission reduction targets under the EU Large Combustion Plant Directive for the 1993-2003 period. James et al. (1997) expand on this, pointing to the fact that German legislation is more often based on discharge limits than UK regulation, which more frequently employs environmental quality standards for air or water bodies. This latter approach makes good environmental performance at the firm level (and thus also for whole industries) less likely. Even though there is (mainly within the framework of EU directives) a trend of convergence with regard to environmental legislation in different EU countries, this is only very recent. One example here is the recent tightening of sulphur dioxide emission reduction targets for the two largest power station operators in the United Kingdom (James et al., 1997). This, however, only occurred in 1996 with the target set for 2005 and has therefore almost no influence on the data analysed in this chapter. A possible influence for the 1997 tightening can theoretically not be ruled out, but, given that the two operators most likely took no measures prior to finalisation of the 1996 tightening of reduction targets can almost be excluded in practice. Based on these considerations it seems likely that differences in the stringency of environmental regulation concerning air emissions are an important explanatory factor for the significant differences found in environmental performance with regard to air emission efficiencies between the two countries.

After this brief explanatory data analysis, the remainder of this article will analyse differences in reporting quality between sectors and countries and in particular the main research question on the link between environmental report quality and corporate environmental performance.

3.2 Correlation between environmental report quality and environmental performance

With regard to the quality of environmental reports analysis-of-variance (ANOVA) tests were carried out to identify significant differences between the two countries and sectors. Subsequent to reporting their results, the core research question of the chapter regarding the association between environmental report quality and corporate environmental performance is addressed. To measure the quality of environmental reports, the length of the report (in pages), the length of the environmental policy (in full page width-equivalent lines) and a 'sustainability reporting index' were used.[3] Variables for the use of quantitative environmental performance indicators were not used separately, since the 'sustainability reporting index' includes them to some extent. The length of an environmental report can be considered in a first approximation as a measure of the information content of the report and hence the level of detail of a firm's environmental reporting. The length of the environmental policy contained in the report is to a considerable degree proportional to the level (i.e. the depth and breadth) of corporate commitment to environmental management in general and as part of this also to firms' environmental reporting activities. One would expect that actual performance in terms of emission efficiencies is associated with the firms' environmental management and reporting quality.

Initially, both sectors were analysed, and Table 2 shows results of this analysis based on the analysis-of-variance (ANOVA) method. It is found that reports from the electricity sector are significantly longer (at 0.05 the level) and provide significantly more discussion of sustainability (at the 0.01 level) than in the paper sector. However, this is partly influenced by the fact that proportionally more reports in the paper sector are site-level statements, whereas comparatively more company-level reports have been received for the electricity sector. The average length of the environmental policy was not significantly longer in the electricity sector than in the paper sector. This is, however, not surprising, given that the contents of an environmental policy are generic, rather than sector-specific (IRRC, 1996).

Table 2*. One-way ANOVA of report quality for the sectors studied (Df (total) = 57)*

Sector	*Mean length of environmental report*	*Mean 'sustainability reporting index'*	*Mean length of environmental policy*
Electricity	32.96 pages	2.50 points	24.89 lines
Pulp and Paper	25.33 pages	1.80 points	23.87 lines
Both sectors	29.02 pages	2.14 points	24.36 lines
Significance of sector difference	Sig. = 0.032 F = 4.811	Sig. = 0.003 F = 9.507	Sig. = 0.796 F = 0.067

An ANOVA was also carried out for the above variables measuring the quality of the environmental reports to establish differences between two countries that were analysed. As can be seen from Table 3, between countries, only the score on the sustainability rating index differs significantly at the 0.05 level with the mean for the United Kingdom being significantly higher than the one for Germany. The quality of environmental reports was also analysed with respect to the number of employees as a proxy variable for firm size. However, no significant association could be found between the number of employees and any of the variables measuring the quality of environmental reports, so that firm size can be excluded as an explanation for the quality of reports.

Table 3. *One-way ANOVA of report quality for the countries studied (Df (total) =57)*

Country	*Mean length of environmental report*	*Mean 'sustainability reporting index'*	*Mean length of environmental policy*
United Kingdom	30.46 pages	2.50 points	24.79 lines
Germany	28.24 pages	1.91 points	24.30 lines
Both countries	29.02 pages	2.14 points	24.36 lines
Significance of sector difference	Sig. = 0.632 F = 0.395	Sig. = 0.025 F = 3.971	Sig. = 0.851 F = 0.162

Regarding the core research question as to whether environmental reporting and a firm's/site's environmental performance are correlated, no significant correlation was identified between different air and water emission efficiency variables in any of the interval-scale variables listed in the middle and right columns of Table 1. It was thus found that neither the use of more EPIs (as measured in terms of the relevant variables in the right column of Table 1) nor the production of an elaborate environmental report (in terms of the above three variables for environmental report quality) are negatively correlated with emission efficiencies/emissions per unit of output (ie associated with better environmental performance). Notably though, positive correlations (significant at the 0.01 and 0.05 levels) between the number of EPIs and emission efficiencies were found for both – air and water emissions – the latter could, however, only be analysed in the paper sector. The only exception to this pattern was a negative correlation ($R = -0.396$, significant at the 0.05 level) between the water input per tonne of paper produced and the number of water indicators used (BOD, COD, AOX, TSS, N, P, pH) for the paper sector data.

The only significant correlation supportive of the idea that environmental report quality and performance are positively linked was for the binary variable of whether an eco-balance was used in the report and different air and water emissions per unit of output with data for both sectors pooled (see Table 4 for a summary). Opposed to this, in the case of the average time that emissions were reported backwards in the reports (measured in years), as Table 4 shows, correlation was only significant for sulphur dioxide emissions per unit of production output. The fact that the correlation was positive means that this element of a report does relate to the environmental performance of firms, but not in the way that longer time-series correspond to better environmental performance, ie reduced emissions per unit of output. This is of particular interest, as usually time-series included in environmental reports show a falling emission trend, sometimes even for the last five to seven years.

Table 4. *Correlations for air emissions and report quality*

Report quality variable Emission variable (per unit of output)	Use of an eco-balance in the environmental report	Average time for which emissions were reported back
Air emissions factor score	Rpb = -0.355 (0.05 level)	R = 0.330 (0.05 level)
Sulphur dioxide emissions	Rpb = -0.310 (0.05 level)	R = 0.284 (0.05 level)
Nitrogenous oxide emissions	Rpb = -0.303 (0.05 level)	No significant correlation
Nitrogen emissions to water	Rpb = -0.504 (0.05 level)	No significant correlation

Next to sulphur dioxide emission efficiency, for the binary variable referring to the use of an eco-balance a negative (point-bivariate) correlation was found for other environmental performance measures, as well as for a factor score constructed from the three air emission efficiencies, indicating that the use of an eco-balance possibly reduces air and water emissions (Table 4). The exception here is the CO_2 emission efficiency which is not significantly correlated at all to the quality of environmental reports (even though in the factor score the significant positive effect of the other two air emissions analysed disguises this).

For the use of an eco-balance, a significant and negative (point-bivariate) correlation was found for the nitrogenous oxide emission efficiency (see Table 4), which suggests that the use of an eco-balance in an environmental report is a possible indicator for above-average/better environmental performance. As this is the only quality variable that had a positive link with the environmental performance of firms this would also be a very robust indicator. One could make the theoretical argument that eco-balancing is probably the most sophisticated form of input-output analysis currently used in corporate environmental management to establish the environmental effects of firms. An eco-balance is also a very sound basis for internal eco-controllling, ie internal decision making aimed at improving environmental performance (James et al. 1997, however also more critical views have been voiced, see e.g. Schaltegger and Sturm, 1992).

This suggests that the eco-balance is useful for reporting the actual environmental performance of a firm as well as for assessing the quality of environmental performance from the environmental report. This interpretation is further supported by the fact that the only significant correlation between water emissions and quality measures for an environmental report that could be established was a negative (point-bivariate) correlation between the use of an eco-balance in the report and the nitrogen emissions to water per unit of output in the paper industry. This implies a link of eco-balance use and better environmental performance for both environmental media analysed (air and water), thus lending further support to the conclusion that the use of an eco-balance is an indicator for above-average environmental performance.

However, this cannot be generalised to other variables, as was illustrated by the case of the average time for which emissions are reported backwards.

4 CONCLUSIONS AND RECOMMENDATIONS

The main objective of the research reported in this article was to assess to what extent the level of the physical environmental performance of companies and the quality of its corporate environmental reports in two industrial sectors and two EU countries are consistent and consequently what credibility should be attributed to such reports. The basic research question was whether environmental reporting and firms' actual environmental performance are positively associated. Also, it was an aim of the chapter to clarify the role of EMA tools for the link between reporting quality and environmental performance. The results suggest that good or elaborate environmental reports on average do not necessarily guarantee higher levels of environmental performance.

In order to assess the importance of other explanatory factors and to provide a more precise description of the variation in the underlying data set, other possible influences on environmental performance were analysed (see Section 3). These included for instance the effects of industry sector and country membership on environmental performance (Section 3.1) and possible sectoral or national differences in the use of physical indicators and the quality of environmental reports (Section 3.2). It was found, that country membership is more strongly associated with the level of environmental performance than is sector membership. All three air emission efficiencies (CO_2, sulphur dioxide, nitrogenous oxide) were on average significantly higher in the United Kingdom, than in Germany in at least one sector[4], whilst differences of emission levels between sectors were not significant, except for carbon dioxide. This probably points to a comparatively higher importance of environmental legislation on environmental performance. Although a relatively small sample size, and some (unavoidable) diversity in the sample due to the use of real-life firms in different industry sectors have to be acknowledged, various additional analyses were made to ensure that this would not seriously affect validity of the basic findings.

Some significant differences in report quality were found between sectors, whereas almost no significant differences were found between the two countries as concerns the quality of environmental reports[5]. The higher quality of reports in the electricity sector (in both countries) can be explained by a higher exposure of the electricity sector to environmentalist pressure. Distinguishing between ISO-certified and EMAS-verified companies, it was found that EMAS-verified firms have slightly higher environmental performance and use slightly less environmental performance indicators. However, due to the structure of the data set, this is explained by the fact that most EMAS-verified firms are in the paper sector, which uses comparatively lower numbers of indicators and that most of the EMAS-verified companies (ie the firms in the paper sector) are located in Germany which has stricter environmental legislation (Gordon 1994, Handler 1997, Scherer 1997).

Taken together, the results firstly suggest that there is no strong association between the quality of corporate environmental reports and the actual environmental performance of firms. It must be noted that this is only assessed in terms of correlation, which cannot necessarily be taken as proof of causation. However, the results imply that it would be rather speculative to assume that better environmental reporting causes better environmental performance, in which case it could be used as a valuable environmental management tool as well as a reliable proxy variable for external assessment of environmental performance given that reports usually address external audiences. It seems that companies do not measure what they can or want to manage from an environmental point of view, but rather measure what legislation requires.

Secondly, the findings also indicate that environmental performance is significantly linked to country (but not much to sector membership), whereas environmental report quality is more strongly linked to sector membership (but not much associated to country). This possibly explains the fact that almost no significant association between these two aspects could be found. One interpretation of this is that environmental legislation, which is mainly country-related, is a stronger driver of higher environmental performance, whereas environmental reporting is mainly rooted in voluntary environmental management schemes that tend to be more sector-related. This would also imply to some degree that legislation is more important in achieving performance than voluntary schemes, a conclusion that is in agreement with economic theory's assessment of different environmental policy tools[6] (Endres, 1994) and recent empirical research on the effect of voluntary schemes on environmental performance (Tyteca et al., 2002).

The results also imply that the use of a higher number of indicators or the production of detailed environmental reports are unlikely to be related significantly to better environmental performance of companies across entire industries. Only the reported use of an eco-balance seems to be positively correlated with better environmental performance. The observed negative correlation between emission efficiencies and the reported use of an eco-balance as an EMA tool for data gathering and aggregation points to the possibility that EMA is potentially very relevant for the ultimate levels of environmental performance that firms achieve. It seems that a detailed data collection process (which is much supported by the use of an eco-balance) and the resulting database assist much in the identification of optimisation potentials for improving environmental performance. This would explain why use of an eco-balance or similar EMA tools enables focus on reporting and improving the most important performance aspects.

In conclusion, the results of the research reported in this chapter point to the considerable need for standardisation of environmental performance measurement and the use of quantitative environmental performance indicators in order to make possible comparisons of environmental performance within and across sectors in future. The research raises certain doubts regarding the credibility of environmental reports, due to the lack of consistency with the firms' environmental performance. This reinforces the need to further support true and fair stakeholder information, e.g. through precise guidelines (see e.g. Grafe-Buckens, 1998, GRI, 2002, IRRC, 1995), in order to avoid confusion. In the case of eco-investment funds, country location of a company, or whether or not firms use the eco-balance method to record their environmental effects (or use similar EMA tools) might be a more reliable predictor for environmental performance than the larger number of criteria based on the quality of environmental reports/statements or on environmental management systems. This proposition should be analysed further in future studies.

Overall, this article finds that consistency in environmental performance, use of EPIs and environmental reporting is rare, but takes the view that future credibility of companies most likely depends on it to a large degree. This suggests the need to revise current standards for environmental management, leading to more standardised indicators and data collection procedures (Ditz and Ranganathan, 1997, Tyteca, 1996). Such a review should aim for example at a life-cycle approach to environmental performance measurement, inclusion and expansion of existing EMA tools and should include the broader sustainability agenda, thereby ultimately aiming at sustainability indicators (Schaltegger and Burritt, 2000, Tyteca, 1996, Wehrmeyer and Tyteca, 1998) and sustainability reporting (GRI, 2002) including for example distribution issues on the firm level as well as issues of employee participation (Cable, 1984). Recent developments in this respect give hope that industry and governments increasingly rise to the challenges of consistency and credibility (GRI, 2002).

Finally, with regard to environmental management accounting, the results indicate that EMA tools may have an important influence on linking the quality of environmental reporting to the environmental performance of firms. The fact that reporting the use of eco-balancing in an environmental report in the research reported in this chapter was significantly related to firms' environmental performance could mean that EMA tools in general have an important role in linking environmental reporting and environmental performance.

NOTES

1 Site-level environmental reports are often termed environmental statements (for example under the EU Eco-Management and Audit Scheme (EMAS) regulations), whereas company-level reports are usually referred to as environmental reports.

2 See Handler (1997) and Scherer (1997) for basic descriptions of the respective regulatory regimes with regard to environmental legislation in general and air emissions regulation in particular.
3 The 'sustainability reporting index' consists of the components eco-balance use, use of CO_2 and NO_x indicators and qualitative discussion of sustainability, which results in a value from 4 to 0, depending on if or if the components were not used in the environmental report. Using the arithmetic mean to calculate this scale was considered acceptable as a first approximation of the quality of sustainability reporting, since no detailed framework exists yet, which could provide appropriate weights for calculating a more refined index. CO2 and NOx are significant global pollutants (contributing e.g. to global warming) and eco-balances are important management tools to holistically reduce a company's environmental impact. Finally, the use of a qualitative indicator of sustainability discussion addresses the fact that many sustainability aspects cannot be quantified easily.
4 Due to insufficient data availability for the electricity sector, a comparison was not possible for water emissions here.
5 The variables measuring report quality were the length of the report, the length of the environmental policy, the sustainability index calculated for the report, whether or not an eco-balance was used, the total number of water-related environmental performance indicators and of air-related environmental performance indicators used in the report and the number of years for which emissions were reported backwards.
6 These are, broadly speaking, legislation, different economic instruments and voluntary schemes (Endres, 1994).

REFERENCES

Bennett, M. and James, P. (1997), *Environment-Related Performance Measurement: Current Practice and Trends*. Ashridge: Ashridge Management College.

Bennett, M. and James, P. (1998), *Environment under the Spotlight – Current Practice and Future Trends in Environment-Related Performance Measurement for Business*. London: Association of Chartered Certified Accountants (ACCA).

Brophy, M. and Starkey, R. (1996), Environmental Reporting. In: Welford, R. (ed.) *Corporate Environmental Management – Systems and Strategies*. London: Earthscan, pp. 150-176.

Cable, J. (1984), *Employee Participation and Firm Performance: A Prisoners' Dilemma Framework* (EUI Working Paper 84/126) Florence: European University Institute.

CEC (Commission of the European Communities) (1993), *EU 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*. Bruxelles: CEC.

CEC (Commission of the European Communities) (2001), Corrigendum to Regulation (EC) No. 761/2001 of the European Parliament and of the Council of 19 March 2001 Allowing Voluntary Participation by Organisations in a Community Eco-Management and Audit Scheme (EMAS). *Official Journal of the European Communities* L114 24 April 2001.

Ditz D. and Ranganathan J. (1997), *Measuring Up. Towards a Common Framework for Tracking Corporate Environmental Performance*. Washington DC: World Resources Institute (WRI).

Endres, A. (1994), *Umweltökonomie* (Environmental Economics). Tübingen: Verlag Cansier (available only in German).

EPA (1995), *Introduction to Environmental Accounting*. Washington, DC: U.S. Environmental Protection Agency.

GRI (Global Reporting Initiative) (2002), *Sustainability Reporting Guidelines*. Boston: GRI.

Gordon, J. (1994), Environmental Policy in Britain and Germany: Some Comparisons. *European Environment* 4 (3): 9-12.

Grafe-Buckens, A. (1998), *Environmental Statements: Meeting the User's Needs*. Paper presented at the International Institute of Industrial Environmental Economics (IIIEE) Invitational Seminar "Continuity, Credibility and Comparability" 13-16 June Eze, France.

Hair, J.F., Anderson, R.E., Tatham, R.L. and Black, W.C. (1998), *Multivariate data analysis with readings* (5th ed.). Englewood Cliffs: Prentice Hall.

Handler, T. (1997), Environmental Regulation in England and Wales. In: Handler, T (ed.) *Regulating the European Environment* (2nd ed.). Chichester & New York: John Wiley, pp. 55-73.

Hillary, R. (2000), ISO 14001 *Case Studies and Practical Experiences*. Sheffield: Greenleaf.

Hitchens, D., Birnie, J., McGowan, A., Triebswetter, U. and Cottica, A. (1998), *The Firm, Competitiveness and Environmental Regulation*. Cheltenham: Edward Elgar.

Hitchens, D., Triebswetter, U., Birnie, J., Thompson, W., Bertossi, P. and Bessori, L. (2000), *Environmental Regulation and Competitive Advantage – A Study of Packaging Waste in the European Supply Chain*. Cheltenham: Edward Elgar.

IRRC (Investor Responsibility Research Centre) (1995), *Environmental Reporting and Third Party Statements*. Washington, DC: IRRC and Global Environmental Management Institute (GEMI).

ISO (International Standards Organisation) (1996), *International Standard ISO 14031 Environmental Management – Environmental Performance Evaluation*. Geneva: ISO.

ISO (International Standards Organisation) (1999), ISO 14031. *Environmental Management. Environmental Performance Evaluation – Guidelines*. Geneva: ISO.

James, P., Prehn, M. and Steger, U. (1997), *Corporate Environmental Management in Britain and Germany*. London/Berlin: Anglo-German Foundation for the Study of Industrial Society.

Peattie, K. and Ringler, A. (1994), Management and the Environment in the United Kingdom and Germany: A Comparison. *European Management Journal* 12 (2): 216-225.

Schaltegger, S. and Burritt, R. (2000), *Contemporary Environmental Accounting*. Sheffield: Greenleaf.

Schaltegger, S. and Sturm, A. (1992), *Ökologieorientierte Entscheidungen in Unternehmen. Ökologisches Rechnungswesen statt Ökobilanzierung: Notwendigkeit, Kriterien, Konzepte* (Environmentally Oriented Decisions in Companies. Environmental Accounting instead of Ecobalancing: Necessity, Criteria, Concepts) (1st ed.). Bern: Haupt (available only in German).

Schaltegger, S. and Synnestvedt, T. (2002), The Link between "Green" and Economic Success: Environmental Management as the Crucial Trigger between Environmental and Economic Performance. *Journal of Environmental Management* 65: 339-346.

Scherer, J. (1997), Environmental Regulation in the Federal Republic of Germany. In: Handler, T. (ed.) *Regulating the European Environment* (2nd ed.). Chichester & New York: John Wiley, pp. 89-112.

Skillius, A. and Wennberg, U. (1998), *Continuity, Credibility and Comparability: Key Challenges for Corporate Environmental Performance Measurement and Communication*. Lund/Sweden: International Institute of Industrial Environmental Economics (IIIEE)/Lund University.

Tyteca, D. (1996), On the Measurement of the Environmental Performance of Firms – A Literature Review and a Productive Efficiency Perspective. *Journal of Environmental Management* 46: 281-308.

Tyteca, D., Carlens, J., Berkhout, F., Hertin, J., Wehrmeyer, W. and Wagner, M. (2002), Corporate Environmental Performance Evaluation: Evidence from the MEPI Project. *Business Strategy and the Environment* 11: 1-13.

Wehrmeyer, W. and Tyteca, D. (1998), Measuring Environmental Performance for Industry: From Legitimacy to Sustainability? *International Journal of Sustainable Development and World Ecology* 5: 111-124.

Young, C.W. and Rikhardsson, P.M. (1996), Environmental Performance Indicators for Business. *Eco-Management and Auditing* 3: 113-125.

Young, W. and Welford, R. (1998), An Environmental Performance Management Framework for Business. *Greener Management International* 21: 30-49.

CHAPTER 7

ENVIRONMENTAL RISK MANAGEMENT AND ENVIRONMENTAL MANAGEMENT ACCOUNTING – DEVELOPING LINKAGES

ROGER L. BURRITT

School of Business and Information Management, The Australian National University, Australia

roger.burritt@anu.edu.au

Abstract. Frameworks for environmental management accounting refer to a number of tools that assist managers to address the environmental effects of their businesses. One area that has not received systematic attention is the link between environmental management accounting information and risk (and environmental risk) management. As a step in this direction the paper, first, reviews risk management and environmental risk management while developing five research questions related to disclosure of information by Australian Commonwealth public sector entities; second, details the research method and sample of public sector entities examined for the four-year period 1999-2002; third, considers the empirical results. These show an increasing level of disclosure and greater disclosure by non-budget entities. The paper draws conclusions and discusses possible future research opportunities in the context of links between environmental management accounting and environmental risk management.

1 INTRODUCTION

Risk is the chance of something happening that will have an impact upon objectives. It is commonly measured in terms of consequences and likelihood (SA/SNZ, 1999a s.1.3.5). Risk management is the term applied to a logical and systematic method of establishing the context, identifying, analyzing, evaluating, treating, monitoring and communicating risks associated with any activity, function or process in a way that will enable organisations to minimize losses and maximize opportunities (SA/SNZ,

P.M. Rikhardsson et al. (eds.), Implementing Environmental Management Accounting, 123-141

1999a p. 1). Since the concept of ecologically sustainable development appeared (Commission for the Future, 1987) and the related ‘precautionary principle’ was introduced (Commonwealth of Australia, 1990 p. 9), environmental risk has become a growing concern (Schaltegger et al., 2003 pp. 195-203). An Australian and New Zealand Standard for risk management was introduced by two bodies working together, Standards Australia and Standards New Zealand, in 1999 (SA/SNZ, 1999a) and this was followed in 2000 by a specific environmental risk management (ERM) standard (SA/SNZ, 2000). The standards make it clear that regular, ongoing communication with the full range of the organisation’s stakeholders is important to the continuing success of the risk management approach (SA/SNZ, 1999a).

In Australia, the Commonwealth[1] government accepted the importance of ERM where the interests of future generations are concerned and where there is the potential for irreversible environmental impacts (Commonwealth of Australia, 1990 p. 9). In 1992, the Commonwealth and other levels of government signed an ‘Intergovernmental Agreement on the Environment’ in which the parties agreed that the precautionary principle should inform policy making and program implementation (IGAE, 1992). When applying the precautionary principle decisions should be guided by (i) careful evaluation to avoid, wherever practicable, serious or irreversible damage to the environment; and (ii) an assessment of the risk-weighted consequences of various options (IGAE, 1992 p. 14). Reconfirmation of a commitment from the Commonwealth government to ecologically sustainable development in the Commonwealth public sector occurred in 1999 with the passing of the Environmental Protection and Biodiversity Conservation Act (the Act). Under the Act section 516A(6)a requires Commonwealth entities[2], in their annual report, to include a report on how the activities of, and the administration (if any) of legislation by, the reporter during the period accorded with the principles of ecologically sustainable development, including the precautionary principle (the Act s3A) and, in effect, to document the outcome of decisions made and actions taken by management. The focus here is on the information that external parties can obtain in Commonwealth public sector annual reports through disclosures of information about management decisions related to risk management, especially ERM.

Management accounting systems provide the basic information for disclosures made in annual reports (Horngren et al., 1997 p. 2). Environmental management accounting (EMA) relates to the environmental component of management accounting (Schaltegger and Burritt, 2000). External disclosure of EMA information about environmental risk management is largely voluntary – at the discretion of management. Given the proclivity of the Commonwealth government to encourage external reporting of ecologically sustainable development activities by Commonwealth entities since 1999, it is of interest to establish the extent and direction of disclosures relating to risk management and ERM by these entities. This provides an indication of the leadership and support being exhibited by Commonwealth entities.

An understanding of the potential EMA disclosures that could form the basis for external disclosures provides some appreciation of the current importance of risk management and ERM. No presumption is made that environmental risk is a matter that Commonwealth entities are exposed to. The empirical component of this paper simply considers whether any such entities do disclose risk, including environmental risk, management information.

The paper proceeds as follows. In Section 2, risk management and ERM processes are introduced and research questions formulated. In Section 3, the research method and characteristics of the sample are explained. Section 4 examines the results of the analysis of communication of risk, including environmental risk, management information by the sample of Commonwealth of Australia public sector entities in annual reports. Conclusions drawn and potential future research are considered in the final section.

2 THE RISK MANAGEMENT AND ENVIRONMENTAL RISK MANAGEMENT PROCESS

Risk management is an iterative process consisting of well-defined steps which, taken together, support better decision making by contributing a greater insight into risks and their impacts (SA/SNZ, 1999a iii, SA/SNZ, 1999b, Beer and Ziolkowski, 1995). The world's first risk management standard was produced by Standards Australia and Standards New Zealand (SA/SNZ, 1999a). It is a generic, strategic and operational tool, designed to help any organisation minimize the losses and maximize the opportunities generated by different types of risk[3]. For example, the effective delivery of public sector programs is enhanced when possible adverse outcomes are managed through this process and their potential severity reduced, or when possible opportunities are taken to benefit the organisation from reduced risk. ERM has been separately addressed, using the same principles and processes as suggested for risk management (SA/SNZ, 2000). Experiences of some organisations in implementing risk management practices have been reviewed by Standards Australia (SA, 2000), although at this stage these do not extend to experiences in implementing ERM systems.

As risk management in the public sector is considered here it is useful to be aware of the Management Improvement Advisory Committee of the Management Advisory Board's model developed for risk management in the Australian Public Service, introduced in 1996 and based on the following six-step approach (MAB/MIAC, 1996):

1. Establish the context (i.e define the political, social, economic, legal and physical environment in which the activity is conducted);
2. Identify all risks arising from the environment (i.e identify the source of each risk, when, where, why and how it is likely to occur, who might be involved and what its consequences might be);
3. Analyze the risks (i.e determine the likelihood and impact of each risk occurring, taking into consideration any existing controls which may detect or prevent potential or undesirable risks);
4. Assess and prioritize (evaluate) risks (i.e. consider the degree of control over each risk, the cost, benefits and opportunities presented by each risk, decide which risk(s) are unacceptable and rank them for treatment);
5. Treat risks (i.e. decide what cost-effective counter-measures need to be in place to help minimize the unacceptable risks and/or their impact and prepare and implement action plans); and
6. Continually monitor and review risks (i.e. periodically review the environment, known and potential risks, priorities, treatments and plans, and make adjustments as necessary).

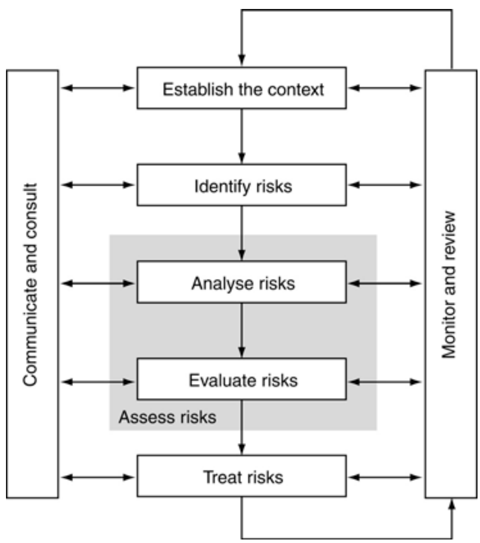


***Figure 1**. Risk Management Process Overview (SA/SNZ, 1999a)*

Communication did not form part of the basic risk management model. However, by 1999, the importance of communication with internal and external stakeholders was specifically recognized and added to the generic risk management process as formalized by Standards Australia and Standards New Zealand (SA/SNZ, 1999a) (see Figure 1). An additional step relating to communication and consultation has been inserted between steps five and six in the MAB/MIAC model (SA/SNZ, 2000 6):

> "*Communicate and consult*. Communicate with and consult internal and external stakeholders at each step of the risk management process."

Hence, external communication is now formally recognized as an integral part of risk management processes. Figure 1 outlines the seven main generic steps in risk management highlighted by the voluntary Australasian Standard (SA/SNZ, 1999a, p.11). In practice the steps interact, for example steps 6 and 7, communication and monitoring, need to be considered at each step in the risk management process.

The links between management accounting systems and external disclosure have been considered in recent reviews of management accounting literature. Otley (2001 244) argues that management accounting has become more strategic and has added the notions of being: forward looking, concerned about planning, externally focused, value focused and with an eye on other aspects of the value chain. This is echoed in DeLoach (2000) where it is argued that successful organisational risk management requires a shift from conventional practices towards characteristics also identified with strategic management accounting (see Figure 2).

Management practices		
Conventional	*Risk Focus (DeLoach 2000)*	*Strategic Management Accounting (Otley 2001)*
Ad Hoc	Continuous/ routine	Continuous and ad hoc
Looking at the past	Looking to the future	Looking to the future (planning)
Fragmented	Integrated	Integrated
Cost based	Value based	Value based
Reactive	Proactive	Proactive
Negative	Positive	Internal to external communication
Functionally driven	Process driven	Marketing based not production based

***Figure 2**. Successful risk management practice and management accounting*

DeLoach (2000) argues that a successful organisational strategy will continually be monitoring, reviewing *and communicating* risk management with internal and external parties. The strategy will be integrated rather than piecemeal, removing barriers between functions and departments. It will proactively manage key organisational risks – both monetary, with a focus on value rather than cost, and non-monetary.

EMA can be analyzed in a similar way. EMA is the part of accounting infrastructure that considers environmental and economic interrelationships. It is concerned with providing information about the organisation's impact on the environment and the effect of the environment on the organisation. Physical (PEMA), monetary (MEMA) and qualitative information about these effects is of concern to management and external parties (Burritt et al., 2002). EMA is concerned to provide information that is useful to managers and provides the foundation for voluntary external communication of environmental information about the organisation and its activities – through annual reports, environmental reports, the media, workshops, etc. Burritt et al. (2002) suggested that a comprehensive framework for EMA can be structured to provide information relevant to management. However, they included neither the risk management nor the communication function of EMA. Figure 3 provides a summary representation of key aspects in the linkages between EMA information and ERM. In terms of the comprehensive EMA framework, a strategic focus suggests the importance of routine rather than ad hoc information, and future rather than past or current information, with a movement from short-term, reactive to long-term, proactive thinking. In addition, as Einhorn and Hogarth (1999 p. 131) recognised, "All decisions are about the future. But deciding what to do and how to do it naturally draws on past experience. Looking forward involves looking back". EMA, in consequence, needs to provide ex post and ex ante information as a basis for decision-making, control and communication. A comprehensive EMA system includes all of these characteristics.

Each element in the EMA matrix (see Burritt et al., 2002) represents the tools of EMA that lend support to management, including risk management. However, as EMA remains in a state of development (see debate over the nature of EMA in for example, Adams, 2000, Bennett and James, 1998, Gray and Bebbington, 2001, Gray et al., 1993, Gray et al., 1996, Hamner and Stinson, 1995, Howes, 2002, Parker, 2000, Schaltegger and Burritt, 2000, US EPA, 1995 and White and Savage, 1995) the framework can only be regarded as a potential guide to the types of information about ERM that might in the fullness of time be disclosed in annual reports of public sector organisations. Present disclosures are expected to be far less comprehensive.

In September 2000, separate voluntary guidelines for ERM were issued by Standards Australia/Standards New Zealand (SA/SNZ, 2000) based on the same generic risk management principles and processes, including the emphasis on communication and consultation. While information about stages in the risk management process provides possible themes for disclosure, in this paper, analysis is restricted to the examination of whether risk management disclosures are made and by how many entities.

		Environmental Management Accounting (EMA)			
		Monetary Environmental Management Accounting (MEMA)		Physical Environmental Management Accounting (PEMA)	
		Short Term Focus	Long Term Focus	Short Term Focus	Long Term Focus
		Risk / *Return*	*Risk* / *Return*	*Risk* / *Return*	*Risk* / *Return*
Past/Present Orientated	Routinely generated information	1. Environmental cost accounting (eg variable costing, absorption costing, and activity based costing)	2. Environmentally induced capital expenditure and revenues	9. Material and energy flow accounting (short term impacts on the environment – product, site, division and company levels)	10. Environmental (or natural) capital impact accounting
	Ad hoc information	3. Ex post assessment of relevant environmental costing decisions	4. Environmental life cycle (and target) costing Post investment assessment of individual projects	11. Ex post assessment of short term envronmental mpacts (eg of a site or product)	12. Life cycle inventories Post investment assessment of physical environmental investment appraisal
Future Orientated	Routinely generated information	5. Monetary environmental operational budgeting (flows) Monetary environmental capital budgeting (stocks)	6. Environmental long term financial planning	13. Physical environmental budgeting (flows and stocks) (eg material and energy flow activity based budgeting)	14. Long term physical environmental planning
	Ad hoc information	7. Relevant environmental costing (eg special orders, product mix with capacity constraint)	8. Monetary environmental project investment appraisal Environmental life cycle budgeting and target pricing	15. Relevant environmental impacts (eg given short run constraints on activities)	16. Physical environmental investment appraisal Life cycle analysis of specific project

Figure 3. *Environmental management accounting comprehensive framework (based on Burritt et al., 2002)*

In summary, application of the ERM and EMA frameworks are in their early days. Case study and empirical evidence about ERM are in short supply.[4] Likewise, for EMA, Bouma and van der Veen (2002 p 279) observed that "Most research in environmental management accounting is prescriptive, contributing to the further development of tools, and often based on a limited number of case studies. Empirical research in EMA (e.g. Bouma and Walters, 1998) is scarce and is focused more on describing the current state of implementation than on analyzing or critically evaluating the effectiveness of the new tools." Applications that involve both areas are even less likely to be observed, but no information is yet available about whether such disclosures are made and by how many entities.

The *first research question* is to what extent do Australian Commonwealth public sector organisations report risk management information in their annual reports.

The *second research question* is to what extent do Australian Commonwealth public sector organisations report ERM information in their annual reports.

Several studies have examined environmental disclosures in the annual reports of Australian public sector entities. Gibson and Guthrie (1995) examined annual report environmental disclosures in the state of New South Wales. For the sample of annual reports of 20 public sector entities in 1994 they found that 55 per cent disclosed some environmental information (Gibson and Guthrie 1995 p. 119). Frost and Toh (1998) reported that the development of environmental accounting practices was significantly associated with management attitudes, entity size and the environmental sensitivity of the entity's operations. Frost and Seamer (2002) extended this analysis in the examination of the annual reports of 35 New South Wales public sector entities for 1996. They built upon the notion that environmental reporting assumes the existence of information generated by an environmental management system or environmental accounting practices (Dierkes and Preston, 1977, Elkington, 1993) and found an association between the level of environmental disclosure and the development of EMA practices. Burritt and Welch (1997) undertook a time series analysis of the environmental disclosures of 60 Australian Commonwealth government entities over the period 1984-1993. They found a significant increase in the average amount of environmental disclosure, with budget entities reporting a larger number of environmental themes than non-budget entities. Burritt and Welch (1997 p. 70) suggested that different commercial orientations of public sector organisations will affect environ-mental disclosures. Non-budget (i.e. company) entities have a focus on profitable trading and a potential interest in keeping some commercial information confidential whereas budget entities have a closer reliance on government for funding, thereby increasing the need for direct disclosure through the annual report. Hence, on the basis of this empirical evidence Commonwealth companies are more likely to have a lower level of (environmental) risk management disclosure than other Commonwealth entities.

Harris and Thomas (2001 p. 46) report that, based on the eight Australian public sector organisations they examined, the public sector appears to be making positive inroads in implementing risk management. Take up and disclosure of risk management and ERM information by public sector entities might be expected to have increased since the 1999 and 2000-Standards were introduced with their increased emphasis on communications with stakeholders through the risk management process. The expected impact would be an increase in risk management disclosures in 2000 and beyond, and an increase in ERM disclosures in 2001 and beyond.

The *third research question* is whether there is a difference in disclosures between Commonwealth budget and non-budget entities.

The *fourth research question* is has there been any change in the amount of risk management disclosure over time.

The *fifth research question* is has there been any change in the amount of ERM disclosure over time.

3 RESEARCH METHOD AND SAMPLE CHARACTERISTICS

The main methods used in this study are a review of relevant literature in section 2, as the foundation for the development of research questions, and content analysis applied to the sample of Australian Commonwealth public sector organisations.

Examination of risk management and ERM disclosures made in the annual reports of Commonwealth of Australia public sector organisations has been undertaken over a four-year period. Commonwealth entities are classified into the following four different categories as identified for annual reporting purposes in s.516A of the EPBC Act:

Category 1. A Department of State and any other Agency (as defined in the Public Service Act, 1999);

Category 2. A Commonwealth authority (as defined in the Commonwealth Authorities and Companies Act, 1997);

Category 3. A Commonwealth company (as defined in the Commonwealth Authorities and Companies Act, 1997); and

Category 4. Any other Commonwealth agency that is established by or under a law of the Commonwealth and is required by law to give an Annual Report to the responsible Minister (defined in s.528 of the EPBC Act to include a body corporate established by a law of the Commonwealth, and a person performing the duties of an office established by or under such a law, or the duties of an appointment made under such a law).

Category 1 includes Commonwealth government departments, executive and statutory agencies acting on behalf of the government. The Head is responsible for the annual report required to be published under the *Financial Management and Accountability Act* 1997. This Act provides the framework for the proper management of public money and public property by the Executive arm of the Commonwealth. Public money and public property is money and property in the custody or control of the Commonwealth. Category 2 includes Commonwealth bodies incorporated for a public purpose through separate legal entities and that hold monies on their own account (*Commonwealth Authorities and Companies Act*, 1997, s.7(1)). The directors are responsible for the annual reports of such bodies. Category 3 Commonwealth companies are registered under the Corporations Act 2001 as companies in which the Commonwealth has a controlling interest (*Commonwealth Authorities and Compa-*

nies Act, 1997, s.34(1)). The directors of Commonwealth companies are responsible for the annual report and the company can obtain monies from the financial market. Category 4 agencies are Government entities not covered by the other three categories under separate legislation and having separate annual reporting requirements. Until the new legislation referred to above was introduced in 1997 entities were conventionally identified as being budget or non-budget (Burritt and Welch, 1997). Budget entities received an allocated annual amount of funds from government, whereas non-budget did not. This distinction is not simply related to the four categories of entity identified under s.516A of the *Environmental Protection and Biodiversity Conservation Act, 1999*.

Information on risk management, and ERM, was gathered for each category and for the total number of Commonwealth entities in the sample. Content analysis was used to identify disclosures in the annual reports relating to risk management and ERM. A maximum number of 100 annual reports each year were considered for inclusion in the sample. However, some organisations did not exist throughout the period, and some copies of annual reports were unavailable even though requests were made to organisations where individual reports were not accessible (see 'Unavailable' in Table 1). In total, available hard copy or web-based copies of three hundred and thirty six annual reports were examined for disclosures over the four-year period 1999-2002. The number of Commonwealth entities and reports examined by Category is presented in Table 1.

Table 1. *Number of Commonwealth of Australia annual reports examined by category for risk management disclosures*

Category of Commonwealth Entity	*Total Entities Selected*	*Total Entities with Reports Available, 1999-2002*	*Total Annual Reports Examined*
1. Department	14	12	48
2. Authority	7	7	28
3. Company	45	37	148
4. Other	34	28	112
Subtotal	100	84	336
Unavailable		16	64
Total	100	100	400

Risk management and ERM disclosures were identified for each entity and a hard copy made, identified by category entity, year of and page in the annual report. Each report was classified according to the scheme identified in Table 2. Classification was also undertaken independently by a second coder. The simple classification scheme adopted meant that there were no areas of disagreement between the coders, hence, there was no need for any formal statistical measure of inter-rater reliability (see also Hackston and Milne, 1996, Milne and Adler, 1999).

Table 2. *Classification scheme for risk management disclosures in annual reports*

Classification Score	*Classification Criteria*
0	no report on risk management
1	risk management information disclosed, but no sub-heading
2	risk management information disclosed under a sub heading
3	environmental risk management disclosures made

4 ANALYSIS AND RESULTS

Descriptive statistics are used here to analyse the results of rankings by disclosure score for the four years in the four categories of Commonwealth public sector entities.

Latest disclosures by category

The first set of comparisons is outlined in Table 3. In the most recent annual reports, for 2002, 80 per cent of entities made risk management disclosures. The range was from 100 per cent of departments to only 71 per cent of Commonwealth Authorities making disclosures. For the same year 62 per cent of annual reports contained disclosures (the range being from 73 per cent for Departments to 52 per cent for Other Agencies). 10 per cent of entities, or 5 per cent of annual reports, in the sample made separate environmental risk disclosures, in 2002. With only one exception these disclosures were made by Company entities.

Table 3. *Percentage disclosures relating to the analysis of disclosures in the sample of Commonwealth public sector entities*

Score	*1999*	*2000*	*2001*	*2002*
0	66.7	39.3	27.4	20.2
1	14.3	21.4	21.4	19.0
2	16.7	34.5	45.2	52.4
3	2.4	4.8	6.0	8.3
Total	100.0	100.0	100.0	100.0

Comparison between budget and non-budget entities

Budget and non-budget sector entities were identified from the Department of Finance classification provided on their web site[5]. There are eight non-budget and 76 budget entities in the sample and, hence, the comparisons are indicative at best. Increases are found in disclosure scores for budget, non-budget and total entities between 1999 and 2002. Likewise, there are increases in the number of budget (1999 3%: 2002 9%) and non-budget (1999 0% and 2002 12%) entities making risk management disclosures. Results show a difference in the sample scores between average disclosures by budget and non-budget entities for each of the fours years (see Table 4). However, the difference is in an unexpected direction, with non-budget (commercial) entities having greater percentage levels of disclosure throughout.

Table 4. *Comparison of average numeric scores relating to the analysis of risk management disclosures of Commonwealth companies and all other Commonwealth public sector entities*

Category of Commonwealth entity	*1999*	*2000*	*2001*	*2002*
Budget	0.487	1.000	1.276	1.461
Non-budget	1.125	1.500	1.500	1.750
Total Average Scores	0.548	1.048	1.298	1.488

Temporal results

The percentage of disclosures in each of the four Score categories (see table 3) reveal a positive trend in the number of entities making risk management disclosures (Total: 1999 33%; 2002 80%). Non-disclosers fell from 66.7 per cent to 20.2 per cent of the sample between 1999 and 2002, while the percentage of entities disclosing their risk management practices under a separate sub-heading in the annual report increased from 16.7 per cent of the sample in 1999 to over half the sample in 2002. Table 3 shows that the small proportion of entities (2.4%) that disclosed environmental risk information in 1999 grew to 8.3 per cent by 2002.

In Table 5 the increase over time in disclosure scores for all Categories, except Commonwealth Authorities, and the total score is evident. With just seven entities and 28 annual reports available for the four-year period, Category 2 consists of the smallest Category in the sample. The apparent reduction in disclosures in 2001 reflects the removal of risk management disclosures by The Australian Rail Track Corporation. Figure 4 shows these results in graphical form. Departments of State demonstrate the most significant increase in disclosures over the four-year period. ERM disclosures have also increased in total over the period (1999 2%: 2002 8%).

***Table 5**. Average numeric scores relating to the analysis of risk management disclosures in Commonwealth public sector entities*

Category of Commonwealth entity	*1999*	*2000*	*2001*	*2002*
1. Department of State	0.500	1.750	1.833	2.000
2. Commonwealth Authority	1.143	1.143	1.000	1.286
3. Commonwealth Company	0.676	1.054	1.324	1.514
4. Other Commonwealth Agency	0.250	0.714	1.107	1.286
Total Average Scores	0.548	1.048	1.298	1.488

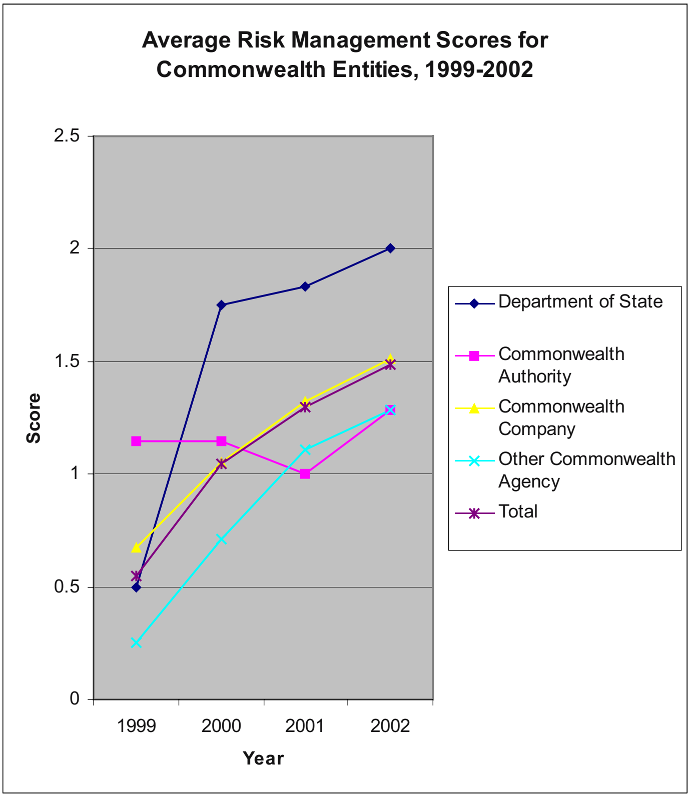


***Figure 4**. Average scores relating to the analysis of risk management disclosure in Commonwealth public sector entities in graphical form*

5 CONCLUSION AND DISCUSSION

In relation to the first two research questions, based on the sample evidence, to an increasing extent risk management and ERM disclosures are being made by Commonwealth public sector entities, there being a reduction in non-disclosers from 66.7 per cent to 20.2 per cent in relation to risk management disclosures, and from 98 per cent to 92 per cent for separate ERM disclosures over the period 1999-2002. The evidence also indicates that, in relation to research question three, a difference between the risk management and ERM disclosures exists, although budget entities consistently disclosed less than non-budget entities.

Research questions four and five considered the changes in risk, and environmental risk, management disclosure over time. Increases in risk management and ERM are observed, in total, for budget and for non-budget entities, over the 1999-2002 period. However, Departments and Companies were responsible for the observed increases, with Authorities and Other Agencies making no ERM disclosures at all. In relation to all of these observations it must be recognized that these comments are based on the trends observable in the tables and the associated descriptive statistics. They only relate to the sample of organisations examined in the Australian public sector.

Risk management and ERM are becoming recognized as an integral part of good management practice. To be most effective, risk management needs to become part of the organisation's culture, integrated into its philosophy, practices and plans and communication processes rather than being practiced as a separate program (SA/SNZ, 1999a p. iii).

The purpose of this paper is to begin the exploration of an under-examined aspect of EMA, the link with external reporting. External communication forms an integral part of the process of risk management and ERM. Management accounting has expanded to incorporate strategic issues that engage external parties as well as the provision of information to management. In some ways the research is premature, as public sector organisations are still in the process of adopting risk management techniques and disclosure is likely to lag this adoption. However, the results do provide a base from which further studies can be undertaken. Such research will be able to examine: the detail of ERM as it is adopted over time; the determinants of current disclosure levels; and investigation of best practice cases. Figure 4 provides information about typical disclosures observed for each score level, as well as some of the ERM disclosures that reflect the presence of ERM practices and the potential for EMA practices.

Figure 5. *Examples of representative disclosures at different score levels*

Classification Score 1 – risk management information disclosed, but no sub heading: Australian Radiation Protection and Nuclear Safety Agency, 2000, p. 6.
"…we have obtained NATA accreditation for the RF laboratory and the personal radiation monitoring service and have established a quality management and risk management culture throughout ARPANSA;"

Classification Score 2 – risk management information disclosed under a sub-heading: Sugar Research and Development Corporation Annual Report 2001, p.51.
"Risk Management
In February 2001, the Audit Committee initiated a revision of SRDC's risk profile using the Comcover Risk Assessor software. All SRDC staff participated in the risk assessment which resulted in the development of a revised risk register. This was used to develop the SRDC Risk Management Plan and was also used as the basis for revision of the SRDC Fraud Control Plan first developed in 1997. In June 2001, the Audit Committee reviewed both Plans and was satisfied that appropriate controls are in place to address key risks. The SRDC Board subsequently endorsed both plans as recommended by the Audit Committee. In 2000–01, SRDC completed and implemented its Business Process Management System (BPMS) which folds active quality assurance into daily management of SRDC. The BPMS is an essential tool in risk management in SRDC. All staff had an input in developing the BPMS and the Board is also involved in the revision of policies and procedures detailed in it to ensure minimisation of risk."

Classification Score 2 – risk management information disclosed under a sub-heading: Australian National Audit Office Annual Report 2002, p.54.
"Risk management
The ANAO adopts the Joint Standard AS/SNZ 4360:1999 in our approach to risk management. The ANAO regularly updates its Risk Management Plan and individual plans for each of the service groups, CMB and R&D branch to take account of any changes to our environment including revised business requirements and changes to our control environment. The plan underpins the ANAO's corporate governance framework. The ANAO's Audit Committee is responsible for oversighting the implementation of the plan. In summary, the ANAO approach to risk management identifies risks associated with each business objective and agreed business targets. Risks are considered first at the strategic level; in particular how they relate to our strategic and business planning processes. In considering these risks we address the following questions: is our overall vision and direction appropriate; do our products (including new products) meet client needs and expectations; are our resources (staff, financial, physical and information) appropriate (capability) and do we have sufficient (capacity) to deliver our products?.
"

Classification Score 3 (environmental risk management information disclosed): National Registration Authority for Agricultural and Veterinary Chemicals Annual Report 2000, p. 47, 74.
"In 2001-02, NICNAS commenced negotiations on a MOU with the Environmental Risk Management Authority (ERMA) New Zealand, to establish a co-operative relationship

between the two agencies in relation to new and existing industrial chemicals that may also be hazardous substances. It is expected that both parties will sign the MOU in early 2002-03."

"Accordance of NICNAS activities with ESD Principles
(a) decision-making processes should effectively integrate both long-term and short-term economic, environmental, social and equitable considerations.
NICNAS undertakes risk assessment within an agreed policy framework and includes within the overall process of decision-making, the hazard assessment, dose-response relationships, exposure assessment and risk management options. Hazard assessment identifies the set of inherent properties that make a chemical capable of causing both short-term and long-term adverse effects to human health or the environment. Based on risk estimates, risk management strategies are recommended. When recommending risk management strategies and considering what constitutes acceptable risk, NICNAS operates within an agreed framework for the environmentally sound management of chemicals, based on the principles and policy of ESD and aligned with the United Nations Conference on Environment and Development (UNCED) Agenda 21 (Rio Declaration), which includes Chapter 19 on the *Environmentally Sound Management of Toxic Chemicals*. The economic and social benefit of risk reduction action is balanced with the economic, political and social costs of implementing the strategies. Risk management also involves monitoring, evaluating and reviewing the strategies recommended.
(b) if there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation.
Caution is applied implicitly or explicitly while conducting risk assessments. In particular, where international chemicals policy negotiations may need to rely on precaution, this is applied in line with the principles of ESD and the UNCED Agenda 21, Principle 15 (precautionary approach).

(c) the principle of inter-generational equity – that the present generation should ensure that the health, diversity and productivity of the environment is maintained or enhanced for the benefit of future generations and (d) the conservation of biological diversity and ecological integrity should be a fundamental consideration in decision making.

The risk management controls recommended by NICNAS are aimed at allowing ongoing environmental integrity and biological diversity. NICNAS risk assessments integrate hazard assessment with any unique exposure or use patterns and also take into consideration the unique nature of Australia's demography, the national ecosystems and fauna and flora. In this way NICNAS provides the information necessary that will allow informed and transparent decisions to be made including trade-offs between competing objectives of current utility and future adverse environmental effects."

Classification Score 3 (environmental risk management information disclosed):
Airservices Australia Annual Report 2002, p. 25.
"The organisation upgraded its environmental risk management software in an effort to improve its capacity to link incident reporting to the risk assessment process and to provide greater flexibility for users. A new facility enabling air route changes to be assessed in accordance with the *Environment Protection and Biodiversity Act*

Figure 5. continued

1999 was used during the year. In 2001–02 Airservices Australia assessed 82 air traffic proposals for business risk and environmental impact. None were found to be environmentally ‘significant’, as defined by the Act.”

Classification Score 3 (environmental risk management information disclosed):
CSIRO Annual Report 2002, p. 66.
“Environmental risk management and review processes
Environmental risk management
CSIRO has introduced an Environmental Management System (EMS) to assist to minimize the impact of its business activities on the environment. CSIRO uses a risk management process whereby all project groups are required to identify potential environmental impacts, assess the risk and implement control strategies.

As part of the EMS, each Division is required to develop an annual Environmental Improvement Plan. These identify improvement strategies such as waste management strategies.

This year CSIRO has continued with the program of independent environmental audits. It has instigated a program to remove underground fuel storage tanks where possible and has reviewed the processes for managing and removing asbestos from sites. In conjunction with the Australian Radiation Protection and Nuclear Safety Agency (ARPANSA), radiation safety and environmental management has been reviewed and the CSIRO Radiation Safety manual updated.

CSIRO recently appointed a Corporate Biotechnology Coordinator and a Corporate Biotechnology Strategy Liaison Group to manage the health, safety and environmental considerations associated with genetic manipulation work.”

Further exploration of elements in the suggested comprehensive EMA framework, and their connection with ERM, its application and external communication, are required if developing linkages between ERM and comprehensive aspects of EMA are to be understood and encouraged.

NOTES

1 Australia has three levels of government – Commonwealth, State and Territory, and local. Commonwealth government relates to the whole of the continent of Australia. The Commonwealth of Australia is a Federation of self-governing States and Territories.
2 The term Commonwealth entity is used here to refer to organisations of the Commonwealth of Australia that are required to provide annual reports under the Environmental Protection and Biodiversity Act 1999, s.516A.
3 The need for standardization of risk management terminology has recently attracted the attention of the International Organization for Standardization (ISO/IEC, 2002). Some key terms include:
Hazard or aspect – a hazard is a source of risk with the potential to cause loss or adverse impacts (e.g. storage of a toxic chemical). An aspect is an organisational activity, product or service that can interact with the environment.

Incident or Event – an occurrence that can have an adverse impact (e.g. a leak from the chemical storage tank). Consequence or impact – any change to the environment whether adverse or beneficial that results from the organisation's activities, products or services (e.g. chemical spills into waterway and kills fish), and any change to the organisation arising from environment-related issues (e.g. fines, lost reputation because of poor environmental management.

4 Standards Australia advises that some information about best practice case studies in environmental risk management were being gathered, however, liquidation of one organisation has delayed the process, as have recent changes in personnel within Standards New Zealand (telephone conversations on 20 January and 2 April 2003 with Geoff Clarke, Project Leader on Risk Management at the Research and Information Department of Standards Australia).

5 http://www.finance.gov.au/

REFERENCES

Adams, C.A. (2000), Ethical Reporting Past and Future, *Management Accounting*, February: 48-51.

Beer, T. and Ziolkowski, F. (1995), *Environmental Risk Assessment. An Australian Perspectiv*e, Supervising Scientist Report #102. Canberra: Environment Australia.

Bennett, M. and James, P. (1998), The Green Bottom Line. In: Bennett, M. and James. P. (eds.) *The Green Bottom Line: Current Practice and Future Trends in Environmental Management Accounting*. Sheffield: Greenleaf Publishing, pp. 30-61

Bouma, J.J. and van der Veen, M. (2002), Wanted: A Theory for Environmental Management Accounting, in Bennett, M., Bouma, J.J. and T. Wolters (eds) *Environmental Management Accounting: Informational and Institutional Developments*. Dordrecht: Kluwer Academic Publishers.

Bouma, J.J. and T. Wolters, (1998), *Management Accounting and Environmental Management: A Survey among 84 European Companies*. Zoetermeer: EIM and Erasmus University.

Burritt, R.L, Hahn, T. and Schaltegger, S. (2002) Towards a Comprehensive Framework for Environmental Management Accounting – Links Between Business Actors and EMA Tools, *Australian Accounting Review* 12 (2), 39-50.

Burritt, R.L. and Welch, S. (1997), Australian Commonwealth Entities: An Analysis of their Environmental Disclosures, *Abacus* 33 (1): 69-87.

Commission for the Future, (1987), *Our Common Future, The World Commission on Environment and Development*. Melbourne: Oxford University Press.

Commonwealth of Australia (1990), *Ecologically Sustainable Development*. A Commonwealth Discussion Paper. Canberra: Australian Government Printing Service, June.

DeLoach, J.W. (2000), *Enterprise-wide Risk Management: Strategies for Linking Risk and Opportunity.* London: Financial Times/ Prentice Hall.

Dierkes, M. and Preston, L.E. (1997), Corporate Social Accounting Reporting for the Physical Environment: A Critical Review and Implementation Proposal, Accounting, *Organizations and Society* 2 (1): 3-22.

Einhorn, H.J and Hogarth, R.J. (1999), Decision making. Going Forward in Reverse, *Harvard Business Review on Managing Uncertainty*, Boston, MA: Harvard Business School Publishing.

Elkington, J. (1993), Coming Clean: The Rise and Rise of the Corporate Environmental Report, *Business Strategy and the Environment* 2 (2): 42-44.

Frost, G.R. and Seamer, M. (2002), Adoption of Environmental Reporting and Management Practices: An Analysis of New South Wales Public Sector Entities, *Financial Accountability and Managemen*t 18 (2): 103-127.

Frost, G.R. and Toh, D. (1998), A Study of Environmental Accounting within the New South Wales Public Sector, *Accounting Research Journal* 11 (2): 400-410.

Gibson, R. and Guthrie, J. (1995), Recent Environmental Disclosure in Annual Reports of Australian Public and Private Sector Organisations, *Accounting Forum* 19 (2/3): 111-127.

Gray, R.H. and Bebbington, J. (2001), *Accounting for the Environment,* 2nd ed. London: Sage Publications.

Gray, R.H., Bebbington, J. and Walters, D. (1993), *Accounting for the Environment*. London: Chapman Publishing

Gray, R., Owen, D. and Adams, C. (1996), *Accounting and Accountability. Changes and Challenges in Corporate Social and Environmental Reporting*. London: Prentice-Hall.

Hackston, D. and Milne, M.J. (1996), Some determinants of social and environmental disclosures in New Zealand companies. *Accounting, Auditing and Accountability Journal* 9 (1): 77-108.

Hamner, B. and Stinson, C.H. (1995), Managerial Accounting and Environmental Compliance Costs. *Journal of Cost Management* Summer: 4-10.

Harris, K. and Thomas, C. (2001), Leaders of the pack, *Australian CPA*, November 46-47.

Horngren, C.T. Foster, G. and Datar, S.M. (1997), *Cost Accounting –A managerial emphasis*, 9th ed. New Jersey: Prentice Hall.

Howes, J. (2002), *Environmental Cost Accounting. An Introduction and Practical Guide*. London: Chartered Institute of Management Accountants.

IGAE (1992), *Intergovernmental Agreement on the Environment*. Canberra: Commonwealth, State and Territory governments and the Australian Local Government Association, May.

International Organization for Standardization/ International Electrotechnical Commission (ISO/IEC), (2002), *Guide 73, Risk management – Vocabulary – Guidelines for use in standards*. Geneva: ISO/IEC 16.

Management Advisory Board's Management Improvement Advisory Committee (MAB/MIAC), (1996), *Guidelines for Managing Risk in the Australian Public Service*, Report No. 22, Canberra, October.

Milne, M.J. and Adler, R.W. (1999), Exploring the reliability of social and environmental disclosures content analysis, *Accounting, Auditing and Accountability Journal* 12 (2): 237-256.

Otley, D.T. (2001), Extending the Boundaries of Management Accounting Research: Developing Systems for Management Performance, *British Accounting Review* 33: 243-261.

Parker, L. (2000), *Environmental Costing. An Exploratory Examination*. Melbourne: Australian Society of Certified Practising Accountants, February.

SA (2000), HB 250-2000 *Organisational experiences in implementing risk management practices* Canberra: Standards Australia.

SA/SNZ (1999a), SA/SNZ 4360 *Risk Management*. Strathfield: Australia:Standards Australia and Standards New Zealand, April.

SA/SNZ (1999b), *HB 143 Guidelines for managing risk in the Australian and New Zealand public sector*. Strathfield: Australia: Standards Australia and Standards New Zealand.

SA/SNZ (2000), *HB 203-2000 Environmental risk management – principles and process*. Canberra: Standards Australia and Standards New Zealand.

Schaltegger, S. and Burritt, R.L. (2000), *Contemporary Environmental Accounting*. Sheffield: Greenleaf.

Schaltegger, S., Petersen, H. and Burritt, R.L (2003), *An Introduction to Corporate Environmental Management. Striving for Sustainability*. Sheffield, UK: Greenleaf.

US EPA (1995), *An Introduction to Environmental Accounting as a Business Tool: Key Concepts and Terms. Office of Pollution Prevention and Toxics* (United States Environmental Protection Agency: Washington D.C.).

White, A.L. and Savage, D.E. (1995), Budgeting for Environmental Projects: A Survey. *Management Accounting* October: 48-54.

CHAPTER 8

USING SOFTWARE SYSTEMS TO SUPPORT ENVIRONMENTAL ACCOUNTING INSTRUMENTS

CLAUS LANG*, DANIEL HEUBACH* AND THOMAS LOEW‡

**Institute for Technology Management and Human Factors (IAT), University of Stuttgart and Fraunhofer Institute for Industrial Engineering (IAO), Germany*

‡Institut für ökologische Wirtschaftsforschung (Ecological Economy Research Institute) (IÖW), Germany

claus.lang@iao.fraunhofer.de, daniel.heubach@iao.fraunhofer.de
thomas.loew@ioew.de

Abstract. In the past 25 years various information instruments for environmental management have been developed. Some of them focus on the production process and hence can be called "process oriented". The most important process-oriented instruments are corporate input-output balance, Environmental Performance Indicators and methods of flow cost accounting. They are described and compared in this paper. Benefits for the use of the different instruments are shown. For a continuous use of Environmental Accounting Instruments in day-to-day environmental management, these instruments need to be supported with modern information technologies. This paper shows IT strategies on how to integrate Environmental Accounting functionalities into a Business Information System, which are discussed and partly supported by results from two surveys. The benefit of a structured approach to develop and integrate Environmental Accounting functionalities into a Business Information System is shown. A process model for the IT implementation of Environmental Accounting instruments taking into account the integration into existing business software is presented based on the prototype model. The nine phases of the model are described and discussed. A case study at the glass manufacturing company SCHOTT Glas shows how Environmental Performance Indicator Systems can be implemented in SAP R/3 and in ERP Systems in general. The findings presented here are results from the research project INTUS[1].

P.M. Rikhardsson et al. (eds.), Implementing Environmental Management Accounting, 143-168

1 CONTROLLING FUNCTIONS OF ENVIRONMENTAL MANAGEMENT

1.1 Objectives of Environmental Management in Companies of the manufacturing sector

According to the position of the European Commission (2002 p. 23), environmental management holds a key role within the concept of corporate social responsibility (CSR) in the manufacturing sector. Environmental improvement measures have to be identified, analysed, managed and controlled with respect to financial and environmental effects. New targets have to be set on a regular bases within a management cycle in order to achieve continuous improvements. Within such a management cycle, information from different company units has to be gathered and consolidated. These are a typical controlling tasks but they all focus on environmental data, so they are usually carried out by the environmental management unit. The environmental manager edits environmental information and makes it available to a variety of company officers including himself as a basis for decision-making.

New interfaces for environmental information flows emerge, which require a systematisation and integration into the organisational structure of the company (Müller-Christ, 2001). Hence, the controlling function of environmental management comprises the following functions (Wöhe, 2002):

- Information supply and choosing the right instruments for it (see below)
- Coordination of environmental issues within corporate planning
- Managing and controlling environmental issues within the realisation of corporate measures and with respect to the environmental dimensions of corporate strategy

A prerequisite to ensure these functions is the availability of relevant information on the environmental performance and environmental aspects of the enterprise in an efficient information system. Nowadays, such an information system can be implemented by means of software. This facilitates the consolidation and aggregation of environmental information such as indicators on resource and energy consumption, waste disposed of or wastewater and air pollution emitted.

1.1.1 Instruments of Environmental Accounting

For the controlling function of environmental management various instruments of environmental accounting have been developed in the last 25 years[2]. They can be categorised according their purpose and focus on:

- Product-oriented instruments (e.g. life cycle assessment instruments)
- Process-oriented instruments (e.g. Environmental Performance Indicators)

The product-oriented instruments focus on the environmental aspects of the products and provide information for environmental product design. Within these instruments life cycle assessment according to ISO 14040 ff is one of the most important ones. Product-oriented instruments may serve various purposes such as design of environment (DFE) (ISO/TR 14062), environmental labelling (ISO 14024) and laws and regulations. The provision of instruments and information for DFE can be seen as part of the controlling function of environmental management.

The process-oriented instruments focus on the environmental aspects of the production process in industry.[3] The most important process-oriented instruments are corporate input-output balance, Environmental Performance Indicators and methods of flow cost accounting (Strobel, 2001). They are all designed to support environmental management by supplying information on the environmental performance with the focus on material and energy flows.

Due to their different focus and purpose, the process-oriented instruments and the product-oriented instruments have to provide very different kinds of information. The distinction between product-oriented and process-oriented instruments is simple but within each category there is an overlap between the functionality of the instruments, and there are different software solutions available to support the collection and calculation of the information needed. In the following the focus is set on process-oriented instruments in order to discuss function overlaps and to introduce modern solutions for software support.

1.1.2 Environmental Performance Indicators

The most popular of the process-oriented instruments are Environmental Performance Indicators (EPI).[4] Their implementation and use is described in various guidelines (BMU, UBA, 1997, LFU, 1999, WBCSD, 2000) and even within the ISO 14000 series (ISO 14031). EPIs are absolute or relative measurements with environmental focus. They can be used to describe amount, mass, concentration, costs or other environmentally relevant figures within the company. With EPI, actual performance can be compared with targets to make sure that targets and objectives are reached (e.g. Kottmann et al., 1999). This management cycle is described as a plan-do-check-and-act process within ISO 14031. EPIs are further used for environmental communications in especially in environmental or CSR reports. The importance of external reporting is stressed by the European Commission which asks all European stock listed companies to give details of their social and environmental performance in their annual report. (European Commission, 2001).

1.1.3 Input-Output Balance

The corporate input-output balance (also called input-output account by Schaltegger and Burritt, 2000) is one of the first instruments developed for environmental management. The first projects were reported in the middle of the 1980s (e.g.

Projektgruppe Stoff- und Energiebilanzen, 1984). A corporate input-output balance lists all materials and energies used as inputs and on the other hand all products, waste and emissions for a certain period of time, usually for one year. The name balance is derived from the balance sheet in financial accounting. In Europe, especially in Germany, Austria and the Scandinavian countries, EMAS (Parliament and Council of the European Union, 2001) was a main driver in spreading the instrument, as EMAS companies have to give a quantitative overview of their relevant environmental aspects. In Denmark and in the Netherlands, mandatory reporting laws demand the publication of input-output balances from the most relevant polluting industries in their country (Danish Environmental Protection Agency, 2003).

Hence, input-output balances mainly serve especially three purposes. They provide a systematic background to identify the relevant environmental aspects, they provide information for environmental communication and they are a starting point to identify environmental protection potentials.

1.1.4 Flow Cost Accounting

According to a study carried out by Loew et al. (2001), flow cost accounting, mainly developed by Strobel (2001) and in a modified version by Fischer (2001), is one of the most developed approaches of Environmental Cost Accounting[5]. This and other related material flow-oriented cost accounting approaches were developed in the late 1990s when it was recognised that the calculation of environmental protection costs does not in itself provide sufficient information to identify measures to improve eco-efficiency. At this time it became clear that for this purpose the focus had to be directed to materials and energy flows.

The basic idea of flow cost accounting is to gain transparency in material flows in order to assign to these all the costs that they cause, from procurement up to disposal or sale by the company. By doing so, one main weak point of conventional cost accounting is tackled: The lack of transparency of the material flows in the cost centres. The improved cost information provided by flow cost accounting helps companies to identify inefficient material use in their production process. The implementation of flow cost accounting can also have a significant effect on the mutual understanding between the controlling department and the environmental manager. The focus of the controlling department is widened to material flows, whereas the environmental manager receives financial information on the hazardous and in other sense environmentally relevant materials, waste and emissions.

As Flow Cost Accounting is further developed it turns out that this approach is more and more becoming a conventional improvement of the cost accounting system with rather an economic then an environmental focus. As this partly is valid for EPIs too, it can still be seen as an Environmental Accounting Instrument.

1.1.5 Comparison of Instruments

The above instruments of environmental accounting show some overlap in their functionality. They can all be used as a tool to identify environmental efficiency potentials. This overlap was the starting point for an in-depth comparison of these instruments in the research project INTUS based on empiric evidence from four case studies with industrial companies.

The result of the comparison is shown in Table 1. It turns out that input-output balances are only one of the three instruments which supports environmental management to identify the relevant environmental aspects of the production site. Only a complete overview of all inputs and outputs enables environmental management to identify all environmental aspects with certainty. This does not mean that the quantities for all in and outputs have to be determined. Here a focus on relevant material and energy flows is sufficient. As a consequence of this finding, companies which alter their products and/or their production process have to work out an input-output balance on a regular basis, e.g. every two or three years. As the input-output balance does not sufficiently support all tasks of environmental management it needs to be combined with further information instruments which provide more detailed information for shorter time periods.

Out of the three discussed instruments Environmental Performance Indicators support the largest number of environmental management tasks. They can be used in an analysis to identify cost saving and non-cost saving environmental protection measures. When provided regularly, they can promote continuous improvements, continuous measures, compliance and information for mandatory reports to environmental authorities. Additionally, EPI can be integrated in the regular Management Performance Indicator System of the enterprise, which is a standard instrument to control corporate activities. For many companies, Environmental Performance Indicators provided regularly and an input-output balance every two or three years seems to be a good combination for ambitious environmental management.

Now and again flow cost accounting is discussed as a powerful instrument to both improve corporate cost accounting and to exploit existing eco-efficiency potentials. A closer look at pilot projects showed that flow cost accounting is usually combined with performance indicators, as for some purposes cost information is more convenient to interpret physical information. But when flow cost accounting is introduced, the set of Environmental Performance Indicators is smaller then without flow cost accounting. So due to the trade offs, flow cost accounting is not a simple additional tool, but it entails a different design of the EPI set. Still flow cost accounting is the less common instrument in practice which seems to be due to the following reasons: The use of flow cost accounting for a single analysis does not need too much effort but already gives helpful information on available cost saving environmental protection potentials. On the other hand, the implementation of flow cost accounting in the existing cost accounting system demands a lot of effort and know-how and usually cannot be done without external consulting. As it turned out in various pilot projects, the implementation of flow cost accounting is only to be recommended under the following circumstances (Loew, 2003):

- High material costs and high value added within material losses
- High complexity of material flows
- Fully developed cost accounting system
- Sufficient database in material-management

If all these characteristics apply, flow cost accounting should be an interesting option to improve the existing cost accounting system. For all other companies – and this seems to be the majority – the combination of the instruments Environmental Performance Indicators and input-output balance is recommended.

***Table 1.** Benefits of the instruments for environmental management (Loew, 2003)*

Benefits for environmental management (*further benefits in italics*)	Input-Output *Balance*	Environmental *Performance* Indicators	Flow Cost *Accounting*
Identification of relevant environmental aspects	l	m	m
Exploitation of cost saving environmental protection potentials (single measures)	l	l	l
Exploitation environmental protection potentials which are not cost saving (single measures)	l	l	m
Support of continuous environmental protection measures / promotion of continuous improvements	m	l	m
Illustration of trends in corporate environmental performance	w	l	w
Compliance	m	l	w
Information for environmental / sustainability reporting	l	l	m
Information for mandatory reports to environmental authorities	m	l	m
Improvement of the corporate cost accounting system	m	m	l
Identification of cost saving potentials (*without environmental benefits*)	m	m	l

key:

l = relevant support by the instrument,

w = partly relevant support by the instrument

1.2 Advantages of IT support for Environmental Management

A major problem in industrial practise is that Environmental Accounting Instruments such as Environmental Performance Indicators are usually generated and interpreted by experts in the environmental management system. Often this expert information is not integrated into a broader scope of business functions. Therefore, many decision making-processes in the general management system cannot be supported. To alleviate this situation it seems to be crucial to focus on the following issues:

- Environmental information often has expert character. Hence, it is necessary to set up Environmental Accounting Instruments to structure this information. They can make the underlying facts understandable for managers without expert knowledge in this field.
- Environmental information is often generated separate from other business information. Thus, it is necessary to integrate Environmental Accounting Instruments into the existing IT infrastructure to reach all relevant persons in the company.

Environmental information can be processed in separate Environmental Management Information Systems (EMIS) or in the existing IT infrastructure (see Page and Rautenstrauch, 2001). In general, Environmental Accounting Instruments integrated into a company's information technology (e.g. in the form of an IT-integrated EPI system) can lead to the following benefits for corporate controlling:

1. Increased information quality within the enterprise
The quality of information regarding environmental and controlling concerns can be increased. An IT-integrated Environmental Accounting Instrument such as Environmental Performance Indicators (EPI) does not necessarily mean that new data are generated, unless new data are collected or gathered automatically. However, existing data can be put into a new perspective and thus create new information in a more efficient way. New references can evolve, such as resource consumption compared with costs or production output. This leads to new information resulting in a better knowledge of what occurs within the enterprise. Additionally, information can then be provided continuously, and be supplied much quicker in a timely manner with easy-to-handle methods. If related directly to cost centres, environmental information can serve as controlling figures.

2. Improved measures for strategy implementation measures
With an IT integrated Environmental Accounting Instrument, new measures become available for the operative controlling of an enterprise. New strategic goals can be derived that can be monitored quantitatively with the higher information density achieved. Information distributed in different parts of the company can be efficiently consolidated in a way to support a management cycle for "green" measures to put into place. On the one hand, the instrument can be used to manage and control goals, and on the other hand, it can be used to derive new goals.

3. Higher Transparency within the Enterprise
An effective access to a highly detailed Environmental Accounting Instruments facilitates a more timely reaction to new challenges at the plant or company level. However, such an increased transparency over cost centres or business divisions can lead to new conflicts of goals. Managers responsible for adverse environmental effects can be forced to explain themselves, which in turn can lead to a rejection of the instrument.

To conclude, an IT-integrated environmental accounting system can provide a systematic basis for an effective diffusion of environmental information into all areas of decision-making in a company. IT makes the continuous supply of user-related information supply.

1.3 Requirements for IT support of Environmental accounting

Workshops and interviews with practitioners of the four pilot companies in the research project INTUS stipulated the following requirements towards an IT-integrated environmental accounting system in order to support planning, management and control of environmental impacts within a producing company (criteria derived from Müller-Christ, 2001 p. 355 and adapted in interviews):

1. Completeness
The completeness of environmental information has to be assured through incorporating different business information such as for instance production amounts, cost information to build indicators with a high significance.

2. Reduction of Complexity
The complexity of the information has to be reduced by supplying information aggregated over business divisions or cost centres and with an appropriate time reference, and by joining indicators into subject groups.

3. User Specific Views on Information
Role concepts have to be defined to allow the user specific views on environmental information. The goal is to allow customized views for the individual users. Since such information can be sensitive and confidential, misuse has to be prevented.

4. Systematics and Plausibility
The collection of data has to be organized in a systematic way and should be plausible and easy to understand for the personnel involved. It should be coordinated by a central officer. The definition of separate business processes for collecting data can lead to systematic data administration and high data quality ensuring a high acceptance of the Environmental Accounting Instruments. This is the more important, the

more environmental aspects become part of a business unit's set of goals, and even wages are connected to the environmental performance of the business unit .

Allocation to Place of Origin
Environmental impacts should be allocated to the place where they originated, if possible on a high level of detail. This can point to measures on how to reduce the environmental impact. If possible, cost centres should be used as such a place of origin. Through this, the environmental and cost responsibility are connected leading to a clear connection with a responsible officer alias the cost centre manager.

1.4 IT Strategies to Integrate Environmental Accounting Functionalities into a Business Information System

Environmental information can be integrated into the information technology infrastructure of a company by adapting or enhancing the existing information system without re-engineering[6]. Rikhardsson identified four general approaches to this strategy (Rikhardsson, 1998, pp. 112-119):

1. In the *office application approach*, standardized office application software for desktop PCs are used, such as text processing, spreadsheet or database applications. This setup is very easy to handle, easy to adapt, and only requires limited training, since the software used is often used for other business purposes already. However, it often creates information islands that are isolated from each other and access is dependent on the staff using it, since the application will often be adapted in a way that is difficult to comprehend by others.
2. Using a *company-wide software system without modifications* of the program code has become more attractive during the last couple years, since the ability of such applications, especially ERP Systems [7] such as SAP R/3®, Oracle®, Baan®, Navision Financials® increased rapidly. ERP Systems and their data are a valuable information source for environmental information and supply functionalities to process it.
3. Using *Environmental Management Information System modules* in ERP Systems: This approach has been given a lot of attention in the past when it comes to the implementation of new functionalities to collect, store, evaluate and display environmental information. It was assumed that such modules would be further developed in a fast pace to administer more and more environmental information (Rautenstrauch, 1999 p. 57, Rikhardsson, 1998 p. 155).

4. In the *Data Warehousing approach*, data is collected from existing information systems in a company and consolidated in a central database (i.e the data warehouse or business warehouse) to facilitate evaluations. This approach has become more and more standard practise for traditional business data and can be used for environmental data as well.

After technological advances in the past years, the situation at present looks as follows:

The office application approach (approach 1) is still widely used in environmental management in manufacturing companies as a survey conducted in the research project INTUS[8] showed . Another survey conducted by IAT University of Stuttgart showed that the hopes of further development of Environmental Management Information System modules (approach 3) have not been fulfilled: Questionnaires were sent to 151 ERP software companies from Germany, Switzerland and Austria in 2001 (Rey et al., 2002). The goal of the survey was to assess to what extent ERP systems can support different tasks of environmental management. Nine per cent of the questionnaires were returned. One of the questions inquired about the controlling features of the systems. There were questions as to whether the integration of environmental goals in the corporate goal system, the aggregation of environmental data for input-output balances can be performed, whether the environmental performance of a company can be evaluated, whether measured data can be compared with target data, and whether eco-indicators can be defined.[9] Answers showed that most ERP systems (71%) do not have any functionality to incorporate environmental accounting features into their system. Other functionalities were prevalent but with a percentage result of less than 30 per cent (see Figure 1).

Data Warehouse functionalities (approach 4) have been integrated into conventional ERP Systems in the last couple years. So-called Management Information Systems were the starting point of that development. They were the precursors to the now prevalent Data Warehouse or Business Warehouse modules that are often part of the ERP System as a separate module or as an integrated part of the ERP System. They provide functionalities to extract data from the operative ERP environment, import data from other data sources, consolidate the data to form a common data base, calculate indicators, which can be stored over long periods of time for time series evaluation, and graphical evaluation of the data. Some work has already been conducted on using data warehouses for environmental accounting (Pfennig and Scheide, 2002).

Approach 2 to use a company-wide software system without modifications has been further developed in the research project INTUS. ERP systems can mainly support environmental accounting in two ways: by supplying the required data for environmental information, and by supplying functionalities to integrate Environmental Accounting Instruments into business processes with regard to analysis and evaluation of production impacts. Within the research project INTUS, concepts were developed and implemented with pilot companies for these two aspects:

- Extension of material master data with a numerical "eco-key" to evaluate material input bookings with regard to environmental aspects and to display them in a corporate input-output balance.
- Extension and adaptation of existing business intelligence functionalities to collect, store and evaluate environmental data in order to calculate and display Environmental Performance Indicators.

The second concept will be presented in the case study in section 3 of this article.

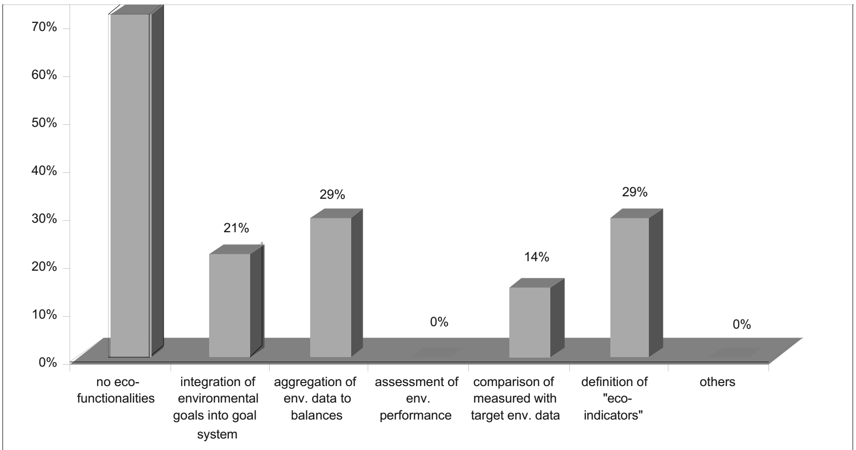


Figure 1. *Results of a survey among ERP vendors in Germany, Austria, and Switzerland with respect to a question for environmental accounting functionalities (see footnote 9)*

2 A STRUCTURED APPROACH TO DEVELOP AND INTEGRATE ENVIRONMENTAL ACCOUNTING FUNCTIONALITIES INTO A BUSINESS INFORMATION SYSTEM

When conducting a project to implement an Environmental Accounting Instrument into the information technology infrastructure of a company, organisational as well as IT aspects have to be considered. Work with the four pilot companies within the research project INTUS showed that a structured approach to conduct such a project facilitates the project progress and its success.

In the literature, different phase concepts dealing with software development are well established. The basis of all these models consists of the following steps: requirements definition, development of a preliminary concept, verification, modification and refinement of the preliminary concept, implementation, testing, final installation operation and maintenance (Krcmar, 2002 p. 123).

In practice, process models are defined based on such phase concepts, consisting of different steps that are well separated. Examples for such process models are the prototype model, waterfall model, or the V-model (Balzert, 2000 or Sommerville, 2000). Process models to implement Environmental Information Systems in the literature have a rather general character and are focused on software modules already existing on the market (Rikhardsson, 1998 pp. 121-123 or Tschandl et al., 2003). Methods presented here focus on the development and implementation of IT-based Environmental Accounting Instruments in already existing business software such as an Enterprise Resource Planning System (ERP System).

Experiences within software development in general have shown the following key problems within software development (Balzert, 1998 p. 114).

- Client and user are often not capable to define their requirements completely. This makes an intensive interaction between users and developers necessary.
- Some development tasks can be solved with several different development methods. After an experimental development of different solutions, a discussion with all relevant people has to be conducted in order to find the best solution.
- Within decision-making about a certain project in a company, it is sometimes necessary to convince the client about the feasibility of an idea.

These problems can, at least partially, be solved with the so-called prototype model. Balzert defines a software prototype as follows: „A software prototype shows a choice of features of a target product in a practical application. It is not only a simulation of the target product“ (Balzert, 1998 p. 114). A prototype can be used to clarify relevant requirements or development problems. It can serve as a discussion basis and can be used experimentally to collect practical experiences (Balzert, 1998 p. 119). Software prototypes can be used to validate requirements, i.e. to find faults, inconsistencies and open questions in the proposed requirements (Sommerville, 2001

p. 181). Developing software with the prototype model necessitates an intensive cooperation of the prospective users and the direct contact of all persons involved in the development process. As a result, risks within development can be reduced, the creativity for solution alternatives can be stimulated, and client and end users can be involved well in the development process (Balzert, 1998 p. 119).

Prototypes are of special interest for the information technology-based implementation of Environmental Accounting Instruments. The experience from work with manufacturing companies in the research project INTUS showed that such an implementation has the following characteristics:

- The involvement of company staff with different backgrounds (e.g. environmental officer, environmental manager, controlling department, IT department, management) leads to a high potential for multi-disciplinary miscommunication. A prototype can serve as the basis for communication and support the process of requirements definition.
- Information might have to be used that was formerly used by single users and tailored only to their needs[10]. This information can often not be accessed by others and is prevalent in so-called information islands. A prototype can serve as a means for integrating all these information.
- Environmental accounting instruments are still not much known to many manufacturing companies. Their adaptation to the company's needs is still characterised by many misunderstandings about their capabilities and their characteristics. Thus, the information needs for the different users and required functionalities can often not be clearly determined. A prototype can visualise planned functionalities and make them tangible for users. It can lead to learning effects and serve as a driving force in the development process.
- In order to implement such instruments into the IT infrastructure, the benefit of such an implementation has to be shown clearly to all people involved. This can be a time-consuming and complicated task. The prototype model incorporates intensive user involvement, which can help to convince members of the project team and prospective users of the project benefit and motivate them.

The prototype model is a good basis to take all this into account. Balzert and Sommerville offer a detailed description of this model[11]. It was adapted within the research project INTUS and further developed to a process model for the IT implementation of Environmental Accounting Instruments taking into account the integration into existing business software. This modified prototype model consists of the nine phases shown in figure 2.

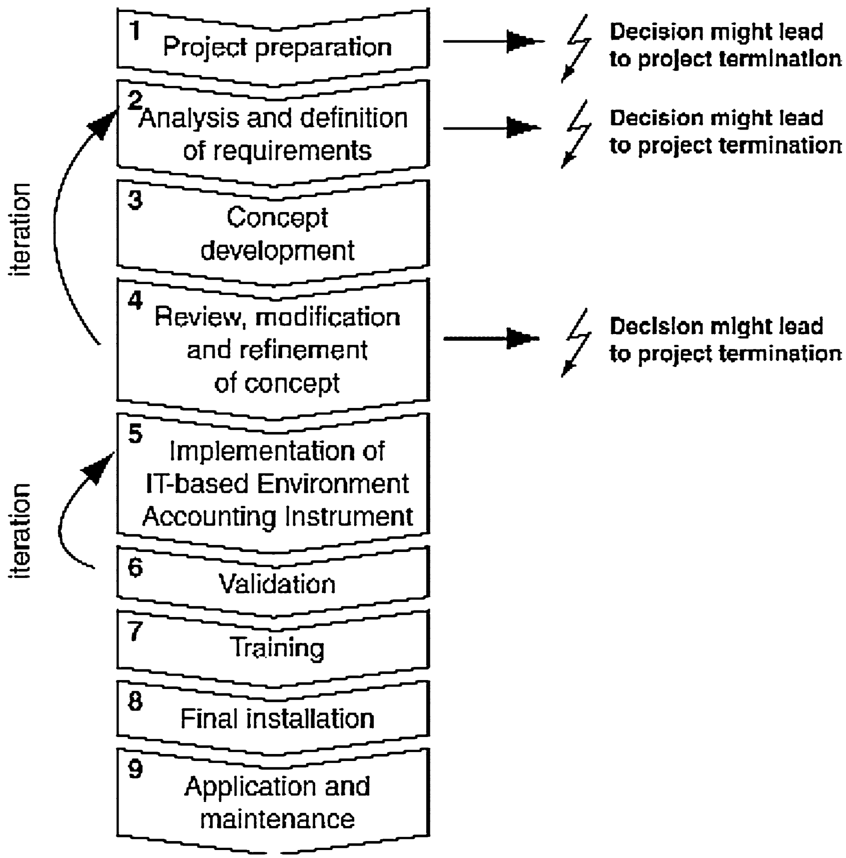


Figure 2. *The Structured Approach to Develop and Integrate Environmental Accounting Functionalities into a Business Information System*

1. Project Preparation

A rough pre-analysis has to be conducted to specify the needs for Environmental Accounting Instruments. A pre-choice of the instruments to be applied has to be made and put into the context of the company. The project has then to be defined and the project team has to be assembled. Choosing the right people as team members is crucial for the project success. Important aspects are whether a prospective team member can either bring in concrete experience and knowledge to work on specific tasks in the project (a so-called know-how promoter) or if he or she has certain sources of power within the enterprise to help overcome barriers within the course of the project (a so-called power promoter). The project coordinator is regarded as the process promoter and must have the ability to mediate between the various team members and to override administrative barriers. Hauschildt offers a description of different promoters in innovation projects (Hauschildt, 1997).

2. Analysis and Definition of Requirements

In the second phase of the process model, organisational, technical and information technology prerequisites have to be examined. This is followed by the development of solution alternatives and a study of their feasibility. After choosing one of these alternatives in a management decision, a product specification is drawn up. These steps will be described in more detail below:

The requirements for environmental information and functionalities should be analysed involving prospective users from all business divisions of the enterprise. Interviews should be conducted to collect these requirements. Collected requirements have to be structured and prioritised. Such an analysis is an iterative process and can be supported by standardised methods such as the VORD-Method (Viewpoint-Oriented Requirements Definition (Sommerville, 2001 p. 127)).

When analysing requirements, three dimensions should be regarded (Sternemann, 1999).

- Information demand: which information does the user need (e.g. performance indicators, material properties, environmental costs, documents, …)
- Business process: which business processes or activities are to be supported with information (e.g. investment decisions, process optimisation, product design, legal requirements, …)
- Scope: which scope is effected by decisions? (e.g. product, production, personnel, organisation, …)

At the same time, existing environmental data should be analysed. This analysis is the basis for a uniform data structure to be developed at a later stage. Data can be available in different structures and formats depending on the standard software used in the company. In addition, data relevant for environmental accounting can also be found in software run as stand-alone systems not connected to any other system.

Solution alternatives have to be defined specifying the use of instruments, their detail with respect to time and space within the enterprise. It should be evaluated how functionalities of existing IT systems can be used to support these alternatives. A brief feasibility study should then be performed for these alternatives including a cost benefit analysis. This can be followed by a management decision on whether to continue with the project and on which alternative to select.

The chosen alternative can then be described in more detail in a requirement concept containing a product specification. The most important part of this specification is the abstract description of the required product functionalities. A formal description language such as UML or ARIS can be used[12].

3. Concept Development

The product specification is the input for the development of a detailed concept for the implementation of the Environmental Accounting instrument in software. It contains the software architecture consisting of technical definition of functionalities within system components, technical requirements, data structures, required programme algorithms, interface specifications and the description of different user groups, their required reports as well as functionalities for data import and export. The use of a formal description language is pivotal to reach the best understanding between personnel from the environmental accounting team and software development staff.

The result of this phase is a concept for an IT-based Environmental Accounting Instrument put together in a so-called functional specifications concept. Some (but not all) aspects of this concept should then be implemented in a software prototype. The prototype should be able to visualise some evaluation capabilities as planned in the concept and should be designed in a way that it can be continuously expanded towards the final IT-based Environmental Accounting Instrument.

Experience from the research project INTUS shows that the concept development as well as the next phase should be performed in a small team, whereas feedback from prospective users should be gathered at a later stage.

4. Review, Modification and Refinement of Concept

The fourth phase of the process model contains a review and an intensive testing of the prototype by the project team using example cases and exemplary data from the real company environment. Prospective users will be included into testing at a later point to make it more efficient. Testing consists of validation (which ensures that the software meets the requirement of the users) and verification (which ensures that the software conforms to specified functional and non-functional requirements) (Sommerville, 2000 pp. 419-420). The required changes have to be incorporated into the definition of requirements (phase 2) and subsequently into the concept development phase in an iterative process. At the end of this phase stands a decision on whether to continue the project and proceed to the fifth phase.

5. Implementation of IT-based Environmental Accounting Instrument

In this phase, the product architecture as described in the functional specifications concept will be implemented into programming code. This leads to a pilot system that has to be integrated into the existing IT infrastructure. Case studies performed with the four companies participating in the research project INTUS showed that today's ERP systems provide functionalities that can be used with relatively low effort to implement IT-based Environmental Accounting Instruments.

Parallel to this process, the required data to be used by the IT-based Environmental Accounting Instrument should be structured according to the rules defined in the concept developed in phase 3. It is necessary to obey this structure to facilitate the development of interfaces.

Through an organisational integration it should be assured that the implementation will be actively used later on. The use of the instrument should be integrated in the management system and business procedures of the enterprise.

6. Verification und Validation of IT-based Environmental Accounting Instrument
After the implementation, the pilot system will be verified and validated by the project team and the prospective users. Modifications will be carried out in an iteration of the implementation phase.

7. User Training
The training of users is an important phase, since it assures the acceptance of an IT-based Environmental Accounting Instrument. Training can be carried out by the project team. Either all users are trained directly by them or via intermediates using the train-the-trainer concept.

8. Installation of IT-based Environmental Accounting Instrument
After positively completing all tests and verifications, the IT-based Environmental Accounting Instrument can be installed.

9. Operation and Maintenance of IT-based Environmental Accounting Instrument
The operation and maintenance of IT products is often underestimated when planning the project. Efforts and costs can arise to adapt the product over the years due to a changed cost centre structure, new Environmental Performance Indicators, new production facilities or business units, technical updates of the software etc. As with IT personnel, a responsible person should be defined to carry out these adaptations, the operation and maintenance of the IT-based Environmental Accounting Instrument.

Experience from case studies within the research project INTUS led to the deduction of this nine phase model. It is well suited for integrating Environmental Accounting Instruments, Environmental Performance Indicators and input-output balances into existing ERP systems. A more detailed description of the nine phases will be published in another article. A case study will be described in the next section of this article.

3 CASE STUDY SCHOTT GLAS

SCHOTT is a technology company producing speciality glass for household appliances, display solutions, pharmaceutical systems, opto-electrics, and advanced optical materials and components. It has about 20,000 employees worldwide.

3.1 Initial Situation of Data Management at SCHOTT GLAS

At the beginning of the project, environmental information at SCHOTT was spread over different information systems. It represented specialized knowledge hard to trace back to its sources. This posed an obstacle to meet requirements of ISO 14000 or the EU Eco-Management and Audit Scheme (EMAS) within Schott's Environmental Management Scheme. In an implementation project of the research project INTUS, it was shown how that problem can be solved by integrating an Environmental Performance Indicator System into the existing ERP system. Schott's decision in favour of environmental performance indicators was based on two considerations. On the one hand, flow cost accounting did not seem to bring additional benefits in terms of better understanding of the costs of the material flows, as within each of Schott's production sectors the complexity of material flows is not so high. There is enough knowledge on the material cost of material losses and awareness on the value added which is wasted with additional losses (see above in the section Comparison of Instruments. So Flow Cost Accounting would not bring more benefits than the implementation of a comprehensive Environmental Performance Indicator system. On the other hand, Schott already had a variety of environmental information in different fields – water and energy consumption, waste disposal, amount of recycled material, emissions, information on occupational safety including associated costs. Originally, respective data was collected, stored and maintained in different divisions of the company in isolated Microsoft Excel databases, in computers for emission measurements required by environmental regulations, and in the existing ERP system, SAP R/3. Thus, collecting and processing data from heterogeneous sources to make internal and external reports took considerable time and effort. This stipulated the decision to store this data centrally in SAP R/3 so that Environmental Performance Indicators could be calculated as a basis for reports to be created directly in the system.

The company defined the following issues as relevant for an Environmental Performance Indicator System:

- waste balances,
- industrial health and safety reports,
- environmental protection costs, as legally required by the German Federal Statistical Agency,

- cost centre-based resource consumption for individual company divisions,

The existing data on these topics was analysed and restructured by topic according to a hierarchy. An Environmental Performance Indicator system was defined based on a general proposal for the chemical industry. EPIs cover absolute quantities and costs of materials, substances, and energies – for example, the amount of a particular production waste in kilograms. Relative EPIs set individual consumption values in relation to specific production output of different business units. The time resolution for the performance indicators ranges from a business year to one month. The EPIs were assigned to cost centres. The existing cost centre key could be used with minimal adjustment.

3.2 Implementation of EPIs in SAP R/3

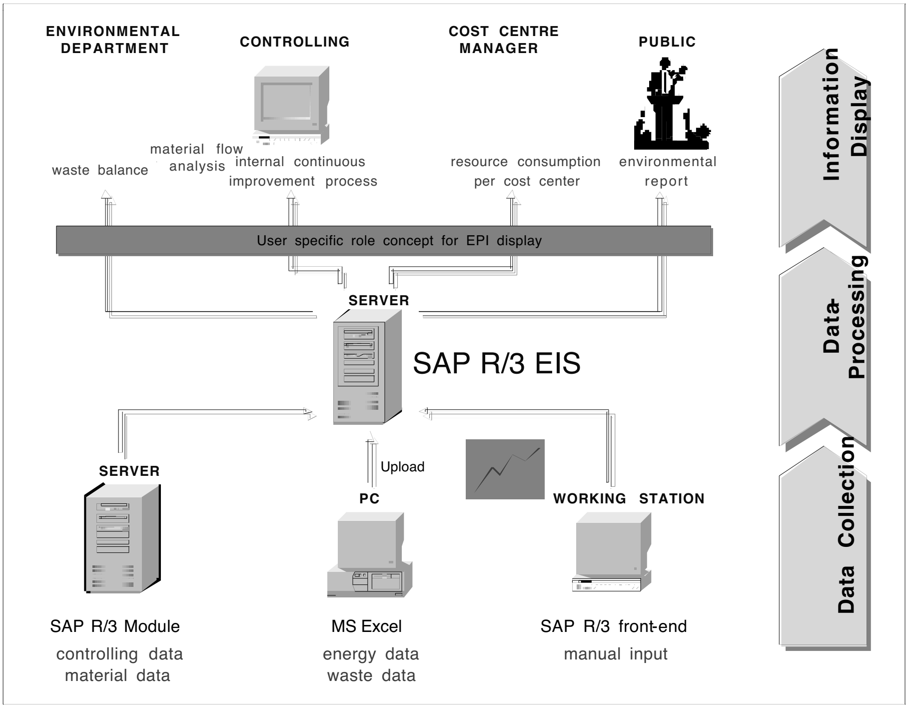
The EPI system was implemented in SAP R/3, which Schott had just migrated to. This migration was a good opportunity for the implementation of the EPI system, since there was still a high openness to change within the company. The EPI system was implemented in the Executive Information System (EIS) of SAP R/3. The EIS allows the easy definition of data structures and has reporting options available. The necessary data structure was created in a simple data table using so-called *aspects*. The data fields for the Environmental Performance Indicators were defined using a number key based on units (for example, kilograms, tons, kilowatt hours) and an additional field for costs. An additional field gives users the option to decide whether the performance indicator contains a planned or an actual value. Individual indicators can be assigned to a cost centre as well as a particular time period (for example, month or business year).

Data entry is performed monthly: SAP internal data is imported into the EIS, specialist information is uploaded from external data sources such as spreadsheet applications, and data can also be entered manually at the SAP front end. The Environmental Performance Indicators are calculated in EIS based on this data, and the details for each cost centre are displayed, as well as aggregated figures for different organisation levels.

EPI reports are used by company managers, division heads, and employees responsible for site controlling or environmental protection and industrial health and safety. A role concept allows the display of information tailored to the needs of the user. Three roles were defined: the display of a group of EPIs for all cost centres (e.g. for the occupational safety department), the display of all EPIs for one cost centre (for the cost centre manager), or the display of all EPIs for all cost centres (for the controlling department and plant management).

At the beginning of each month, the EPIs from the previous month are available. Users can view the indicators at their work place in SAP R/3, generate reports, and carry out evaluations. For the individual cost centre, the performance indicators are shown graphically or in multi-level lists and can be used as control quantities in decision processes.

***Figure 3**. Integration of Environmental Performance Indicators at SCHOTT GLAS*



3.3 Flexible Concept of EPI Implementation in ERP systems

The implementation has shown that SAP R/3 can, with little tailoring, support planning and decision processes in the areas of industrial ecology and industrial health and safety. The programming required for the implementation of the EPI system was minimal, since existing import, calculation, and display functionalities of SAP R/3 could be used. However, the structuring of the imported data and associated discussions with staff in different areas involved significant effort – about as much as the implementation process.

The concept developed at Schott is flexible, adaptable, and transferable to other companies. In principle, an Environmental Performance Indicator system can be implemented using other SAP software, such as SAP Business Information Warehouse (SAP BW). Hence, environmental information can be integrated in SAP R/3 without the acquisition of new software. Functionalities similar to those used in this project can be found in many other ERP Systems on the market. Thus, the IT-based implementation of an EPI System is generally feasible in manufacturing companies using ERP systems.

The EPI system is currently being used at Schott. Existing work processes were adapted and new work processes are being created that enable better integration of environmental issues in standard business processes.

3.4 Benefits of Integration in this Case Study for SCHOTT GLAS

The case study SCHOTT GLAS showed that the integration of an Environmental Performance Indicator system can be realised within the existing information technology infrastructure using existing functionalities of the ERP system SAP R/3. Developing a uniform data structure for environmental data was a key issue and required approximately as much effort as the adaptation of the software. This has to be done once – the continuous effort to collect information is subsequently reduced. Expert systems in different enterprise divisions accepted by their users (mainly based on Microsoft Office applications) remained in use. However, data needed from these systems were integrated into the SAP R/3 system and evaluated in Environmental Performance Indicators. These are now available throughout the company and the generation of specific EPI-based reports contribute to a better diffusion of environmental information into the decision making at SCHOTT GLAS by supplying information tailored to the needs of the respective cost centre. Such a project cannot only be conducted using SAP software – many other ERP systems provide functionalities similar to those used in this case study.

Experience from the project with SCHOTT GLAS also showed that EPI were not only developed following set objectives in environmental management – existing EPIs can also lead to new objectives by combining information previously not linked, for example the relation of investments in occupational safety and work accidents, or the relation of energy consumption to CO_2 emissions.

It could also be shown that by integrating EPI into an ERP system, benefits additional to these mentioned in table 1 (section 1) can be realised. First, the use of the ERP system (well known to most employees as compared to new software) and the utilisation of a personalised user concept improves user acceptance. Standard interface functionalities already available within the ERP system can be used to gather data which minimises programming effort. Data availability, level of detail and the methodological approach of the Environmental Accounting Instrument to be used determine the need to integrate data from subsystems. If environmental questions such as the *polluter pays principle* are to be integrated into a company's organisation, the cost centre structure in the ERP system can be used if available with enough detail. Using existing data in the ERP system about material flows, costs, or occupational health leads to a common decision base for environmental and traditional business management. Using an ERP system for the IT support of Environmental

Accounting Instruments as opposed to developing a new software tool also means that the costs for maintenance and software support are lower throughout the lifespan of the software, especially since programming and maintenance know-how as well as reviews and audits already exist in the enterprise.

4 CONCLUSION

Out of the three discussed instruments, Environmental Performance Indicators support the largest number of environmental management tasks. When provided regularly, they can promote continuous improvements, continuous measures, compliance and information for mandatory reports to environmental authorities. For many companies, Environmental Performance Indicators provided regularly and the set up of an input-output balance every two or three years seems to be a good combination for ambitious environmental management. For some companies, flow cost accounting can be an interesting option to improve the existing cost accounting system.

In general, Environmental Accounting Instruments integrated into a company's information technology can lead to advantages such as increased information quality and higher transparency within the enterprise. Different requirements have to be fulfilled to support instruments with information technology. The existing business information system such as an ERP system can often be used to integrate Environmental Accounting Instruments. Using a company-wide software system without modifications is one approach that can be used with most ERP systems nowadays. This was shown in the case study presented in this paper. A structured approach as shown with the nine-phase process model for the IT implementation of Environmental Accounting Instruments can facilitate such a project. Such a structured approach is crucial for project success and to ensure the use of the instrument in the day-to-day routine in the company.

NOTES

1 The distinction between environmental management and environmental controlling is to our understanding mainly popular in Germany. This is reflected by publications called Öko-Controlling (Hallay and Pfriem, 1992) or Environmental Controlling (BMU and UBA, 2001). A comparison of environmental management and environmental controlling has been carried out by Loew et al. (2002).

2 A good overview is given for instance by Schaltegger and Burritt (2000), BMU, UBA (2001) Bennett and James (2000). Also see Bennett et al. (2003).

3 In a wider sense, considering other sectors, production-oriented instruments consider the in- and outputs of any kind of organisation.

4 First empirical evidence for the broad use of EPI is given by Loew and Hjalmarsdottir (1996). The popularity of EPIs is also reflected by their use in environmental/sustainability reports, and EMAS statements.

5 For a summary of the results see Loew (2003).

6 This is only one of four different strategies to set up an Environmental Management Information System as described by Rikhardsson (1998). Other strategies include the design of a new Environmen-

tal Management Information System (EMIS), the re-engineering of an existing corporate information system, or the implementation of a standard system package.

7 An ERP (Enterprise Resource Planning) system can be considered as a company's backbone information system containing data on materials, production planning, purchasing and sales, cost accounting, etc.

8 See Beucker et al. (2002) for a survey among 1,300 EMAS-registered manufacturing companies in Germany. 11 per cent of the questionnaires were returned, main industry branches were chemical, paper, electric/electronic, manufacturing and food industries.

9 The question was: Does your system support one or more of the following functionalities: the integration of environmental goals in the corporate goal system, the aggregation of environmental data for product, process, plant or corporate balances, the assessment of environmental performance of a company with regard to types of impact, equivalence factors, etc., the comparison of measured data target data, and the definition of eco-indicators (e.g. energy consumption per planning period).

10 Microsoft Office Tools are widely used within Environmental Accounting, see survey in Beucker et al. (2002).

11 See Balzert (1998), p.114f and Sommerville (2001) p. 181f.

12 UML: Unified Modelling Language, a standard maintained by OMG (Object Management Group). See http://www.omg.org/uml/ or (Fowler, 2003), for ARIS see (Scheer, 1998).

REFERENCES

Balzert, H.H. (2000), *Lehrbuch der Software-Technik, Bd. I. Software-Entwicklung*, 2nd ed. Heidelberg, Berlin: Spektrum Akad. Verlag, (available only in German).

Bennett, M. and James, P. (eds.) (2000), *The Green Bottom Line. Environmental Accounting for Management Current Practice and Future Trends*. Sheffield: Greenleaf.

Bennett, M., Rikhardsson, P.M. and Schaltegger, S. .(2003), (eds.). *Environmental management Accounting – Purpose and Progress*. Dortrecht: Kluwer Academic Publishers.

Beucker, S., Jürgens, G., Rey, U. and Lang, C. (2002), B*etriebliche Umwelt-informationssysteme (BUIS) im Umweltcontrolling – Umfrage zur Nutzung von Instrumenten des Umweltcontrollings und deren informationstechnischen Unterstützung,* INTUS-Zwischenbericht aus Arbeitspaket 1.3, Arbeitsbericht des IAT, Stuttgart (available only in German).

Bundesumweltministerium (BMU); Umweltbundesamt (UBA) (eds.) (2001), *Handbuch Umweltcontrolling*, 2nd ed., München (available only in German).

Bundesumweltministerium (BMU), Umweltbundesamt (UBA) (eds.) (2002), *Leitfaden Betriebliches Umweltkostenmanagement*, Berlin (available only in German).

Danish Environmental Protection Agency (eds.) (2003), *The Danish Green Accounts: Experiences and internal effects* (online) http://www.mst.dk/indu/05050000.htm (25.2. 2004).

European Commission (eds.) (2002), *Communication from the Commission concerning Corporate Social Responsibility: A Business Contribution to Sustainable Development*. Brussels.

European Commission (eds.) (2001), *Communication from the Commission concerning the EU-Strategy for Sustainable Development*. Brussels.

Federal Environmental Ministry (BMU), Federal Environmental Agency (UBA) (eds.) (1997), *A Guide to Corporate Environmental Indicators*. Bonn/ Berlin.

Fischer, H. (2001), *Reststoffcontrolling* (Residues Controlling). Berlin/Heidelberg: Springer. (available only in German).

Fowler, M. (2003), *UML Distilled: A Brief Guide to the Standard Object Modeling Language*, 3rd ed. Boston, MA: Addison-Wesley.

Hallay, H. and Pfriem, R.(1992), *Öko-Controlling – Umweltschutz, in mittelständischen Unternehmen*. Frankfurt, New York: Campus Verlag (available only in German).

Hauschildt, J. (1997), *Innovationsmanagement*, 2nd ed. München: Verlag Vahlen, (available only in German).

Hessisches Ministerium für Wirtschaft, Verkehr und Landesentwicklung (eds.) (1999), *Leitfaden Flusskostenmanagement – Kostensenkung und Öko-Effizienz durch eine Materialflussorientierung in der Kostenrechnung*, Wiesbaden (available only in German).

ISO 14024 (1999), *Environmental labels and declarations – Type 1 environmental labelling – principles and procedures,* Geneva.

ISO 14031 (1999), *Environmental management – Environmental performance evaluation – Guidelines*.

ISO 14040 (1997), *Life cycle assessment, Principles and framework*.

ISO 14041 (1998), *Life cycle assessment, Goal and scope definition*.

ISO 14042 (2000), *Life cycle assessment, Life cycle impact assessment*.

ISO 14043 (2000), *Life cycle assessment, Life cycle interpretation*.

ISO/TR 14062 (2002), *Environmental Management – Integration of Environmental Aspects into Product Design and Development,* Geneva.

Kottmann, H., Loew, T. and Clausen, J. (1999), *Umweltmanagement mit Kennzahlen*. München: Vahlen Verlag (available only in German).

Krcmar, H. (2000), *Informationsmanagement*. 3rd ed. Berlin: Springer Verlag (available only in German).

Landesanstalt für Umweltschutz Baden-Württemberg (LfU) (eds.) (1999), *Arbeitsmaterialien zur Einführung von Umweltkennzahlensystemen*, Karlsruhe (available only in German).

Loew, T. (2003), Environmental Cost Accounting: Classifying and Comparing Selected Approaches. In: Bennett M., Rikhardsson P.M. and Schaltegger, S. (eds.) *Environmental Management Accounting – Purpose and Progress*. Dordrecht: Kluwer Academic Publishers, pp. 41-57.

Loew, T., Beucker, S. and Jürgens, G. (2002), *Vergleichende Analyse der Umweltcontrolling-instrumente Umweltbilanz, Umweltkennzahlen und Flusskostenrechnung* (Comparison of the Environmental Controlling Instruments Input-Output Balance, Environmental Performance Indicators and Flow Cost Accounting) discussion paper DP 53/02 Berlin Available from Internet URL http://www.bum.iao.fraunhofer.de/downloads (available only in German).

Loew, T., Fichter, K., Müller, U., Schulz, W.F. and Strobel M. (2001), *Ansätze der Umweltkostenrechnung im Vergleich – unveröffentlichter Endbericht für das Umweltbundesamt und das Bundesumwelt-ministerium* (Comparison of Approaches to Environmental Cost Accounting – unpublished final report for the Greman Federal Environmental Agency and the Federal Environmental Ministry, to be published in 2004) Berlin. (available only in German).

Loew, T. and Hjalmarsdottir, H. (1996), *Umweltkennzahlen für das betriebliche Umwelt-management* (Environmental Performance Indicators for Corporate Environmental Management) IÖW Paper 99/96 Berlin.

Müller-Christ, G. (2001), *Umweltmanagement*. München: Verlag Vahlen, (available only in German).

Page, B. and Rautenstrauch, C. (2001), Introduction to Environmental Information Systems. In: Rautenstrauch, C. and Patig, S. (eds.), *Environmental Information Systems in Industry and Public Administration*. Hershey: Idea Group Publishing.

Parliament and Council of The European Union (2001), *Regulation (EU) Nr. 761/2001of the European Parliament and of the Council on the voluntary participation by organisations in a Community eco-management and audit scheme (EMAS)*, Brussels.

Pfennig, R. and Scheide, W. (2002), Business Intelligence und Nachhaltiges Wirtschaften. *uwf-Umwelt-wirtschaftsforum* 2: 74-80 (available only in German).

Pojasek, R. (1997), Material Accounting and P2. *Pollution Prevention Review*, Autumn: 95-97.

Projektgruppe Stoff- und Energiebilanzen (1984), Stoff und Energiebilanzen – Ein Instrument zur Kontrolle und Einschätzung ökologischer Auswirkungen des Produktionsbereichs, dargestellt am PVC-Werk ICI Wilhelmshaven In: Bechmann, A. (ed.) *Berlin: Werkstattberichte des Instituts für Landschaftsökonomie der TU Berlin* (available only in German).

Rautenstrauch, C. (1999), *Betriebliche Umweltinformationssysteme: Grundlagen, Konzepte und Systeme*. Berlin, Heidelberg, New York: Springer (available only in German).

Rey, U., Lang, C. and Beucker, S. (2002), *ERP-Systeme und ihr Datenangebot für die Ressourceneffizienz-Rechnung*, project report of the research project CARE, Stuttgart, availabe from Internet URL http://care.oekoeffizienz.de (available only in German).

Rikhardsson, P. M. (1998), *Corporate Environmental Performance Management. Systems and Strategies*. PhD thesis, Aarhus School of Business, Department of Organization and Management, EF-number: 555.

Schaltegger, S. and Burritt, R. (2000), *Contemporary Environmental Accounting Issues Concepts and Practice*. Sheffield: Greenleaf.

Scheer, A.-W. ARIS (1998), *Modellisierungsmethoden, Metamodell, Anwendungen,* 3rd ed. Berlin: Springer (available only in German).

Sommerville, I. (2000), *Software engineering*, 6th ed, Essex: Pearson Education Limited.

Sternemann, K.-H. (1999), *Team-Informationssysteme – Beitrag zur Informations- und Wissensbereitstellung in dezentralen Strukturen*, Dissertation an der Otto-von-Guerike-Universität Magdeburg, Magdeburg.

Strobel, M. (2001), *Systematisches Flussmanagement*. Augsburg: Ziel Verlag, (available only in German).

Tschandl, M., Posch, A. and Ortner, W. (2003), Webbasierte Unterstützung zur Implementierung eines integrierten Umweltcontrollingsystems. In: Heubach, D. and Rey, U. (eds.) *Integration von Umweltinformationen in betriebliche Informationssysteme,* Tagungsband zur 11. Tagung der Fachgruppe Betriebliche Umweltinformationssysteme der Gesellschaft für Informatik e.V. am 1. April 2003 in Stuttgart. Aachen: Shaker Verlag (available only in German).

Wöhe, G. (2002), *Einführung in die allgemeine Betriebswirtschaftslehre*. München: Verlag Vahlen, (available only in German).

Verfaillie, H. and Bidwell, R. (2000), *Measuring Eco-Efficiency – a guide to reporting performance*. World Business Council for Sustainable Development. Available from www.wbcsd.org.

CHAPTER 9

APPLICATIONS OF AN ENVIRONMENTAL MODELLING SYSTEM IN THE GRAPHICS INDUSTRY AND ROAD HAULAGE SERVICES

TUULA POHJOLA

Helsinki University of Technology, Department of Industrial Engineering and Management, Finland

tuula.pohjola@hut.fi

Abstract. Environmental management is an increasingly important part of strategic management in companies, and the significance of environmental issues is increasing in business worldwide as companies form large global networks. The environmental pollution caused by industrial countries – especially air emissions – is a topic of global concern, but environmental debates often focus on finding the guilty companies instead of suggesting schemes for preventing environmental harm. Companies and administrators should aim to develop their environmental decision-making; to this end, the environmental modelling system and its applications presented in this article have been designed to identify, analyse, manage and report environmental factors in relation to operational and financial functions in business processes. The model addresses the process, environmental and financial aspects of operations on the basis of process management, environmental management and environmental business accounting. The model can also be used to determine alternatives for cost-effectively improving environmental performance.
The environmental modelling system enables a company to:

1. Identify key environmental aspects of operations.
2. Analyse, manage and report current environmental performance
3. Determine the relationship between pollution abatement measures and internal environmental costs and investments
4. Compare alternatives for cost-effectively decreasing environmental loads generated by business

P.M. Rikhardsson et al. (eds.), Implementing Environmental Management Accounting, 169-192

1 INTRODUCTION

The difficulties in dealing with environmental issues in a company come from the number of business processes that have environmental effects: all operations, not just production plants, can have negative impacts on the environment. The definitions of environmental effects in business operations should be established in the definitions of the operational processes, and through these the environmental management system of a company may be designed and developed. Decision-making on environmental issues needs a systematic method to deal with all the factors that cause environmental loads. Firstly, procedures should be designed to consider business processes from an environmental point of view, and secondly, a company needs to analyse the financial factors of environmental issues concurrently with process and environmental factors. In other words, both the environmental loads and costs should be included in the framework.

A framework that can deal with business processes from both an environmental and financial point of view needs a systematic model to manage existing links and relationships between operational, environmental and financial factors. In addition, the model should make it possible to plan investments needed to realise improvements, thereby abating environmental loading generated by business processes, and to consider environmental performance and economic efficiency in alternative propositions. All these requirements mean a modelling system needs to be designed that can manage all the aspects and interrelations of environmental and financial factors of business processes.

The viewpoints presented above include the following requirements for a systematic approach to environmental decision-making:

- Concurrently identifying and analysing the environmental, financial and process factors of business processes and defining the interrelations of these factors.
- Determining the current environmental performance as well as legislative and internal environmental costs on the basis of the factors defined above.
- Identifying and analysing potential alternatives to improve environmental performance cost-effectively.

This method of environmental modelling includes the main guidelines for identifying environmental aspects in relation to operational and financial factors in companies. According to the environmental aspects defined, a company's environmental performance and internal environmental costs can be determined, and these factors can be used when a company searches for alternatives to improve environmental efficiency. There are four classes of environmental factors – energy and water consumption, purchases, transportation and waste management (including reuse and recycling) – which have many similar features in several business fields. But the detailed variables of the environmental model must be defined for different areas of business, such as the forestry industry, electrical industry, logistics companies, etc.

The environmental modelling system is based on the method of environmental accounting. In order for the modelling system to be a useful tool for business fields in environmental decision-making, a computer-aided application – the Environmental Internet System – is needed as a practical tool in daily environmental management.

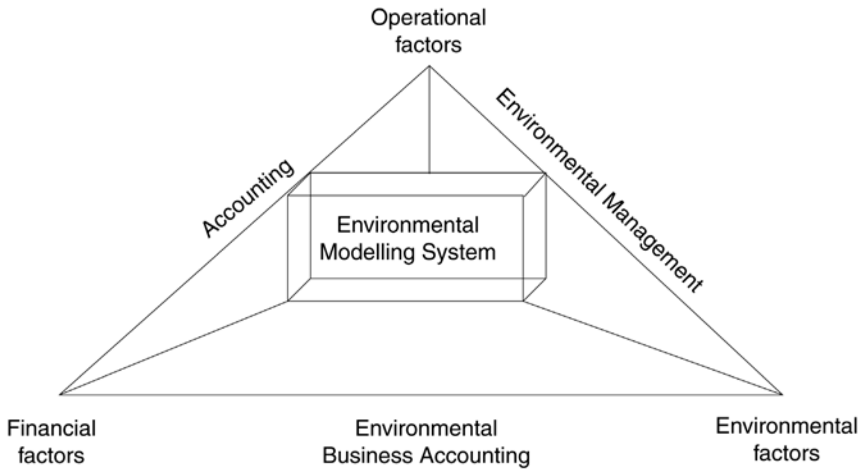


Figure 1. *The framework of the environmental modelling system (modified from Pohjola, 1999 p. 10).*

2 THE FRAMEWORK OF AN ENVIRONMENTAL MODELLING SYSTEM

2.1 Environmental business accounting

Environmental business accounting was first discussed in the 1990s in Europe and the United States. 'Accounting for the Environment' (Gray et al., 1993) which was published in the United Kingdom in 1993, and the research reports published by the Environmental Protection Agency and the Tellus Institute in the USA, are considered the leading publications in the field (Bennett and James, 1997a). In 1996, Epstein published one of the first research papers on environmental performance and cost accounting.

> Increased environmental legislation, public opinion and stakeholders' requirements put pressure on companies to develop their environmental management, accounting and reporting (Halme, 1997, Hofstra and Suerink, 1995, Mätäsaho and Niskala, 1997, van der Bosch and van Riel, 1998). The management of

environmental issues concerns every company because all business operations include environmental aspects (Gray et al., 1993). In general, companies manage the process and financial factors of business processes using the systems of process management and accounting linked together. However, environmental functions, which also need to be analysed and managed, are inherent in a company's operations, but seldom recognised and analysed formally (Shrivastava, 1995).

Developing a system to recognise and improve environmental aspects entails many challenges to existing management and accounting systems. The first significant task is to identify and analyse the environmental factors of business operations and manage them using an environmental management system integrated into the total management system (Epstein, 1996a, Welford and Gouldson, 1993). Secondly, internal environmental cost factors in relation to environmental factors should be defined and analysed for accounting the internal environmental costs of an organisation (Bennett and James, 1997a, Parker, 1995, Schroeder and Winter, 1997). Finally, environmental aspects and their financial factors should be reported so that the decision-making processes in business can be developed (Heiskanen et al., 1997, Spengler et al., 1997).

Environmental performance evaluation and cost accounting are essential methods for analysing alternatives for environmental decision-making, which requires information on the process, environmental and financial functions of the activities, and operations in business (Bennett and James, 1997b). The aim of environmental business accounting is to produce cost information on environmental and financial performance, thereby enabling decision-making on operations, processes and products to include environmental viewpoints (Epstein, 1996b, Schroeder and Winter, 1997, Wills, 1994).

Before environmental business accounting can be developed, a company should develop a system to manage and control its environmental aspects (Klassen and Laughlin, 1996). However, a company needs to extend its understanding of environmental management with the help of environmental business accounting in order to meet the requirements of integrated environmental decision-making.

2.2 Environmental business accounting as part of the framework of environmental accounting

Environmental business accounting is a part of environmental accounting. Environmental accounting as a concept includes both national and business accounting, and deals with both financial and non-financial information (EPA, 1995a, Schaltegger, 1997).

In this study, environmental business accounting is defined to cover the aspects of financial and management accounting in the framework of environmental accounting as defined by EPA (1995a p. 28) as follows: environmental national accounting, environmental financial accounting and environmental management accounting. This definition is rooted in the contemporary discipline of business accounting, covering environmental business accounting needs for both external and internal corporate stakeholders (Klassen and Laughlin, 1996, Schaltegger, 1997).

> Environmental accounting has connections to environmental economics, sustainable development and environmental management. Environmental economics describes interrelations between the environment and its economic aspects (Field, 1997). Sustainable development outlines the ecological use of natural resources (Callan and Thomas, 1996). Environmental management and environmental management systems are the foundation for a systematic approach to environmental aspects in business (Klassen and Laughlin, 1996, Welford and Gouldson, 1993).

Environmental aspects are often linked to quality management in companies because environmental management systems include features that are similar to quality management systems. In general, environmental issues are seen as a part of Total Quality Management (TQM), but according to the arguments concerning environmental aspects above, environmental management requires an extension of TQM. Epstein (1996a p. 66) defines Total Quality Environmental Management (TQEM) as follows: "The TQM principles are applied to environmental management to provide a systematic approach and methodology for continuous improvement in environmental performance." Hence, TQEM forms a method to manage environmental aspects systematically and according to the principles of continuous improvement.

> Environmental business accounting consists of two components: environmental performance evaluation and environmental cost accounting. Environmental performance is an indicator of the ecological effects generated by business operations (Epstein, 1996b). Current environmental performance is defined using evaluation methods such as environmental impact assessment (EIA) and life-cycle assessment (LCA), which are used to identify and estimate direct and indirect environmental loads (Gray et al., 1993). Environmental cost accounting is a method to define internal environmental costs in relation to process and environmental factors of business processes (EPA, 1995a). Environmental risks, liabilities and costs included in business processes are determined according to environmental performance evaluation and ECA. The context of environmental business accounting is depicted in Figure 2.

The framework of a systematic approach to environmental decision-making involves the definition of environmental, financial and process factors and their interrelations needed in the identification phase of a decision-making process. In addition, the framework includes the structure of measurement systems for environmental and financial performance needed in the development phase of decision-making.

> A systematic approach to environmental decision-making processes should take into account the external and internal requirements of environmental aspects in business (EPA, 1994, Miller, 1996, Wolters et al., 1995). Significant external requirements derive from environmental legislation and external stakeholders (Freimann, 1997, Spengler et al., 1997), and in addition to environmental regulations, government incentives and subsidies attempt to advance innovations in pollution abatement (Dobers, 1997, Field, 1997, OECD, 1989). Increasing requirements by various interest groups, such as business partners and customers, also place environmental demands on companies (Chadwick, Garrod and Larsson, 1996, Renn, Blättel-Mink and Kastenholz, 1997). Internal functions include logistics operations, management accounting and the demands of internal stakeholders (Linnanen, Böström and Miettinen, 1994, Moilanen and Martin, 1996). The number of individual factors involved in external and internal requirements is large, and the interrelations between the different requirements also extend the scope of environmental issues (WCED, 1987).

Decision-making processes need accurate information on environmental loads, risks and liabilities, and the legislative and internal environmental costs generated (Wolters et al., 1997). The need for relevant information is an important reason for developing a systematic approach to deal with business functions in relation to environmental factors and costs (Schaltegger and Sturm, 1996). Such an approach should cover the following three dimensions:

- Identification of environmental factors on the basis of external and internal requirements.
- Identification of environmental financial factors.
- Definition of interrelations between environmental, financial and process factors.

Environmental factors should be defined on the basis of an analysis of the requirements and demands of external and internal stakeholders (Earl, 1996, Moilanen and Martin, 1996). The description of business processes is crucial in identifying existing environmental factors in a company (Spengler et al., 1997), and an input-output model of business processes assists in understanding the interrelations between process and environmental factors (Pollack, 1995, Strong, 1995).

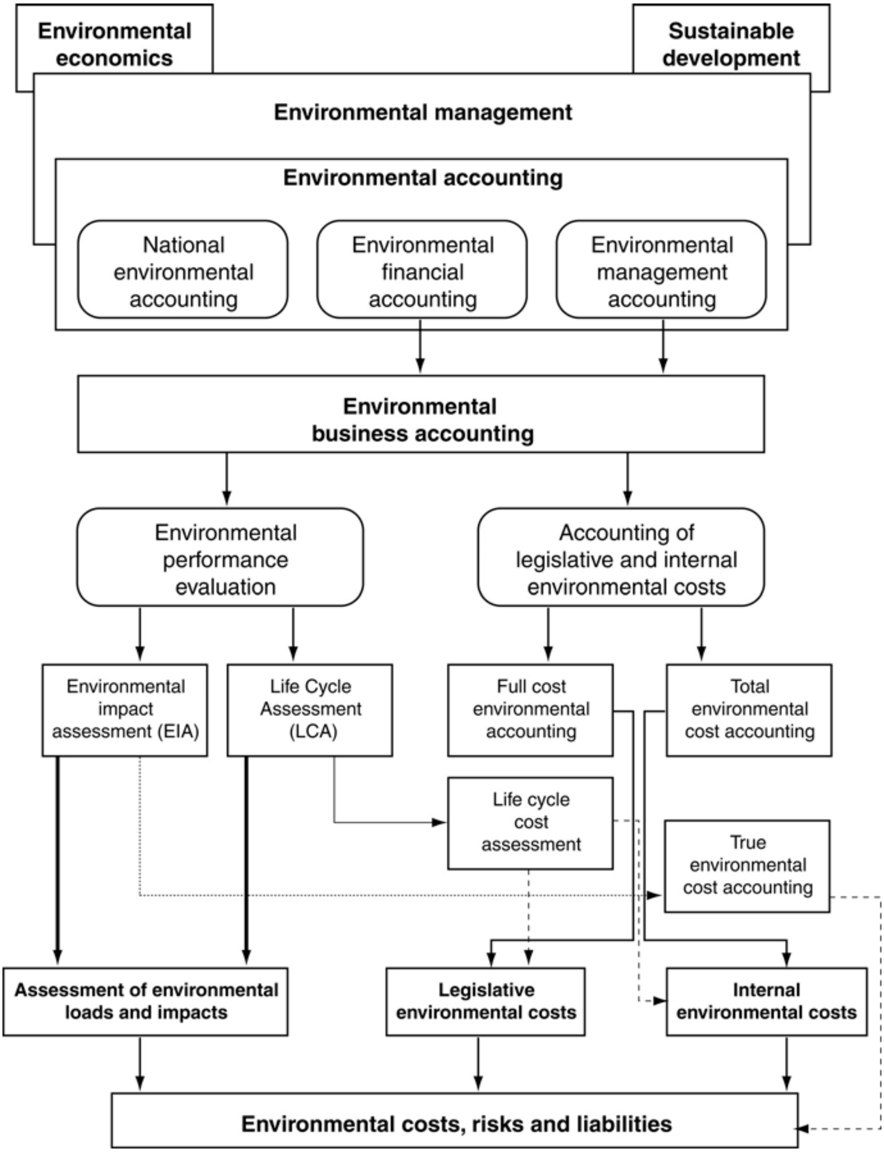


Figure 2. *The context of environmental business accounting as part of environmental accounting (Pohjola, 1999 p. 21).*

A prerequisite for identifying and planning investment costs to improve environmental performance cost-effectively is the determination of legislative and internal environmental costs in a company (EPA, 1995b). Data on legislative and internal environmental costs (direct, indirect and investment costs) are an essential tool for designing and planning environmental improvements in business (Epstein, 1996b).

2.3 The method of an environmental modelling system

The aim of modelling environmental aspects is to combine functional and financial management with environmental management to generate information for decision-making. The modelling of environmental aspects requires two elements: a system to analyse current environmental performance, legislative and internal environmental costs, and alternatives for improving environmental issues; and a system to analyse and manage environmental decision-making processes.

The generic environmental model is developed to connect the process, environmental and financial components of business processes for analysing, managing and reporting environmental aspects and their interrelations. On the basis of the definition of these components, the current environmental performance of business processes and the financial performance of environmental aspects are determined. The relationship between the elements of the generic environmental model is depicted in Figure 3.

The factors used to determine environmental loads are defined on the basis of operational processes. For example, energy consumption includes three components used to determine environmental loads: the amount of energy, the shares of energy sources used to produce energy in power plants, and the emission coefficients of energy production. As another example, transportation consists of four sectors: road haulage, railway traffic, shipping and air traffic, which include their own factors for determining environmental loads. The general environmental factors of transportation are fuel consumption, transport distance or time, weight of freight and the environmental coefficients of the fuel used. The waste management module includes the factors of energy consumption used to determine environmental loads generated by landfill waste management and the factors of transportation to determine the environmental loads caused by waste transportation. In addition, waste burning has its own emission coefficients. Environmental loading factors can vary between different business fields – purchases of raw materials, substances and products, for example – but the basic factors of energy and water consumption, amount and quality of packing materials, amount of transportation, and amount and type of waste are often similar.

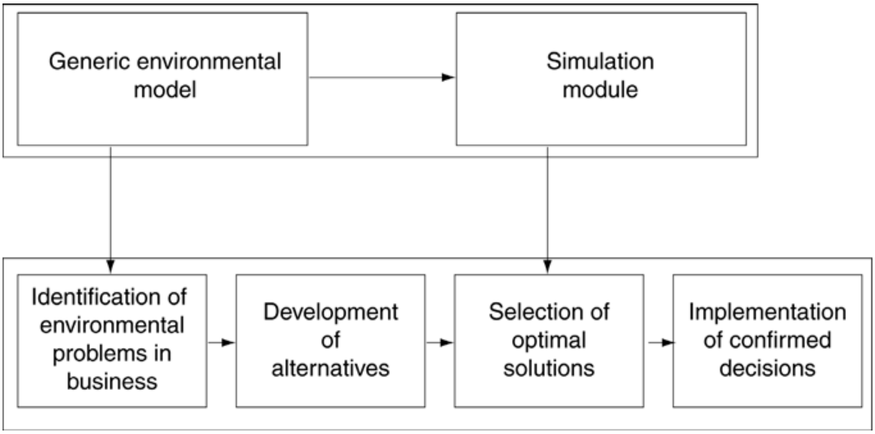


Figure 3. *The foundation of environmental modelling (Pohjola, 1999 p. 57)*

The financial factors consist of costs generated by environmental legislation, the environmental factors of operations, environmental liabilities, and potential revenues from recycling and reusing materials. In the generic environmental model, the principle for determining environmental costs is based on the link between process and environmental factors: if a factor of a process causes indirect or direct environmental loads, it generates environmental costs. Revenues gained when reused or recycled materials, products or goods are sold are included in the accounting of financial factors, which will be determined according to environmental issues in various business fields; the methods for defining environmental costs being similar in most companies.

The first phase of the framework for environmental decision-making is designed to identify, analyse, manage and report factors for defining the current environmental performance of business processes and the financial impacts of environmental aspects in a company. The second phase of the framework includes the determination of the current environmental performance in relation to outputs of operational processes and the financial performance of environmental aspects as measured by legislative and internal environmental costs.

The financial performance of environmental aspects is defined as the relation between the legislative and internal environmental costs and the outputs of process and environmental factors in relation to the pollution generated. The costs of environmental liabilities are not taken into account in the generic environmental model, but they are estimated on the basis of the environmental risks assessed, the environmental loads generated and the financial factors defined.

The simulation module is based on the description of business processes in the generic environmental model. Only the variables of the process, environmental and financial factors specified in the generic environmental model can be simulated. The accounting rules of environmental loads and costs in the simulation module are similar to the rules for accounting current environmental loads and costs. The accounting of investment costs is done using general accounting methods, such as payback periods, net present value or annuity. The environmental risks related to the alternatives are estimated on the basis of the amount and type of environmental loads, the assessments of environmental impacts generated by emissions, effluents and waste, and the environmental and process factors. Environmental liabilities and their costs are assessed by the company on the basis of environmental risks and the financial performance of environmental aspects. Consequently, the simulation module offers a method of managing the three phases of the decision-making processes concerning environmental improvements to business processes.

2.4 Computer-aided application of environmental modelling

The purpose of a computer-aided application to combine operational, environmental and financial functions of business processes is to assist companies in managing their business processes from an environmental point of view. A computer-aided application enables a company to analyse, manage and report the significant factors of environmental loading caused by business operations; it should have a dynamic design structure because the system has different requirements for different kinds of business.

The *Environmental Internet System* (EIS) is a tool for companies (particularly SMEs) to monitor and improve their environmental aspects and performance. The EIS was designed to complement firms' environmental management systems by collecting and managing environmental data. In addition to harmonising the information collected on environmental issues, the EIS also encourages companies to use the same meters and indicators to evaluate their environmental performance and offers a basic form of environmental reporting, such as the Environmental Statement required by EMAS. Environmental reports can be compared using coordinated metrics and indicators, and information for national environmental reports can be collected. The EIS tool is a web-based application, so no special software is required beyond a browser, though you do need to buy a licence to use it. For an SME, this is currently about EUR 1,500 per year. The EIS application has five main elements:

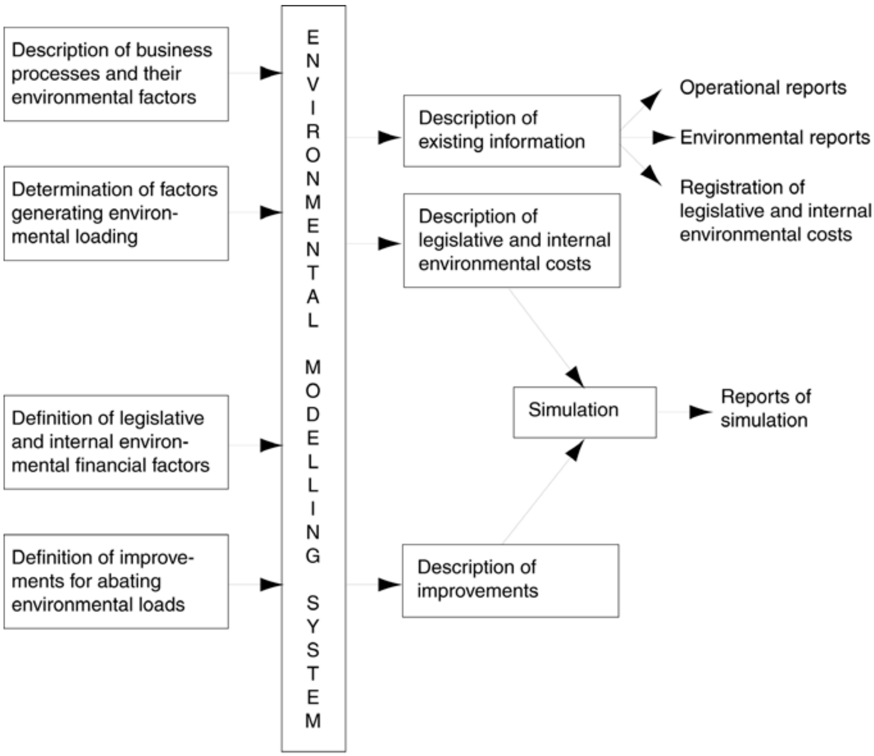


Figure 4. *The framework of an environmental model for analysing operational, environmental and financial factors in the business processes of companies (Pohjola, 1997).*

1. Defining the environmental strategy of a company

This element contains the key business operations and the main environmental requirements for a business field, as well as alternatives for each part of a SWOT (Strengths, Weaknesses, Opportunities, Threats) analysis.

2. Information on a company's business processes

Data on operational processes and their financial implications includes the following:

- Amount and costs of raw materials and other purchases
- Amount and costs of energy and water consumption
- Distances and costs of transportation
- Amount of waste and costs of waste management.

3. Elements for documentation of the EMS
By means of this element, data on environmental agreements, audit programmes, persons who are accountable for developing environmental issues, and further information needed to develop a firm's EMS are entered into the tool.

4. Training tool
The training tool was developed to help EIS users clarify environmental expressions and terms, and it can also be used as part of a company's environmental education programme.

5. Reports generated by the EIS tool
Environmental reports are classified into three categories:

- Documentation of the environmental management system
- Environmental reports for customers and government
- Environmental reports for internal use, containing information on operational, environmental and financial indicators used in the firm.

The core idea of EIS is to qualify information collected on environmental issues and the metrics used to evaluate environmental performance, but equally to improve environmental reporting. The EIS enables cooperation between firms (particularly those operating in the same field) on related environmental issues, allowing them to exchange information and experiences and further develop the tool. The structure of the tool is shown in Figure 5.

On a technical level, the EIS uses a Linux database accessible over the Internet. Apart from the annual licensing costs, EIS is also inexpensive to use because the only cost is the Internet connection. This web-based tool is offered to companies as a service of Bitblit Ltd, a Finnish IT firm.

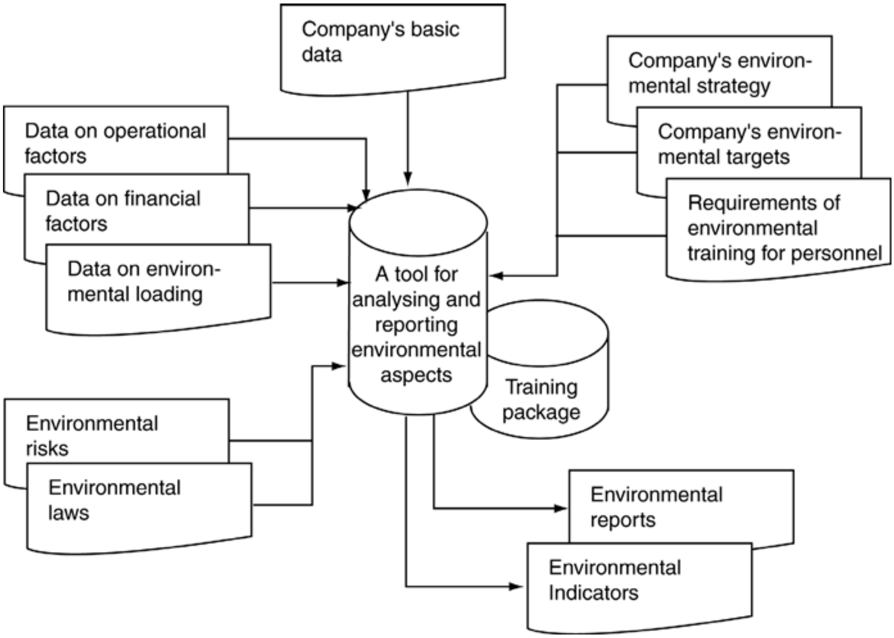


Figure 5. *The structure of an Environmental Internet System*

3 TWO EXAMPLES OF AN ENVIRONMENTAL INTERNET SYSTEM (EIS)

These two cases represent two different business fields: the graphics industry and transport services. The graphics industry is also an example of logistics chains and covers energy consumption, transportation and waste management – an important environmental area for this industry. Transport services include the phases of transportation (loading, transporting and unloading) and data on maintenance works and fuel consumption, which can be entered into the modelling system.

The case studies were carried out according to a uniform framework. Firstly, the business process was selected and its process, environmental and financial factors were defined. Secondly, the measurements of variables and the values of environmental parameters included in the model were defined, and the computer-aided model was adapted to the case study. Thirdly, the current environmental performance was analysed, and alternative improvements were identified.

3.1 The graphics industry

The main environmental issues of the graphics industry include the consumption of paper and various solvents, and the amount of hazardous waste generated. The amount of energy and water consumption is considerable, and logistics operations cause direct environmental loads. The EIS tool (www.4eis.net) is currently in use in

Table 1. *Environmental metrics of the graphics industry*

Accounting level: annual or monthly total

	Operational factor	*Data source*	*Reporting unit*	*Measurement unit*
Acquisition	Paper and board Newsprint Fine paper Magazine printing paper Other cardboard Chipboard Labels Corrugated board Others	Store bookkeeping	Tons	Tons
	Dissolvents	Store bookkeeping	Litres	Litres
	Repro chemicals	Store bookkeeping	Litres	Litres
	Printing inks	Store bookkeeping	Litres	Litres
	Glues	Store bookkeeping	Litres	Litres
	Printing plates	Store bookkeeping	Block	Blocks
	Product packages	Store bookkeeping	Kg	Tons
	Acquisition packages	Store bookkeeping	Kg	Tons
	Damping solution additives	Store bookkeeping	Litres	Litres
	Amount of acquisition transportations	Store bookkeeping	Km	Tons
Purchases	Purchases, paper	Bookkeeping or Bills of freight	Tons	Tons
	Purchases, dissolvent	Bookkeeping or Bills of freight	Litres	Litres
	Purchases, repro chemicals	Bookkeeping or Bills of freight	Litres	Litres
	Purchases, toner	Bookkeeping or Bills of freight	Litres	Litres
	Purchases, glues	Bookkeeping or Bills of freight	Litres	Litres
	Purchases, printing plates	Bookkeeping or Bills of freight	Block	Blocks
	Purchases, product packages	Bookkeeping or Bills of freight	Kg	Tons
	Purchases, acquisition packages	Bookkeeping or Bills of freight	Kg	Tons
Delivery	Delivery transportations	Logistics database	Km	Km
Energy and water consumption	Consumption, electricity	Metrics of buildings	kWh	MWh
	Consumption, heat energy	Metrics of buildings	kWh	MWh
	Consumption, fabrication water	Metrics of buildings	m3	m3
Process factor	Amount of used paper	Counting value	Tons	Tons

	Operational factor	Data source	Reporting unit	Measurement unit
Waste management	Recycled paper	Waste bookkeeping	Tons	Tons
	Recycled cardboard	Waste bookkeeping	Tons	Tons
	Assorted waste	Waste bookkeeping	Tons	Tons
	Scrap metal	Waste bookkeeping	Tons	Tons
	Hazardous waste	Waste bookkeeping	Tons	Ton
	Waste water	Metrics	m3	m3
	Waste management transportations	Bookkeeping	Km	Km
Personnel transportation	Personnel transportation	Bookkeeping	Km	Km
Environmental costs	Costs, acquisition transportations	Bookkeeping	Euros	Euros
	Costs, delivery	Bookkeeping	Euros	Euros
	Costs, electricity	Bookkeeping	Euros	Euros
	Costs, heat energy	Bookkeeping	Euros	Euros
	Costs, fabrication water	Bookkeeping	Euros	Euros
	Waste management costs, paper	Bookkeeping	Euros	Euros
	Waste management costs, cardboard	Bookkeeping	Euros	Euros
	Waste management costs, assorted waste	Bookkeeping	Euros	Euros
	Waste management costs, scrap metal	Bookkeeping	Euros	Euros
	Waste management costs, hazardous waste	Bookkeeping	Euros	Euros
	Waste water fee	Bookkeeping	Euros	Euros
	Costs of personnel transport	Bookkeeping	Euros	Euros

six Finnish printing houses; the main environmental metrics used for accounting and calculating are shown in Table 1.

The calculating rules for environmental loads were defined when operational factors were defined and the system for collecting data on these factors was planned. The EIS includes the database which contains all the rules for calculating various environmental loads; the database also includes the environmental parameters needed for calculation, which were provided by research centres such as the VTT Technical Research Centre of Finland. Environmental loads calculated in the EIS are shown in Table 2.

The initial project involving four Finnish printing houses started in 1999 and finished in 2000. It defined environmental indicators for that business field, which are still used today when printing houses report their environmental issues. The indicators are shown in Table 3.

Table 2. *Environmental loads calculated in the EIS*

Load	*Calculating unit*	*Reporting unit*
Power production Carbon dioxide CO_2	Kg	Tons/year
Power production Carbon oxide CO	Kg	Kg/year
Power production Sulphur dioxide SO_2	Kg	Kg/year
Power production Nitrogen oxides NO_2	Kg	Kg/year
Power production Hydrocarbon HC	Kg	Kg/year
Power production Particles	Kg	Kg/year
Transportation Carbon dioxide CO_2	Kg/km	Tons/year
Transportation Carbon oxide CO	G/km	Kg/year
Transportation Sulphur dioxide SO_2	G/km	Kg/year
Transportation Nitrogen oxides NO_x	G/km	Kg/year
Transportation Hydrocarbon HC	G/km	Kg/year
Transportation Dinitrogen oxide N_2O	G/km	Kg/year
Transportation Particles	G/km	Kg/year
Transportation Methane CH_4	G/km	Kg/year

3.2 Road haulage/LIFE02 project

The main direct environmental loads of transport services are generated by fuel consumption, dust, noise caused when trucks are used and hazardous waste from vehicles maintenance works. Fuel consumption and distances driven can be measured accurately, but dust and noise measurement are more complicated and the determination of environmental effects generated by them can be only estimated. In addition, indirect environmental loads are generated by vehicle manufacture. EcoTra is a tool for collecting data and calculating and reporting environmental indicators in road haulage. The tool was developed as part of the LIFE project 'Environmental Management Systems for Small and Medium-Sized Companies'[1]. The environmental metrics of road haulage are shown in Table 4.

Table 3. Indicators of printing houses

Indicator	Unit
Environmental efficiency	
Consumption, electrical energy/amount of used paper	kWh/tons
Consumption, heat energy/amount of used paper	kWh/tons
Consumption, fabrication water/amount of used paper	m^3/tons
Amount of dissolvent/amount of used paper	Litres/tons
Amount of chemicals/amount of used paper	Litres/tons
Amount of assorted waste/amount of used paper	Litres/tons
Maculature/amount of purchased paper	Tons/tons
Amount of acquisition and delivery transportation/amount of used paper	Km/tons
Amount of waste transportations/amount of used paper	Km/tons
Amount of personnel transportation/amount of used paper	Km/tons
Amount of hazardous waste/amount of used paper	Tons/tons
Economic efficiency	
Energy costs/amount of used paper	Euros/tons
Water costs/amount of used paper	Euros/tons
Disposal costs of hazardous waste/amount of used paper	Euros/tons
Waste disposal costs paper/amount of used paper	Euros/tons
Waste disposal costs other/amount of used paper	Euros/tons
Transportation costs other/amount of used paper	Euros/tons
Environmental loading	
Energy consumption CO_2/Quantity of paper used	Tons/tons
Transportation CO_2/Quantity of paper used	Tons/tons

Table 4. *Environmental metrics of road haulage*

Operation factor	*Data source*	*Reporting unit*	*Measurement unit, Accounting level*
Distance driven	Driver gives data or it is collected by a black box*	Km	Km, Drivers/month or Drivers/year Km, Drivers/customers (the accounting done for a vehicle and for a company)
Road journey	Driver gives data or it is collected by a black box	Km	Km, Annual or monthly total
Town journey	Driver gives data or it is collected by a black box	Km	Km, SAnnual or monthly total
Freight	Driver gives data or bill of freight	Tons	Tons, SAnnual or monthly total
Volume	Driver gives data or bill of freight	m3	m3, Annual or monthly total
Loading time	Driver gives data or it is collected by a black box	Hour	Hours, SAnnual or monthlyr total
Unloading time	Driver gives data or it is collected by a black box	Hour	Hours, Annual or monthly total
Total work time	Driver gives data or it is collected by a black box	Hour	Hours, Annual or monthly total
Status of journey			
Fuel consumption	Driver gives data or is collected from oil companies	Litre Litre / 100 km	Litres, Fuel consumption/ month or Fuel consumption/ year (accounting done for a vehicle and for a company)
Maintenance and repair	Driver gives data	Euro	Euros, Annual or monthly total
Tyres	Driver gives data	Euro	Euros, Annual or monthly total

* A black box is a mechanical device installed in a vehicle for registering distances driven and fuel consumption.

The environmental loads calculated using the EcoTra tool (the EIS being used) are shown in Table 5.

Table 5. Environmental loads calculated by EcoTra

Load	*Calculating unit*	*Reporting unit*
Carbon dioxide CO_2	Kg/km	Tons/year
Carbon oxide CO	G/km	Kg/year
Sulphur dioxide SO_2	G/km	Kg/year
Nitrogen oxides NO_x	G/km	Kg/year
Dinitrogen oxide N_2O	G/km	Kg/year
Particles	G/km	Kg/year
Methane CH_4	G/km	Kg/year
Hydrocarbon HC	G/km	Kg/year

The types of hazardous waste measured are shown in Table 6.

Table 6. Types of hazardous waste

Type of waste	*Data source*	*Reporting unit*	*Measure unit, Accounting level*
Oil filters	Bookkeeping	Litres/year	Litres, Annual or monthly total
Waste oil	Bookkeeping	Litres/year	Litres, Annual or monthly total
Tyres	Bookkeeping	Euros/year	Euros, Annual or monthly total

Environmental metrics of energy and water consumption of buildings are shown in Table 7.

Table 7. Metrics of energy and water consumption

Objective	*Data source*	*Reporting unit*	*Measure unit, Accounting level*
Electricity consumption	Bookkeeping	MWh/year	MWh, Annual or monthly total
Heating energy consumption	Bookkeeping	MWh/year	MWh, Annual or monthly total
Water consumption	Bookkeeping	m^3/year	m^3, Annual or monthly total

Indicators used for environmental reporting were defined in collaboration with Finnish transport companies some years ago. There are a few companies which have used these indicators in their reports.

Indicators of road haulage are as follows:

Fuel consumption	Litres/100 km
Tyre usage	Euros/100 km
Maintenance costs	Euros/100 km
Repairing costs	Euros/100 km
Hazardous waste costs	Euros/100 km

The process management procedure and environmental management systems varied between different companies. In the case studies in which a process management system was not outlined, the definition of process factors required more time than the author had expected. The lack of a documented environmental management system was not a critical aspect because the only benefit for modelling in companies using environmental management systems was in data collection. Several companies started to form their own environmental management systems when they tested the modelling system. However, when a company had to measure and collect data according to legislative requirements, the testing of the environmental modelling system was more systematic. Existing accounting systems did not include cost allocation, and so the collection of data on the internal environmental cost factors defined was difficult. Consequently, when a company has good knowledge of its processes and process factors, the definition of environmental factors can best be realised. The definition of internal environmental cost factors is not a problem, but the collection of cost data on environmental aspects is frequently difficult because firms do not use the method of cost allocation, but account for internal environmental costs in their overheads.

4 CONCLUSIONS

The focus of this study is environmental business accounting in relation to environmental management. The method of the environmental modelling system developed in the study connects environmental performance to process management, financial aspects and management accounting in business processes. The environmental modelling system is designed to address the needs of managing environmental aspects in relation to the process and financial factors of business processes, and the requirements for environmental management caused by internal and external stakeholders. The two examples presented above proved that the environmental modelling system enables companies to use a systematic approach to environmental aspects in relation to process management and management accounting. The examples – the graphics industry and road haulage services – show how companies are using the method to achieve better environmental reporting and improve their environmental performance. The application of the model to the graphics industry is now in use by six Finnish printing houses, while the application to road haulage services is being tested in ten logistics companies in Finland, Hungary and Portugal.

The method of the environmental modelling system includes the following steps:

- Defining the process, environmental and financial factors of business processes, and their interrelations.
- Determining environmental loads, risks and liabilities on the basis of the factors defined above.
- Determining the elements of environmental business accounting:
- Current environmental performance.
- Legislative and internal environmental costs.
- Determining financial performance of environmental aspects.
- Reporting information on the current environmental performance and the financial performance of environmental aspects.
- Identifying processes and operations in which environmental performance can be improved.
- Identifying the conditions for developing the environmental aspects of processes and operations selected.
- Defining alternative solutions to improve environmental performance in relation to financial performance.
- Simulating the solutions selected by determining environmental loads, assessing the environmental risks and liabilities generated by the alternatives, and calculating the profitability of the investments planned.
- Comparing the environmental and financial outcomes of alternatives with the current environmental and financial performance.
- Selecting the solutions that are the most effective in improving environmental and financial performance for use in decision-making processes.

The environmental modelling system was developed using the modelling framework and the applications of the three basic environmental models designed by Pohjola as part of her PhD thesis (Pohjola, 1999). The modelling of environmental aspects included in a business process could be realised in each case study, but the extent of these studies varied according to the size of the company, so the modelling framework, a basic environmental model and its computer-aided model, needed to be adapted for each case study. The method of the environmental modelling system can be used in companies which operate in different business fields, and can be adapted to the needs of small, medium-sized and large companies. Consequently, the environmental modelling system developed in the thesis forms a method to identify, analyse and improve environmental aspects as an integrated part of business management.

The scope of the environmental modelling system was limited in terms of external environmental costs, comprehensive life cycle assessments and environmental impact assessments, and analyses of the social and ethical consequences of business processes. According to Gray, et al. (1993), Epstein (1996c), Klassen and Laghlin (1996), Linnanen et al. (1994), Schaltegger and Sturm (1996), and Welford and Gouldson (1993), the first phase in environmental improvement is to manage environmental aspects in relation to companies' own business operations. The second phase is to develop an environmental management system, which enables an organisation to extend the consideration of environmental issues to external issues, such as social environmental costs and comprehensive life cycle assessments. Ethical questions related to environmental issues cover various political, global, local and economic viewpoints, and the research field is extremely wide. However, the connection between business operations and ethical questions is included in the principles of sustainable development, which is generally considered relevant for the environmental strategy and policy of companies. Consequently, when the understanding of and responsibility for environmental issues increases in business, the environmental modelling system is a method to advance companies' knowledge of environmental aspects, thus enabling an extension of the scope of environmental management to social and ethical fields.

NOTES

1 (www.life02.net)

REFERENCES

Bennett, M. and James, P. (1997a), Environment-Related Management Accounting: Current Practice and Future Trends. *Greener Management International* 17: 32-52,

Bennett, M. and James, P. (1997b), Making Environmental Management Count: Baxter International's Environmental Financial Statement. *Greener Management International* 17: 114-128.

Callan, S.J. and Thomas, J.M. (1996), *Environmental Economics and Management. Theory, Policy, and Applications*. USA: Times Mirror Higher Education Group.

Chadwick, P., Garrod, B. and Larsson, N. (1996), Integrating Environmental Issues into Business Strategy: The Experience of Sweden. *Greener Management International* 16: 61-75.

Dobers, P. (1997), Strategies for Environmental Control: A Comparison Between Regulation and Centralized Control in Germany and Reforms Leading to Decentralized Control in Sweden. *Business Strategy and the Environment* 6 (1): 34-45.

Earl, G. (1996), Total Value Analysis for Environmental Investment Projects: A Model. *Greener Management International* 15: 87-102.

Environmental Protection Agency (EPA) (1994), *Stakeholders' Action Agenda: A Report of the Workshop on Accounting and Capital Budgeting for Environmental Costs*. Washington DC United States Environmental Protection Agency.

Environmental Protection Agency (EPA) (1995a), *An Introduction to Environmental Accounting As a Business Management Tool: Key Concepts And Terms*. Washington DC United States Environmental Protection Agency.

Environmental Protection Agency (EPA) (1995b), *Environmental Cost Accounting for Capital Budgeting: A Benchmark Survey of Management Accountants*. Washington D.C United States Environmental Protection Agency.

Epstein, M.J. (1996a), *Measuring corporate environmental performance: best practices for costing and managing an effective environmental strategy*. IMA Foundation for Applied Research, Inc., Times Mirror Higher Education Group, Irwin Professional Publishing.

Epstein, M.J. (1996b), You've Got a Great Environmental Strategy – Now What? *Business Horizons* 39(5): 53-59.

Epstein, M.J. (1996c), Accounting for Product Take-Back. *Management Accounting* 78 (2): 29-33.

Field, B.C. (1997), *Environmental economics: an introduction*. USA: McGraw-Hill Companies Inc.

Freimann, J. (1997), Environmental Statements: Valid Instruments for Measuring the Environmental Management Success of A Company? *Eco-Management and Auditing* 4 (3): 109-115.

Grey, R.H., Bebbington, K.J. and Walters, D. (1993), *Accounting for the Environment*. London: Paul Chapman Publishing.

Halme, M. (1997), *Environmental Management Paradigm Shifts in Business Enterprises. Organisational Learning Relating to Recycling and Forest Management Issues in Two Finnish Paper Companies*. Ph.D. Dissertation, Acta Universitatis Tamperensis 542, Finland: University of Tampere, School of Business Administration.

Heiskanen, E., Heininen, M., af Heurlin, E., Lovio, R., Pänkäläinen, M. and Tuleheimo V. (1997), *Energiayhtiöiden ympäristölaskenta ja – raportointi* [Environmental accounting and reporting of energy utility companies]. Espoo: Technical Research Centre of Finland, VTT Research Notes 1857, (in Finnish).

Hofstra, N.A. and Suerink, J.M. (1995), Environmental Audit and Protection: Towards an Industrial Application Model. *Greener Management International* 11: 89-102.

Klassen, R.D. and Laughlin, C.P. (1996), The Impact of Environmental Management on Firm Performance. *Management Science* 42 (8): 1199-1214.

Linnanen, L., Boström, T. and Miettinen, P. (1994), *Ympäristöjohtaminen – elinkaariajattelu yrityksen toiminnassa* [Environmental Management – Life Cycle Thinking in Corporate Management], Espoo: WSOY (in Finnish).

Mätäsaho, R. and Niskala, M. (1997), Ympäristölaskentatoimi ja valtaympäristö [Environmental Accounting in Power Context]. *The Finnish Journal of Business Economics* 1: 76-91 (in Finnish).

Miller, J. (1996), Working in Environmental Skills, Expertise and new Opportunities. *Greener Management International* 13: 66-77.

Moilanen, T. and Martin, C. (1996), *Financial evaluation of environmental investments*. Warwickshire: Institution of Chemical Engineers.

Organisation for Economic Co-operation and Development (OECD) (1989), *Environmental Policy Benefits: Monetary Valuation*. Paris: OECD,.

Parker, J.N. (1995), Profits and Ethics in Environmental Investments. *Management Accounting* 39 (5): 52-53.

Pohjola, T. (1997), Case Report of Helsinki Telephone Corporation's Energy Model, Helsinki, Finland (unpublished).

Pohjola, T. (1999), *Environmental Modelling System – a Framework for Cost-Effective Environmental Decision-Making Processes*, Ph.D. Dissertation, Helsinki: Helsinki University of Technology, Femdi Research Series No 12.

Pollack, S. (1995), *Improving Environmental Performance*. London: Routledge.

Renn, O., Blättel-Mink, B. and Kastenholz, H. (1997), Discursive Methods in Environmental Decision-making. *Business Strategy and the Environment* 6 (4): 218-231.

Schaltegger, S. (1997), Information Costs, Quality of Information and Stakeholder Involvement – The Necessity of International Standards of Ecological Accounting. *Eco-Management and Auditing* 4(3): 87-97.

Schaltegger, S. and Sturm, A. (1996), Managerial Eco-Control in Manufacturing and Process Industries. *Greener Management International* 13: 78-91.

Schroeder, G. and Winter, M. (1997), Environmental Accounting at Sulzer Technology Corporation. *Greener Management International* 17: 141-155.

Shrivastava, P. (1995), The Role of Corporations in Achieving Ecological Sustainability. *Academy of Management Review* 20 (4): 936-960.

Spengler, T., Geldermann, J., Hähre, S., Sieverdingbeck, A. and Rentz, O. (1997), A Multi-Criteria Decision-Support System for Ecological Management: Structure and Application to the German Steel Industry. *Greener Management International* 18: 59-77.

Strong, C. (1995), Are Grocery Retail Buyers Making Greener Purchasing Decisions?, *Greener Management International* 11: 103-112.

van den Bosch, F.A.J. and van Riel, C.B.M. (1998), Buffering and Bridging as Environmental Strategies of Firms. *Business Strategy and the Environment* 7 (1): 24-31.

Welford, R. and Gouldson, A. (1993), *Environmental Management & Business Strategy*. London: Pitman Publishing.

Wills, P. (1994), Going to Green? *Management Accounting* (UK).72 (5): 42-43.

Wolters, T., Bouman, M. and Peeters, M. (1995), Environmental Management and Employment: Pollution Prevention Requires Significant Employee Participation. *Greener Management International* 11: 63-72.

Wolters, T., James, P. and Bouman. M. (1997), Stepping-Stones for Integrated Chain Management in the Firm. *Business Strategy and the Environment* 6 (3): 121-132.

World Commission on Environment and Development (WCED) (1987), *Our Common Future*. Oxford: Oxford University Press.

CHAPTER 10

IMPLEMENTING ENVIRONMENTAL COST ACCOUNTING IN SMALL AND MEDIUM-SIZED COMPANIES

NATALIE WENDISCH* AND THOMAS HEUPEL‡

**Hamberg GmbH and ‡University of Siegen, Germany*

n.wendisch@hamberg.de, thomas.heupel@unr-siegen.de

Abstract. As a result of increased corporate environmental costs since the 1970s and steadily rising costs and innovation pressure in globalised competition, corporate environ-mental cost accounting (ECA) is continuously under attention. Cost management decisions – and ensuing entrepreneurial decisions – will increasingly depend on successful acquisition and transfer of information and data that consider ecological as well as economic effects. Sustainable future-oriented corporate governance will not function without an ECA to support the planning, management and control of the company.

Within the framework of the project Integration of ECA into environmental management systems in SME's sponsored by the German Federal Foundation for the Environment (Deutsche Bundesstiftung Umwelt – DBU), Osnabrück, ECA was successfully implemented in more than ten companies. The project was carried out in co-operation between the Institut für Ökologische Betriebwirtschaft (IöB), Siegen, and the Internationales Hochschulinstitut (IHI), Zittau, both Germany. The objective of this project was to show economic and ecological advantages of, but also barriers to, ECA implementation by examples of German companies on the one hand and Czech and Polish ones on the other. The selection criteria as regards the companies were on one hand the size of the enterprise and on the other the willingness of management to implement an ECA. The project was especially focused on the operational use in SMEs and represents a further development of existing flow cost accounting systems (see e.g. Burritt and Schaltegger, 2000).

The following describes the implementation methodology developed in the project and illustrates how this method was applied in one of the companies which participated in the study.

P.M. Rikhardsson et al. (eds.), Implementing Environmental Management Accounting, 193-205

1 ENVIRONMENTAL COST ACCOUNTING IN SMES

Since its inception some 30 years ago, Environmental Cost Accounting (ECA) has reached a stage of development where individual ECA systems are separated from the core accounting system based an assessment of environmental costs with (see Fichter et al., 1997, Letmathe and Wagner , 2002).

As environmental costs are commonly assessed as overhead costs, neither the older concepts of full costs accounting nor the relatively recent one of direct costing appear to represent an appropriate basis for the implementation of ECA. Similar to developments in conventional accounting, the theoretical and conceptual sphere of ECA has focused on process-based accounting since the 1990s (see Hallay and Pfriem, 1992, Fischer and Blasius, 1995, BMU/UBA, 1996, Heller et al., 1995, Letmathe, 1998, Spengler and Hähre, 1998).

Taking available concepts of ECA into consideration, process-based concepts seem the best option regarding the establishment of ECA (see Heupel and Wendisch , 2002). These concepts, however, have to be continuously revised to ensure that they work well when applied in small and medium-sized companies.

Based on the framework for Environmental Management Accounting presented in Burritt et al. (2002), our concept of ECA focuses on two main groups of environmentally related impacts. These are environmentally induced financial effects and company-related effects on environmental systems (see Burritt and Schaltegger, 2000, p. 58). Each of these impacts relate to specific categories of financial and environmental information. The environmentally induced financial effects are represented by monetary environmental information and the effects on environmental systems are represented by physical environmental information. Conventional accounting deals with both – monetary as well as physical units – but does not focus on environmental impact as such. To arrive at a practical solution to the implementation of ECA in a company's existing accounting system, and to comply with the problem of distinguishing between monetary and physical aspects, an integrated concept is required. As physical information is often the basis for the monetary information (e.g. kilograms of a raw material are the basis for the monetary valuation of raw material consumption), the integration of this information into the accounting system database is essential. From there, the generation of physical environmental and monetary (environmental) information would in many cases be feasible. For many companies, the priority would be monetary (environmental) information for use in for instance decisions regarding resource consumptions and investments.

The use of ECA in small and medium-sized enterprises (SME) is still relatively rare, so practical examples available in the literature are few and far between. One problem is that the definitions of SMEs vary between countries (see Kosmider, 1993 and Reinemann, 1999). In our work the criteria shown in Table 1 are used to describe small and medium-sized enterprises.

Table 1. *Criteria of small and medium-sized enterprises*

Number of employees Up to 500 employees	*Turnover* Turnover up to EUR 50m
Management - Owner-cum-entrepreneur - Varies from a patriarchal management style in traditional companies and teamwork in start-up companies - Top-down planning in old companies;	*Organization* - Divisional organization is rare - Short flow of information - Strong personal commitment - Instruction and controlling with direct personal contact - Delegation is rare - Low level of formality - High flexibility
Finance - family company - limited possibilities of financing	*Personnel* - easy to survey number of employees - wide expertise - high satisfaction of employees
Supply chain - closely involved in local economic cycles - intense relationship with customers and suppliers	*Innovation* - high potential of innovation in special fields

Keeping these characteristics in mind, the chosen ECA approach should be easy to apply, should facilitate the handling of complex structures and at the same time be suited to the special needs of SMEs.

Despite their size SMEs are increasingly implementing Enterprise Resource Planning (ERP) systems like SAP R/3, Oracle and Peoplesoft. ERP systems support business processes across organisational, temporal and geographical boundaries using one integrated database. The primary use of ERP systems is for planning and controlling production and administration processes of an enterprise. In SMEs however, they are often individually designed and thus not standardized making the integration of for instance software that supports ECA implementation problematic. Examples could be tools like the "eco-efficiency" approach of IMU (2003) or Umberto (2003) because these solutions work with the database of more comprehensive software solutions like SAP, Oracle, Navision or others. Umberto software for example (see Umberto, 2003) would require large investments and great background knowledge of ECA – which is not available in most SMEs.

The ECA approach suggested in this chapter is based on an integrative solution – meaning that an individually developed database is used, and the ECA solution adopted draws on the existing cost accounting procedures in the company. In contrast to other ECA approaches, the aim was to create an accounting system that enables the companies to individually obtain the relevant cost information. The aim of the research was thus to find out what cost information is relevant for the company's decision on environmental issues and how to obtain it.

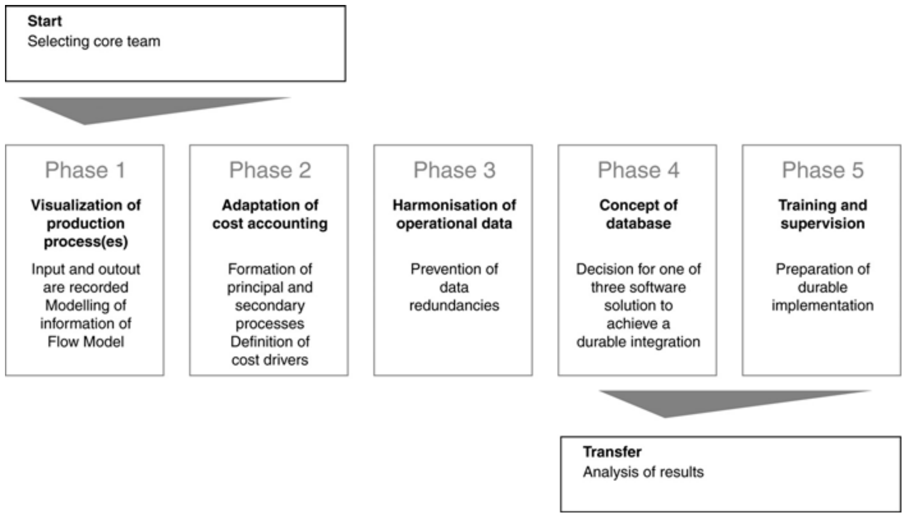


Figure 1. *Method for implementing ECA*

2 METHOD FOR IMPLEMENTING ECA

Setting up an ECA system requires a systematic procedure. The project thus developed a method for implementing ECA in the companies that participated in the project; this is shown in Figure 1. During the implementation of the project it proved convenient to form a core team assigned with corresponding tasks drawing on employees in various departments. Such a team should consist of one or two persons from the production department as well as two from accounting and corporate environmental issues, if available. Depending on the stage of the project and kind of inquiry being considered, additional corporate members may be added to the project team to respond to issues such as IT, logistics, warehousing etc.

Phase 1: Production Process Visualization

At the beginning, the project team must be briefed thoroughly on the current corporate situation and on the accounting situation. To this end, the existing corporate accounting structure and the related corporate information transfer should be analysed thoroughly. Following the concept of an input/output analysis, how materials find their ways into and out of the company is assessed. The next step is to present the flow of material and goods discovered and assessed in a flow model. To ensure the completeness and integrity of such a systematic analysis, any input and output is to be taken into consideration. Only a detailed analysis of material and energy flows from the point they enter the company until they leave it as products, waste, waste water or emissions enables the company to detect cost-saving potentials that at later stages of the project may involve more efficient material use, advanced process reliability and overview, improved capacity loads, reduced waste disposal costs, better transparency of costs and more reliable assessment of legal issues. As a first approach, simplified corporate flow models, standardized stand-alone models for supplier(s), warehouse and isolated production segments were established and only combined after completion. With such standard elements and prototypes defined, a company can readily develop an integrated flow model with production process(es), production lines or a production process as a whole. From the view of later adoption of the existing corporate accounting to ECA, such visualization helps detect, determine, assess and then separate primary from secondary processes.

Phase 2: Modification of Accounting

In addition to the visualization of material and energy flows, modelling principal and peripheral corporate processes helps prevent problems involving too high shares of overhead costs on the net product result. The flow model allows processes to be determined directly or at least partially identified as cost drivers. This allows identifying and separating repetitive processing activity with comparably few options from those with more likely ones for potential improvement.

By focusing on principal issues of corporate cost priorities and on those costs that have been assessed and assigned to their causes least appropriately so far, corporate procedures such as preparing bids, setting up production machinery, ordering (raw) material and related process parameters such as order positions, setting up cycles of machinery, and order items can be defined accurately. Putting several partial processes with their isolated costs into context allows principal processes to emerge; these form the basis of process-oriented accounting. Ultimately, the cost drivers of the processes assessed are the actual reference points for assigning and accounting overhead costs. The percentage surcharges on costs such as labour costs are replaced by process parameters measuring efficiency (see Foster and Gupta, 1990).

Some corporate processes such as management, controlling and personnel remain inadequately assessed with cost drivers assigned to product-related cost accounting. Therefore, costs of the processes mentioned, irrelevant to the measure of production activity, have to be assessed and surcharged with a conventional percentage.

At manufacturing companies participating in the project, computer-integrated manufacturing systems allow a more flexible and scope-oriented production (economies of scope), whereas before only homogenous quantities (of products) could be produced under reasonable economic conditions (economies of scale). ECA inevitably prevents effects of allocation, complexity and digression and becomes a valuable controlling instrument where classical/conventional accounting arrangements systematically fail to facilitate proper decisions.

Thus, individually adopted process-based accounting produces potentially valuable information for any kind of decision about internal processing or external sourcing (e.g. make-or-buy decisions).

Phase 3: Harmonization of Corporate Data – Compiling and Acquisition

On the way to a transparent and systematic information system, it is convenient to check core corporate information systems of procurement and logistics, production planning, and waste disposal with reference to their capability to provide the necessary precise figures for the determined material/energy flow model and for previously identified principal and peripheral processes. During the course of the project, a few modifications within existing information systems were, in most cases, sufficient to comply with these requirements; otherwise, a completely new software module would have had to be installed without prior analysis to satisfy the data requirements.

Phase 4: Database concepts

Within the concept of a transparent accounting system, process-based accounting can provide comprehensive and systematic information both on corporate material/energy flows and so-called overhead costs. To deliver reliable figures over time, it is essential to integrate a permanent integration of the algorithms discussed above into the corporate information system(s). Such permanent integration and its practical use may be achieved by applying one of three software solutions (see Figure 2).

For small companies with specific production processes, an integrated concept is best suited, i.e. conventional and environmental/process-oriented accounting merge together in one common system solution.

For medium-sized companies, with already existing integrated production/accounting platforms, an interface solution to such a system might be suitable. ECA, then, is set up as an independent software module outside the existing corporate ERP system and needs to be fed data continuously. By using identical conventions for inventory-data definitions within the ECA software, misinterpretation of data can be avoided.

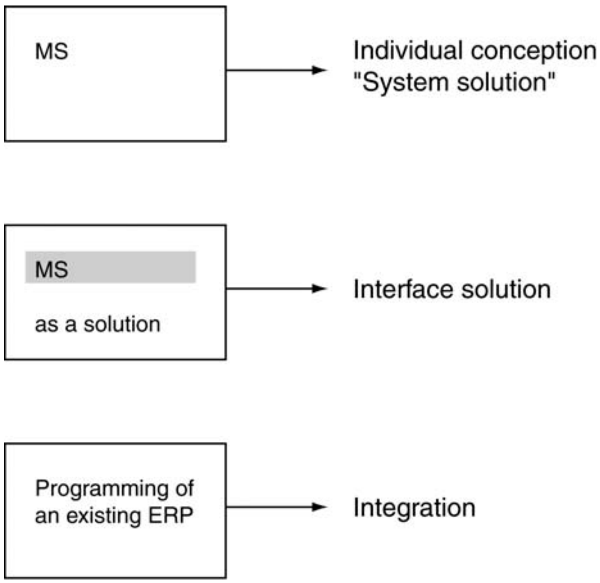


Figure 2. *Different software support solutions*

For large companies with complex ERP systems, the existing platform may be used to run an individually programmed ECA, to give relevant process figures on the one hand and to satisfy ecological requirements on the other (integrative solution).

Process-based ECA may respond to individual needs of surveying corporate user groups and guaranteeing adequately designed reports. Consistent and evident data is assessed in a transparently functional and numerical context of corporate inventory data, all stored and processed in database applications. Combining all of these data, controlling environmentally relevant figures may be put into practise successfully.

Phase 5: Training and Coaching

For the permanent use of ECA, continuous training of employees on all matters discussed remains essential. To achieve a long-term potential of improved efficiency, the users of ECA applications and systems must be able to continuously detect and integrate corporate process modifications and changes in order to integrate them into ECA and, later, to process them properly.

3 SOME PRACTICAL IMPLICATIONS: THE SURFACE OFFTEC INC. CASE

Surface Offtec was founded in 1996. In recent years, the company has expanded continuously, increasing the number of employees from 15 in 2000 to 45 in 2003.

This company focuses on surface finishing of metal pieces of various kinds and sizes. The services range from de-edging and de-greasing to ready-to-paint characteristics of workpieces. Core activities are oriented to suppliers in the automotive industry.

The implementation of ECA in the companies focused on

- systematic data acquisition of material and energy flows;
- individually-tailored database design for bid calculation and survey of environmental data;
- determination of relevant (peripheral and principal) corporate processes;
- design of a to-do concept for the implementation of a production planning system;
- detection and localization of potential to optimise production and administration to cope with future guidelines DIN EN ISO 14000.

Phase 1: Production Process Visualization

At project start, corporate material and information flows were acquired in a tailored corporate flow model by a task force covering all company departments. It became obvious that there were numerous non-planned and non-standardized corporate activities parallel to the regularized standard procedures. Although the company's technical process of de-greasing and de-edging could be described in a very simple model, a precise assignment of processing times and resources used, of consumption of electrical energy and emulsion to costs was not possible. Accordingly, the company failed to assess the exact price of a single workpiece or order. Orders were assessed and calculated on the basis of estimations derived from orders that had been successfully completed before. A post-calculation of processed orders was performed only to a small extent, as data was often missing.

The manufacturing process is as follows: Customers ship metal work pieces to the factory site; the pieces stored are temporarily at two warehouses for wire-mesh boxes and one for handling of small pieces. One area outside the factory provides space for very greasy or oily work pieces; a second area is used for the less greasy ones. Dry pieces are moved temporarily to a third area. From each storage area, forklifts transport work pieces to their processing access point inside the factory. In special machines, workpieces get de-greased and de-edged by abrasives, emulsion, water and other additives such as sand or pearls of glass used with special applications. Workpieces are then dried by adding corn-straw granulate to the machines or by hot air fanned onto the work pieces when leaving the machines. Process water circulates in a closed system equipped with a water-treatment system. Continuously, water is separated from induced metal particles in a centrifuge and chemically treated before re-entering the system feeding the centrifuge machines. Process water may be used until its defined life cycle has been reached. Then the batch of process water is exchanged with fresh water and a small amount of additives. Waste water is stored in an intermediate tank and disposed of at fixed intervals by a waste disposal company.

Processed work pieces are packed and re-shipped to the customers in cartons for small pieces or wire-mesh boxes wrapped in paper. Just in time shipment to customers may require intermediate storage at delivery storage areas. Customer and suppliers may be identical. Processed workpieces are also delivered directly to the assembly lines of the automobile industry.

Some of the processed goods are transported by company-owned vans, others are transported by the customers themselves.

Figure 3 shows Surface Offtec's process flow model.

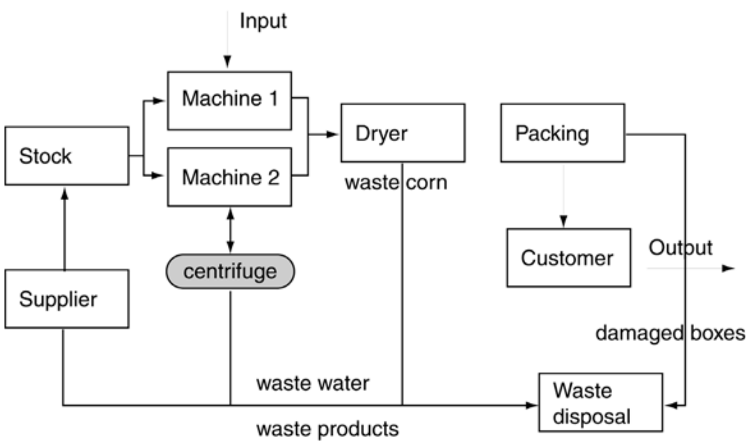


Figure 3. *Offtec's process flow model*

Phase 2: Modification of accounting

The weaknesses of conventional accounting schemes were illustrated in phase 1 regarding definition of cost types as well as cost centre structures. Due to the high number of repetitive activities in the company production process, a process-based accounting system was called for. Following the process model, the existing conventional production parameters in the accounting system for secondary ('de-edge', 'degrease', 'in-house transport') and primary ('storage', 'finishing', 'drying', 'shipment') processes were replaced by parameters such as 'level gauge', 'degree of pollution', 'set-up times for processing steps', 'processing machinery capacity' etc. As mentioned above, several partial processes were in functional context with each other which results in one primary process and improves the basis of realistic production cost assessment and calculation. Production activities with cost allocation irrelevant to the quantity produced are surcharged to the price of processed work pieces by the database application.

Phase 3: Harmonization of Corporate Data – Compiling and Acquisition

At Surface Offtec, relevant data to determine the material/energy flow model is derived from for instance company information systems, various corporate inventory records and individually-recorded forms and tables, both on paper and in electronic format. To facilitate the integration between ECA and the conventional accounting system at a later date, the ECA database design follows a data model that, by its conventions and applied software standards, allows integration of the existing company-conventional accounting system, including for example with human resources, billing, material supply and output planning.

Phase 4: Database concepts

For the permanent use of ECA, the system solution discussed above was selected. As the conventional accounting system is an MS Access application, the ECA has the same software format. At any time, all of the software can be used in one application. The structure of the database designed mirrors the corporate structures worked out in flow models. The advantage of such programming becomes particularly evident, as the use, care and further development of software can easily be assigned to the corporate user at later stages. Figure 4 shows the basic concept of the database application.

Basic data are recorded in the four units 'Supplier', 'Customer', 'Raw materials', and 'Article'. To enter an order, the data sheet 'Order' is used. This data sheet accesses the stored data and drafts a specific order. The calculated data are used for an archival data backup. From these data, all relevant reports, such as 'Labour costs', Waste balance', 'Energy use' etc., can be generated. The reports can focus on either the environmental or the economic situation.

4 IMPLEMENTATION EXPERIENCES AND CONCLUSIONS

The use of the database software and its advantageous realization of integrated accounting generally provided improved transparency and better comprehension of intra-corporate processes and contexts. By combining both conventional accounting and the ECA system, the company was also able to fill in information gaps relevant to environmental management.

Experience gained while implementing ECA involves not only positive aspects. One of the great problems was the time consumption in the early stages. To devise a useful flow model for the start requires a substantial space of time. There were also some problems involving personnel because the project demanded work in a team across company divisions. At first, the internal changes in the company were not seen as positive, but, later on, they provided greater satisfaction for the employees.

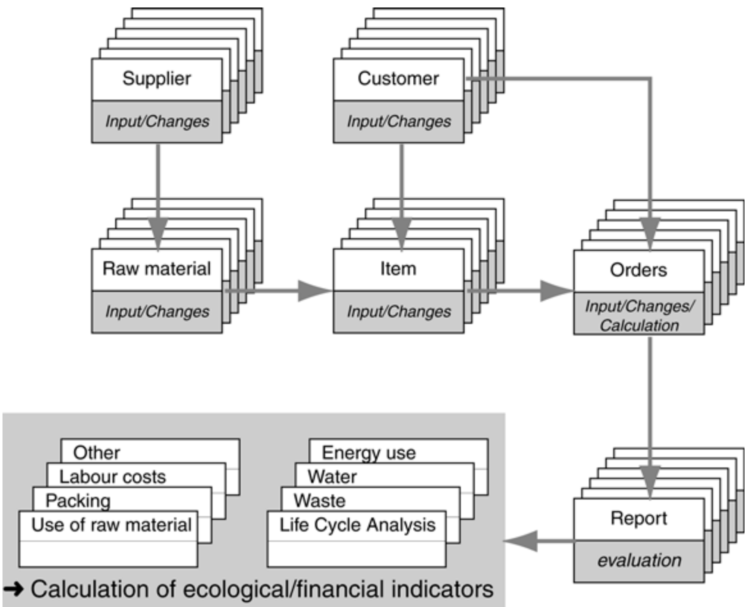


Figure 4. *The database application*

With the detailed representation of single orders in the order processing cycle, an efficient cost-control system was set up to compare profitability and efficiency of every single item; this allowed proper allocation of costs accumulating within an order. There are also positive effects involving the following aspects:

- improved certainty on delivery time;
- increased flexibility to respond to short-term customer requirements;
- reduced processing cycles for all orders as a result of improved production planning;

- improved segmentation of ordering, depending on the basis of the work piece characteristics specified by the customer;
- data and trend acquisition for future investments (i.e. consideration of waste heat or regenerative energy for heating systems of additional/new building enlargement/construction).

As shown in the example discussed above, software-based implementation for the permanent use of process-based ECA is important if ECA is to be applied in the organisation on a permanent basis. A tailored software solution was presented as an initial and substantial measure. Process-related analysis of corporate processes, the adaptation of existing accounting systems in selected corporate areas and the effective use of existing corporate information systems disclose potentials for environmental protection measures and, especially, for cost reduction to an extent which should not be underestimated.

The implementation of process-based ECA in the companies which participated in the project has resulted in several enhancements of the existing accounting system. In addition to being able to identify weaknesses in the existing accounting system, the user can obtain a clear and consistent basis for planning and decision making with data generated from the appropriate database application.

The broad conclusion of the project is that ECA is a natural part of how environmental management accounting develops and can contribute to its further innovation and evolution.

REFERENCES

Burritt, R.L., Hahn, T. and Schaltegger, S. (2002), An Integrative Framework of Environmental Management Accounting – Consolidating the Different Approaches of EMA into a Common Framework and Terminology. In: Bennett, M., Bouma, J.J., and Wolters T. (eds.), *Environmental Management Accounting: Informational and Institutional Developments*. Dordrecht: Kluwer Academic Publishers, pp. 21-35.

Burritt, R.L. and Schaltegger, S. (2000), *Contemporary Environmental Accounting*. Sheffield: Greenleaf Publishing.

Burritt, R.L., Petersen, H. and Schaltegger, S. (2003), *An Introduction to Corporate Environmental Management: Striving for Sustainability*. Sheffield: Greenleaf Publishing.

European Union (EU) (2001), *Verordnung (EG) Nr. 761/2001 über die freiwillige Beteiligung von Organisationen an einem Gemeinschaftssystem für das Umweltmanagement und die Umweltbetriebsprüfung* (EMAS), Amtsblatt L 114/1, 24th April 2001.

Fichter, K., Loew, T. and Seidel, E. (1997), *Betriebliche Umweltkostenrechnung*. Berlin: Springer (Available only in German).

Fischer, H. and Blasius, R. (1995), Umweltkostenrechnung. In: German Federal Environmental Agency (Umweltbundesamt – UBA) (ed.): *Handbuch Umweltcontrolling*, 1st ed. Munich: Vahlen (Available only in German).

Foster, G. and Gupta, M. (1990), Manufacturing Overhead Cost Driver Analysis. *Journal of Accounting and Economics* 12: 309-337.

German Federal Environmental Agency (Umweltbundesamt – UBA) (1996), *Handbuch Umweltkostenrechnung*. Munich: Vahlen. (Available only in German).

Hallay, H. and Pfriem, R. (1992), *Öko-Controlling – Umweltschutz in mittelständischen Unternehmen*. Frankfurt: Campus (Available only in German).

Heller, M., Shields, D. and Beloff, B. (1995), Environmental Case Study: Amoco Yorktown Refinery, in: Ditz, D., Ranganathan, R. and Darryl, R. (eds.) *Green Ledgers*. Baltimore: WRI, pp. 47-81.

Heupel, T. and Wendisch, N. (2003), Green Success: Process based Environmental Cost Accounting – Implementation in SME's in Germany. In: Bennett, M., Rikhardsson P.M. and Schaltegger, S. (eds.), *Environmental Management Accounting – Purpose and Progress*. Dordrecht: Kluwer Academic Publishers, pp. 333-363.

IMU (2003), *Eco-Efficiency through Flow Management*, [online] [cited 04 Nov. 2003] Available from Internet URL <:http://www.eco-effizienz.de/eco/>

International Standards Organization (ISO) (1996), *ISO 14001:1996, Environmental management systems, Specification with guidance for use*. Brussels.

Kosmider, A. (1993), *Controlling im Mittelstand*, 2. ed. Stuttgart: Schaeffer (Available only in German).

Letmathe, P. (1998), *Umweltbezogene Kostenrechnung*. Munich: Vahlen (Available only in German).

Letmathe, P. and Wagner, G.R. (2002), Umweltkostenrechnung. In: Küpper, H.-U. and Wagenhofer, A. (eds.) *Handwörterbuch Unternehmensrechnung und Controlling*, 4th ed, 1988-1997. Stuttgart: Schaeffer-Poeschel (Available only in German).

Reinemann (1999), Was ist Mittelstand? In: *Wirtschaftwissenschaftliches Studium, 1999*, 12 661 et sqq. (Available only in German).

Spengler T. and S. Hähre (1998), Stoffflussbasierte Umweltkostenrechnung zur Bewertung industrieller Kreislaufwirtschaftskonzepte. *Zeitschrift für Betriebswirtschaft* 2: 147-174 (Available only in German).

Umberto (2003), *umberto – the software tool for the environmental management* [online] [cited 04 Nov. 2003] Available from Internet URL <:http://www.umberto.de/english/> .

CHAPTER 11

ENVIRONMENTAL MANAGEMENT ACCOUNTING IN SMALL AND MEDIUM-SIZED ENTERPRISES:

HOW TO ADAPT EXISTING ACCOUNTING SYSTEMS TO EMA REQUIREMENTS*

ALESSIA VENTURELLI AND ALDO PILISI

Associazione Industriale Bresciana, Italy

venturelli@aib.bs.it, pilisi@aib.bs.it

Abstract. The research project "EMA in SMEs" arose from a wider programme which Associazione Industriale Bresciana (AIB)[1] launched about three years ago to promote the diffusion of integrated management systems in local SMEs.
In this programme the environmental accounting system (EMA), linked with a quality costing, has represented an instrument to overcome the reluctance of small companies towards management systems.
First AIB developed basic evaluation check lists consistent with the implemented environmental management systems (EMSs) and then it tested and improved them in ten different pilot companies[2].
In the stage now in progress, AIB experts are implementing EMAs in companies having suitable accounting systems, or adapting the existing ones to EMA requirements, with two main results:

- First: correct implementation of EMA.
- Second, but no less important: the improvement of accounting systems of small companies and, consequently, also of their organisations.

This paper will present three complete case studies of three SMEs that prior to the AIB Project had no system for measuring and analysing environmental costs and which have now successfully implemented an EMA. For each case the identification and quantification of environmental costs will be described, as well as the solutions adopted to identify and register them periodically through the information systems.

P.M. Rikhardsson et al. (eds.), Implementing Environmental Management Accounting, 207-235

1 INTRODUCTION

The preliminary results of the experimentation on environmental management accounting in ten local SMEs have already been presented in a previous paper[3].

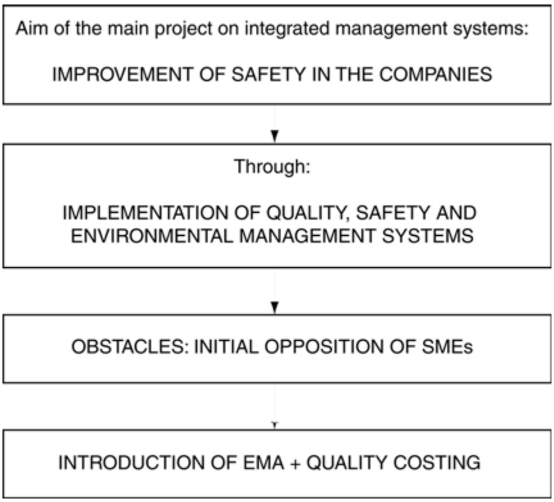


Figure 1. *The "unusual route" to EMA in the project*

The following pages will describe the results of a more advanced stage of experimentation and will focus on how existing accounting systems of the companies involved have been modified to permit a periodic monitoring of environmental costs. In particular, these modifications will be described in three detailed case studies.

Before entering this advanced stage of the project, we would like to summarise the context in which the research project was developed. From the beginning EMA testing in local SMEs has in fact been characterised by very peculiar and unusual motivations, as shown in Figure 1.

Due to the companies' real interest in this instrument, the introduction of EMA was not conceived by AIB to promote the diffusion of integrated management systems of quality, environment and safety in the associated SMEs, but, rather, to different needs arisen within a five-year project. This project is addressed to improve the health and safety at the workplaces through the improvement of company organisation.[4] AIB is in fact deeply convinced that the Management Systems of Quality, Safety and Environment, if properly integrated and certified, can contribute significantly towards improving the organisation and consequently the safety of the SMEs. This improvement of the organisation in small companies consists in developing information flows and dialog among the various departments (sometimes lacking), in increasing knowledge of aspects and activities usually ignored, in a better training of human resources, etc.

Along the way AIB encountered a series of obstacles, such as the lack of interest and often even the opposition of companies, especially small and medium ones.

Environmental management accounting has been introduced in the Project on implementation of management systems with the purpose of convincing companies to participate. In particular, EMA has been introduced during the implementation of environmental management systems (according to ISO 14001 standards) in a sample of 60 SMEs. The experience of environmental management systems implementation has been described by Pilisi and Venturelli in Introducing environmental management accounting in small and medium-sized enterprises, in Bennett et al. (2003).

Table 1. *Total number of Italian and Brescia local units*[5]

Employees	*10-50*	*50-100*	*100-200*	*200-500*	*over 500*	*Total*
Brescia						
Number of firms	3,757	268	107	56	6	4,194
%	89.6%	6,4%	2,6%	1.3%	0.1%	100.0%
Italy						
Number of firms	89,022	7,417	3,262	1,467	407	101,575
%	87.6%	7.3%	3.2%	1.4%	0.4%	100.0%

It is noteworthy that the main project on management systems was directed towards SMEs and to show how much they really represent the backbone of the local industrial context.

Both in Italy and in Brescia about 90 per cent of industrial companies have between 10 and 50 employees[6], and 95 per cent have less than 100. As the large majority are SMEs, it made sense to direct the project at them, although they really were the companies with least interest in the adoption of new systems of management.

The offer of free-of-charge EMA, arisen to overcome the reluctance of companies to participate, was not sufficient to motivate the companies: the owners still were fairly sceptical, considering environmental costs relatively low and negligible.

Faced with these difficulties, AIB decided to enter companies through a sort of “Trojan horse”: the costs of quality. The industrialists were very interested in knowing the quality costs, since these costs and their impact on the organisation were considerable.

To this end, joint check lists to collect quality and environment costs have been developed[7] and provided to the companies. These check lists contain a series of environmental and quality cost items[8], which were a result both from a survey of literature on this issue, and from direct experience in SMEs involved in the project. The check lists, which gather environmental costs as a complement to quality costs, use the same logic and the same classification for both categories.
Environmental costs are therefore divided in:

1. Prevention costs: all costs sustained within the production site to prevent and avoid negative environmental effects, and to improve the firm's image. Included here are, for example, costs for running the EMS, costs for measures to prevent negative environmental impact at the source, and managing relations with third parties.
2. Monitoring costs: costs sustained to monitor and control the working of the EMS and the cost of monitoring environmental performance, such as the cost of laboratory analysis.
3. Failure costs (or costs of non-environment) divided into internal and external failure costs:
   3a Internal failure costs: all costs strictly connected to the environmental impact of the production process within the site, costs caused either by inefficient use of natural resources, or by the treatment of the pollution produced (end-of-pipe solutions) that were not avoided by preventive action. These include waste water treatment, air emission treatment and on-site storage of waste.
   3b External failure costs: costs for impact outside the site, therefore more visible to the public and for which the firm is economically responsible. These include transport and off-site treatment of refuse, fines and payments to third parties for environmental damage.

With the proposal of a joint evaluation (quality + environment) the attitude of the companies changed and, on this basis, the collaboration started to be fully satisfactory and useful.

2 THE APPLICATION OF THE ENVIRONMENTAL ACCOUNTING SYSTEM (EMA) IN THE PILOT COMPANIES: THE STATE-OF-ART

At the beginning of 2003, after about two years of experimentation, thirteen companies were involved in EMA.

Table 2 highlights that all companies are SMEs, mostly from the mechanical sector and with a staff of between 22 and 156. The sample was divided into two groups: one which is in the "first stage" of experimentation and another in the "second stage.

Table 2. The companies involved

N°	Production sector	Production	Discontinued	Staff
First stage				
1	Foundry	Alloy wheels	X	140
2	Mechanical	Design and sale of alloy wheels		25
3	Mechanical	Injection presses for plastics		85
4	Chemical	Production and sale of additives and detergents		57
5	Chemical	Blowing and filling of plastic containers		22
6	Mechanical	Development and production of prototypes and serial production ofsprings	X	68
7	Chemical	Production and sale of industrial gaskets and technical items in rubber	X	156
Second stage				
8	Mechanical	Production of spare parts and accessories for cars, lorries, tractors, motorbikes, micromotors; mechanical working in general		150
9	Mechanical	Production of valves for taps		100
10	Mechanical	Production of pistons for cars		90
11	Foundry	Production of lead shot for hunting and lead parts for batteries		20
12	Foundry	Production of lighting systems in aluminium for outdoors		44
13	Beverages	Treatment, bottling and sale of wine		30

In the first stage AIB staff approaches a company and, together with its employees, they identify and quantify environmental and quality costs of the year considered, giving a sort of "snapshot" through an analysis of each item listed in the check lists. This gives the companies a basis for deciding whether the collection of costs should be continued or not.

The second stage consists in setting up a periodic monitoring of quality and environmental costs through suitable analyses and modifications of the accounting and information systems. At this stage the "snapshot" of costs switches to a "film".

Seven companies out of thirteen have participated in the first stage of experimentation (although three of these stopped before the conclusion of this stage); six companies completed the second stage and have successfully implemented an EMA:

they have in fact adopted a system of periodic monitoring of environmental and quality costs. This can certainly be considered a good result, but it should, however, be compared, with the difficulties encountered both in first and second stages of implementation.

Evidence of these difficulties is in the three firms that stopped after the first stage, and thus did not have a complete view of their environmental and quality costs. Reasons for these failures extend from general company problems, such as factory transfer, to certain SME characteristic like lack of personnel or, more in general, organisational problems due to lack of time and specific knowledge about these issues.

In the companies that decided to go through with the activities encountered more difficulties. Where pressure and motivation from the Owner and from General Management were not felt, the project encountered lots of obstacles and unavoidably time ran short.

Figure 2 shows an example of reminders that were needed in four companies involved in the project. These reminders consisted in numerous requests from AIB to the companies to get cooperation in gathering the data necessary to identify, quantify and analyse costs. Although most of the work was done during the meetings with AIB, the staff also had to do some work outside the meetings.

Numbers speak clearly: 15, 12, 10 and 9 reminders were necessary in the four companies taken as example.

Once again this fact proves that the majority of companies adhere to the project not because of a real interest in instruments like EMA or environmental management system (EMS), but because of a trust in the Industry Association. Usually there is also a strong spirit of competition that encourages owners to establish these systems to copy their rivals or to beat their competitors to it. It is worth mentioning that the major part of the companies involved has less than 100 employees and doesn't have important environmental impacts: these companies do not reap substantial benefits from the adoption of an EMS or EMA in terms of improvement of visibility or enlargement of markets.

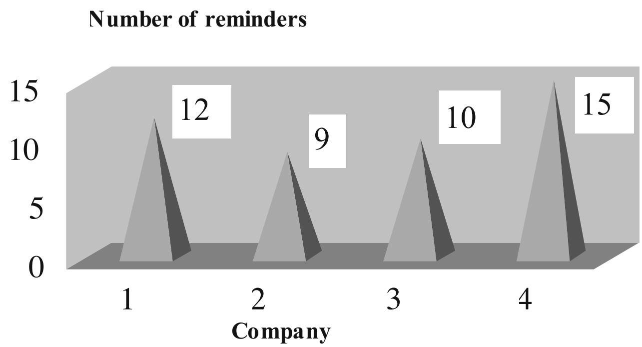


Figure 2. *An example of companies with low motivation*

In common fairness to the companies it should be mentioned that environmental costs of the pilot companies lie between 0.07 and 1.26 per cent of sales. This is relatively little compared with quality costs and probably not sufficient alone to create the necessary motivation.

Figure 3 shows how environmental costs are distributed, in average, in the three categories of prevention, control and failure.

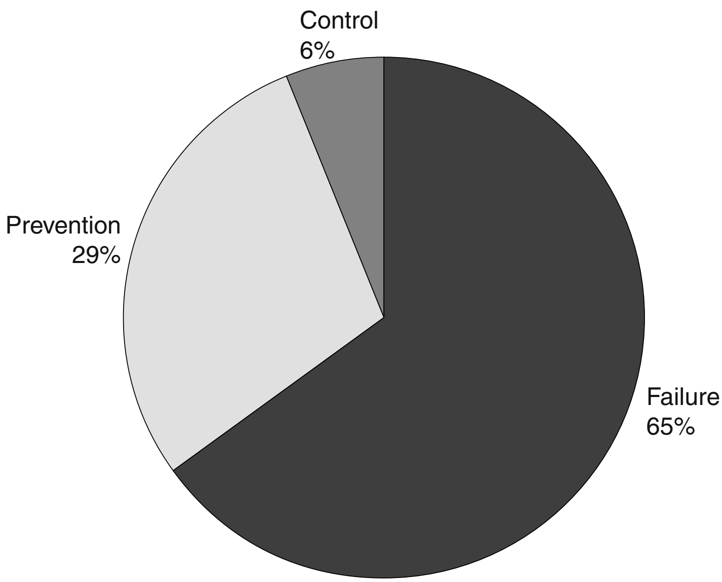


Figure 3. *The three categories of environmental costs*

It is obvious that the large majority of costs are in the third category showing the companies' rather passive attitude towards environmental issues: consequently the companies are not naturally attracted by EMA.

Let us now examine the behaviour of the six companies which completed both stages: they can be considered the "best in class". In these companies General Management (which in all cases was in fact also the owner) showed a strong interest making it possible to apply EMAs effectively.

Below is shown the effort, in terms of number of meetings – in the first and the second stage – that these companies put into implementing an EMA combined with quality costing. The number includes only the meetings between AIB staff and the staff of the company; internal meetings among the different functions to gather or analyse data are not included.

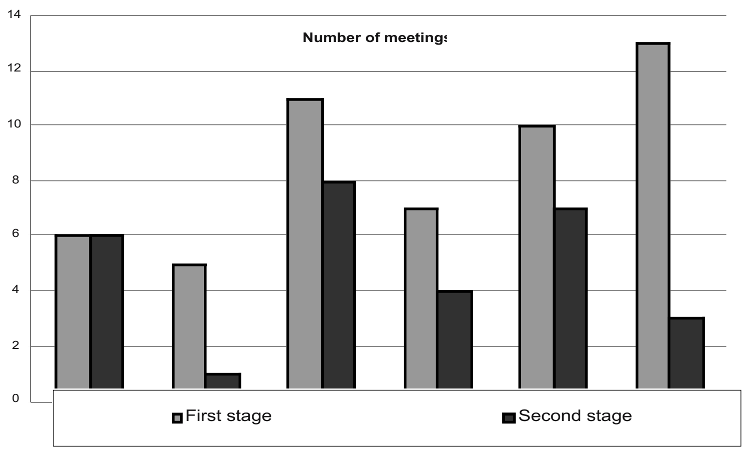


Figure 4. *The best in class*

Given the small size of companies and the limited resources they could dedicate to these unusual activities, their effort must be considered notable, in particular for the first stage of identification and quantification of costs.

The number of meetings in the second stage is, in general, low. However, to these meetings has to be added the time spent on operationalising the system. Moreover, the changes made to the companies' information systems imply some important novelties which need time to be assimilated.

They include (see Table 3):

1. The introduction of a new environmental cost centre, meaning that the company has added a new cost centre to collect environmental costs

2. New accounts in the accounting system where the chart of accounts was extended with accounts specifically for collecting environmental information
3. New items in the automatic registration of personnel time for employees involved in environmental management. For some activities it was not possible to propose this automatic registration in which case the registration was based on estimates made by the Environmental or Production manager.
4. Specific codes to identify and to characterise environmental orders – meaning alpha-numeric character associated with a commercial order to identify it as relevant to Environmental Management (e.g. new control instruments; environmental consulting etc.)

Table 3. *Main modifications to accounting systems of the companies*

Company	*Env. Cost Centre*	*New accounts*	*New items in the automatic Registration of personnel time*	*Estimatated % for env. personnel time*	*Specific codes for env. orders*
1	X	X	X		X
2	X	X	X		X
	X	X			X
4				X	X
5		X		X	X
6		X		X	X

The solutions adopted are different, depending on structure and organisation of each company. To understand the reasons of each choice it is helpful to analyse in depth three out of the six companies involved that have successfully implemented an EMA.

3 SUCCESSFUL IMPLEMENTATIONS OF EMA: THREE CASE STUDIES [9]

All the three cases presented in this paper regard companies located in Lumezzane, a town in the Province of Brescia. This is one of the areas with the highest density of industries in Italy, with more than 1,800 industrial companies for 24,000 inhabitants. In other words, in Lumezzane there is one companyfor every 13 inhabitants (meaning one company for every three family units!)

Lumezzane is an important industrial district for metal products, such as household articles, valves and fittings.

3.1 EMA at Rubinetterie Bresciane S.P.A.

Rubinetterie Bresciane (RB) is a mechanical company employing 100 people; it produces valves for taps (see main data in Table 4). The majority of products are used in the water, heating, sanitary, gas and marine industries.

Table 4. *Description of RB*

Production	*Employees*	*Sales (2002)*	*Markets*	*Certifications*
Taps and valves	100	36,814,000 Euros	Italy: 45% Europe: 30% Others: 25%	ISO 9001 ISO 14001 (from 2001) OH SAS 18001 (in progress)

RB was the first company to take part in the wider project on EMSs, and is now participating also in AIB experimentation on health and safety management systems (OH SAS 18001). The pioneering spirit of this company is obvious.

Before the company makes modifications to implement an EMA, it is important to describe the main environmental impacts.

The following figure shows part of the conclusions of the preliminary environmental analysis, carried out by the firm in 2001, during EMS implementation.

It can be seen that the main environmental impacts are noise produced by trucks during loading and unloading (the firm is situated in the middle of a residential area) and waste, mostly due to the packaging of raw materials. Also the presence of roofing containing asbestos has a potentially significant environmental impact that is to be managed with specific operative procedures.

"……
The main environmental problems associated with the production activities of Rubinetterie Bresciane Bonomi regard the production of waste and noise. In particular, the main problems are associated with the raw materials: most of the waste produced by the firm is a result of packaging, and the external noise is mostly caused by loading and unloading, necessarily done outdoors.
In the production cycle possible risks due to dangerous substances polluting the ground are highly improbable, except for possible leakage from the old underground tank.
Other environmental problems are the presence of building materials containing asbestos mostly due to the age of the building."

Figure 5. *From the preliminary environmental analysis*

3.1.1 Environmental costs before the AIB Project
Before starting the project, RB did not monitor its environmental costs.

There were no specific environmental accounts or cost centres, no environmental codes within the information system used by the company to record employees' time. On the other hand, in this information system there was both a quality cost centre and specific codes to calculate the time of personnel involved in quality management.

The first stage of the project, which provided a calculation of environmental and quality costs for 2000 and 2001 using AIB check lists, gave overall data on environmental costs (0.23 per cent of sales for 2000 and 0.24 per cent for 2001) and a high detail of the various cost items.

Figure 6, which represents the situation in 2000, shows the environmental costs divided by area of impact: costs referred to"air", "water, "waste", "noise" areas, etc. There is also a category called "general expenses", which does not include all expenses in a specific environmental area and that concern environmental management system in general.

The figure below highlights that most expenses are represented by the decontamination of roof containing asbestos (63 per cent) and by waste (collection, management, taxes, disposal: 25 per cent) respectively. These costs are followed by costs for general expenses (mainly personnel time to prepare the necessary documentation for EMS: procedures, manual, etc) and costs for air (analysis of emissions to air) and noise areas (analysis of external noise).

In 2001 the largest portion (43%) consists of general expenses (cost of personnel dedicated to documentation for EMS, the cost of training and the cost of certification); minor costs are due to waste management (24%), to water area (21%), due to reconstruction of sewage systems, and to emissions to air (4%).

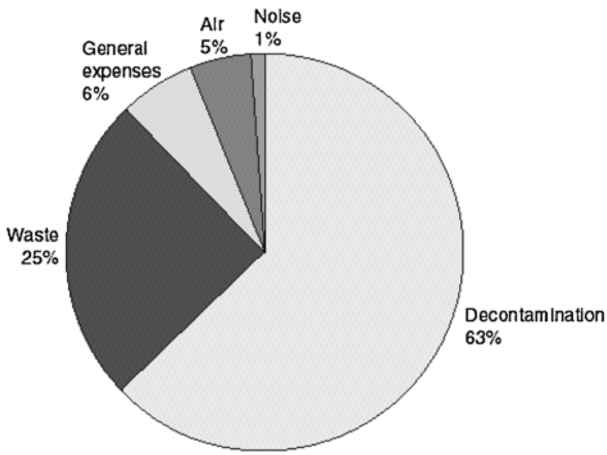


Figure 6. *Environmental costs by areas in the year 2000*

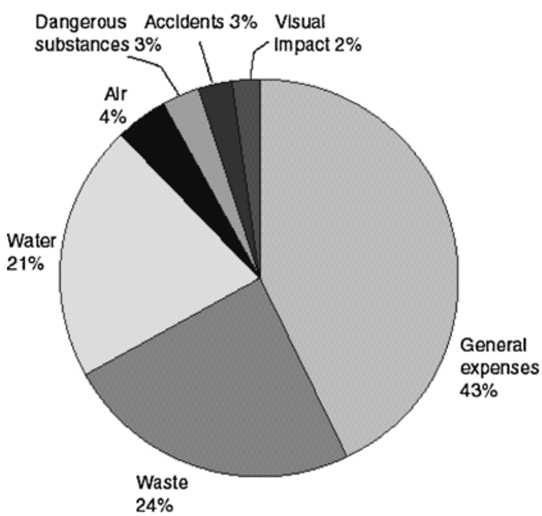


Figure 7. *Environmental costs by area in 2001*

Using the typical classification adopted for quality costs, the composition of environmental costs appears the same for both years: the majority of costs are preventive costs, followed by failure and control costs. The first category ("prevention") also includes the costs for EMS implementation (consulting, time for production and updating of documentation), the training, the cost of certification, the purchase of plants with lower impact, etc.

Based on the analysis of quality plus environmental costs (2.09 and 2.26 per cent of sales for 2000 and 2001 respectively) AIB staff, together with Environmental, Administration and IT managers, drew up a schedule for implementing the EMA system, after receiving the authorisation by the owner to proceed with the necessary modifications.

It is important to note that this decision was made by the owner wholly on account of amount of quality costs, to which environmental costs were added on.

3.1.2 Previous allocation of environmental costs

After identification and quantification of costs defined as environmental by the AIB framework, these costs were verified in the existing accounting system. Table 5 shows the previous allocation of these costs.

In the first column all environmental costs of the company (taken from the list of items in AIB check lists) are listed; in the second one the number and the name of accounts in existing accounting system are placed. The third column shows the classification of costs adopted by the company that divides costs into direct costs of production, indirect costs of production and overhead costs.

Table 5. *Previous allocation of environmental costs*

Environmental costs	*Account in the accounting system of the company*		*Type*
Purchase of materials for EMS	50101007	Purchase of equipment	Indirect production costs
Purchase of control instruments	50101007	Purchase of equipment	Indirect production costs
Environmental taxes for CONAI	0101025	Env. taxes for CONAI (packaging)	Direct costs
Env. Consulting	50103005	Technical consulting	Overhead costs
External audit	50103005	Technical consulting	Overhead costs
Operational costs of waste water plants	50101007	Purchase of equipment	Indirect production production
Monitoring of audit emissions to air and waste water, noise measurement, waste analysis	50103005	Technical consulting	Overhead costs
Operational costs of aspiration and abatement systems	50103008	Maintenance of plant, machines, equipment of production	Indirect costs
Communication for environment	50104005	Communication	Sales costs
Legal expenses for environment	50105010	Legal expenses	Overhead costs
Waste disposal	50201001	Various expenses	Overhead costs
Training for Environment	50105030	Training	Overhead costs
Waste taxes	50201001	Taxes	Overhead costs
Penalities/fines	50105034	Costs for responsibility of accidents	Overhead costs

It is evident that only one environmental cost is directly allocated to the product – i.e. the tax on packaging. The other costs are allocated to overhead costs, or are considered as indirect costs of production.

3.1.3 New allocation of environmental costs

In order to implement an EMA it was necessary to introduce various modifications to the existing accounting system.

Firstly it was necessary to add an environmental cost centre (see Figure 8), which did not exist before. It attributes more precisely times and costs of the environmental department. Before the AIB experimentation these costs were scattered among the various cost centres of departments or in the overhead costs.

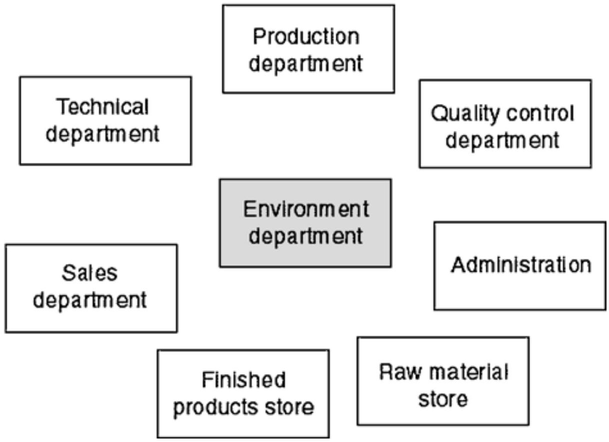


Figure 8. *Costs centres of RB: departments*

Then it was necessary to add seven new accounts to the company's accounting system to address environmental costs. The new items are listed in Table 6.

The only cost considered as direct is the cost of waste disposal, which is now allocated to the various machines according to percentages estimated by the production and environmental departments.

Furthermore, it was necessary to introduce a mechanism to identify environmental costs at the time of ordering (and employees were appropriately trained on introduction of this mechanism) to ensure that the administration assigned costs to the appropriate account.

To record personnel costs new codes were introduced in the automatic system[10] of registration of personnel activities (see Table 7). This was possible after updating the procedures for data insertion already used by the company and after specific training of the employees involved.

Table 6. *New accounts introduced*

New accounts	*Number*	*Type*
Purchase of materials for EMS	50101026	Indirect production costs
Consulting for EMS (consulting, monitoring of emissions to air and waste water, noise measurement)	50103019	Overhead costs
External audit for environment and quality	50103020	Overhead costs
Purchase of materials for waste water plant	50103021	Indirect production costs
Waste analysis	50103022	Overhead costs
Environmental maintenance (operational costs of aspiration and abatement systems)	50103023	Indirect production costs
Waste disposal	50101027	Allocated directly to manufacturing departments

Table 7. *The new codes introduced*

Code number	*Activities*
0513	EMS Management
0515	Production and updating documents for EMS
0518	Internal audits for Environment
0520	Environmental audits from Environmental Bodies and audits to customers
0523	Implementation of EMA
0526	Environmental internal training
0528	Management of waste
0529	Environmental audits to suppliers

It was, however, impossible to propose automatic registration for some activities carried out by the workforce (for instance the collection and treatment of waste). In this case, estimates were made by the environmental and production managers.

Before going on to the next company, it could be interesting to take a look at the time needed for the various stages of experimentation in RB.
Figure 9 gives a general outline of how these periods were rather long, due to the staff involved being pressed for time, and who sometimes had to be reminded.

It should be taken into account that without the friendly relationship between AIB and the company this project would have been unmanageable. The companies were in fact "forced" to participate by AIB[11].

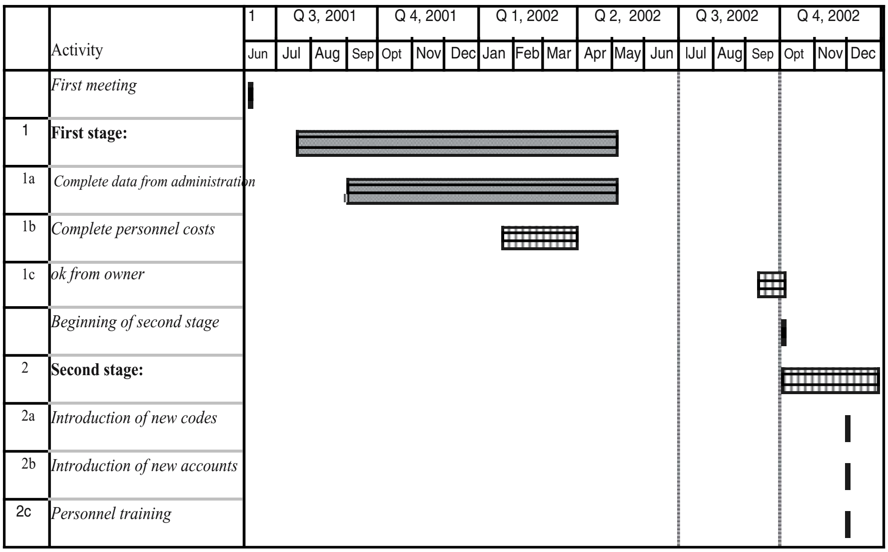


Figure 9. *Timing*

3.2 EMA at Ghidini Illuminazione S.r.l.

Ghidini Illuminazione has about 40 employees and produces outdoor lamps in aluminium, mostly for export (see Table 8).

Table 8. *Description of Ghidini Illuminazione*

Production	*Employees*	*Sales (2001)*	*Markets*	*Certifications*
Production of Outdoor Lighting fixtures Made of die-cast Aluminium alloy	40	6,407,000 Euros	Italy: 38% Others: 62%	ISO 9001 (1995) ISO 14001 (2002)

This case concerns a small, mainly family-run, business: it is very representative of the great majority of firms in the Province of Brescia.

The organisation chart of the firm shows very clearly that seven members of Ghidini family are directly involved in management, covering nine roles as can be seen in figure 10.

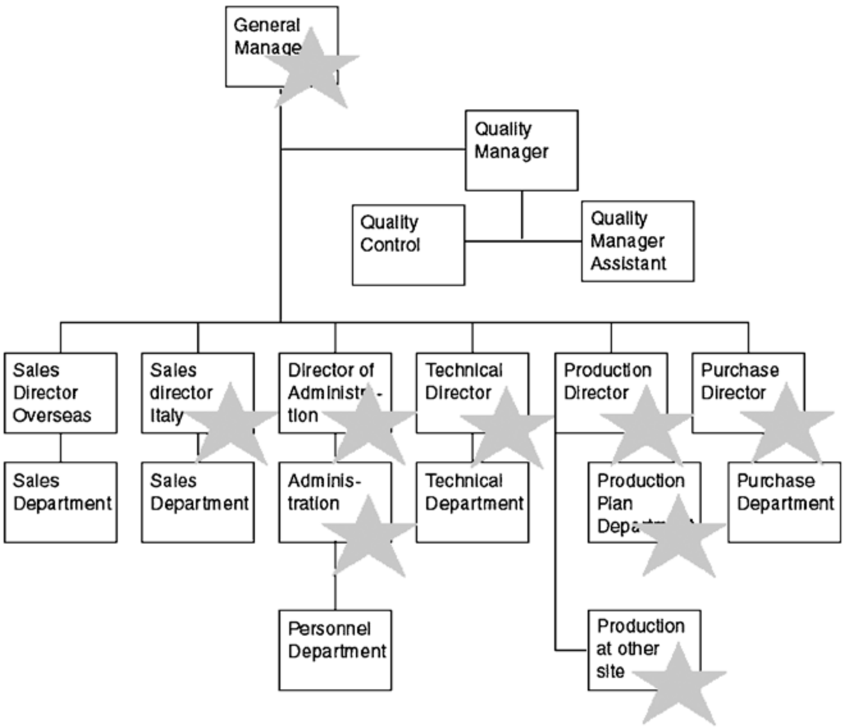


Figure 10. *Organisation chart: The role of the Ghidini family*

The experimentation in this small firm was therefore characterised by a marked participation and helpfulness by the owners themselves, who were often present at meetings (although they showed much more interest in quality costs than in environmental costs).

Before the AIB project in Ghidini, there was no systematic measurement of environmental costs – as was the case in the first case study.

There were, however, two specific items in the chart of accounts: waste disposal and purchase of chemicals for water purification, both allocated to overhead costs. Their presence was (and is) justified by the size of the costs.

In fact, even though environmental costs quantified in 2001 are modest as a whole (0.72 per cent on sales), they are mostly concentrated in the waste water area which is the firm's main environmental impact.

The production cycle includes galvanic treatment (see Figure 11) with an intermittent discharge of process waters. After treatment in a special purification plant, this water are discharged into the local sewage system. This discharge and potential accidents associated with the water treatment plant are the main environmental impacts, both in fact and potentially.

Other significant impacts are waste (mainly sludge from the water treatment plant), possible spillage (including once again the chemicals of the water treatment plant) and the noise produced by the factory which is situated in the middle of a residential area.

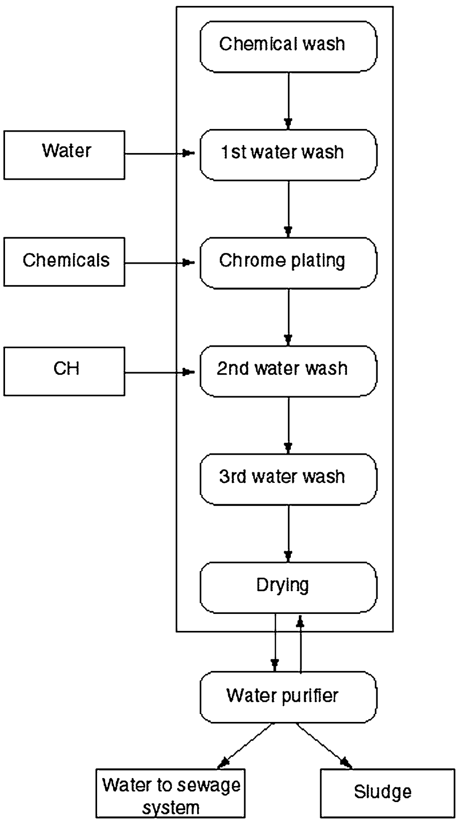


Figure 11. *The galvanic treatment*

3.2.1 Modifications to implement EMA

As a result of the AIB experimentation Ghidini Illuminazione has introduced into its chart of accounts five new accounts so that management can easily obtain periodic data without doing a difficult search through the invoices.

Table 9 shows both the new accounts introduced with AIB and the two accounts already present in the bookkeeping systems of the company (purchase of materials for chrome plating and purification plant and waste disposal and transport).

Table 9. *New accounts in bookkeeping system*

Code number	*Activities and cost items*
6301652	Consulting for EMS
6101604	Purchase of materials for chrome plating and purification plant
6801691	Waste disposal and transport
6201633	Environmental training for personnel
6301661	Environmental maintenance
6701682	Waste taxes
6801697	Environmental penalties

The depreciation of plants in terms of environmental impact reduction and the cost of certification are not included, but they are subsequently added to total environment costs.

All these costs, along with that of personnel involved in EMS, make up the new cost centre: "Expenses for EMS".

Cost types are identified at the time of ordering and initially allocated to the cost centre "Expenses for EMS". They are then assigned to the various production stages (assembly, chrome plating, spray painting, etc) on the allocation base of impact at each stage, as shown in Figure 12 (the outline has been provided from the administration department of the company). Each portion attributed to each stage is finally allocated directly to the product (with the exception of costs assigned to cromatisation that go to spray painting stage and then to the product).

Production stage	*%*	*Destination*
Assembly	0,87	Directly on product
Cromatisation	78,26	Spray painting (and then on product)
Fusion 001	1,74	Directly on product
Fusion 002	1,74	Directly on product
Fusion 003	1,74	Directly on product
Mechanical manufacturing	0,87	Directly on product
Sandblast	1,74	Directly on product
Deburring	1,74	Directly on product
Deburring	1,74	Directly on product
Painting	0,87	Directly on product
Spray painting	8,70	Directly on product

Figure 12. *The allocation of the costs in the cost centre "Expenses for EMS"*

In accordance with the first case study, a Gantt diagram with time required for EMA implementation in Ghidini's company was worked out.

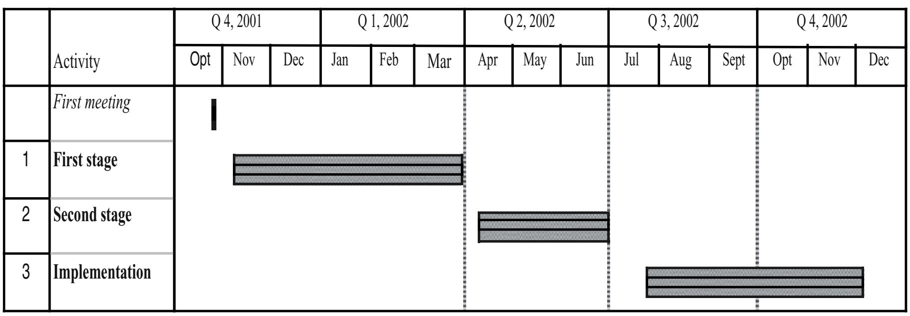


Figure 13. *Timing*

As can be seen the work covered a period of one year. This is not negligible for a small firm, but were necessary in gradually introducing the modifications required.

To sum up, with this new system Ghidini company can now identify and monitor costs that previously were not evident. The main benefit, however, is once again the improvement in management and therefore in organisation.

Through AIB experimentation aspects have been hightlighted which previously were undervalued, neglected or ignored by the company. There were improvements also in the administration as a result of searching costs in the accounting system: it was founded that some costs were not allocated correctly, as the person who entered the invoices into the system did not know the correct account or code numbers. This gave rise to a general revision of the existing accounting.

Again, the owner was involved in allocation of costs of new cost centres to the different production stages, with the result that now also other managers and employees have a major awareness on this issue.

This case is thus an example of how EMA can be, above all, an instrument for improving the organisation of small companies.

3.3 EMA at Industrie Saleri Italo S.P.A.

The final case concerns a company which even before the AIB experimentation had a detailed quality costing.

Industrie Saleri Italo (SIL) is a company with 150 employees, producing water pumps for cars.

Table 10. *Information about Industrie Saleri Italo*

Production	*Employees*	*Sales (2001)*	*Markets*	*Certifications*
Design and production Of water pumps for Cooling automobile Engines	150	27,010,972 Euros	Europe: 62% Italy: 33% USA: 2% South Africa: 2% Japan: 0,5% Others: 0,5%	ISO 9001 from 1992 ISO 14000 from 2001

It was the first company to take part in AIB project on environmental costs and is now participating also in the implementation of an occupational, health and safety management system (based on OHSAS 18001 standards). This goes to show that, as in the first case study, this company is particularly close to AIB.

The factory was built recently in an industrial area. The impact of noise is therefore not very significant, making it different from the first two cases.

The main environmental impacts are waste, air emissions and potential accidental spillage of oil, as the company uses large quantities of this.

3.3.1 Environmental costs before AIB Project

As the two last cases, SIL had no system to quantify environmental costs either. However, when AIB staff started working iatn SIL, the company already had a detailed system of quality costing. This was a good occasion to test the effectiveness of the AIB check lists, which are based on integration between quality and environment.

In 2001 SIL had a list of quality costs divided into the traditional three quality categories: prevention, control and failure. Each activity in this list was matched by estimated costs of personnel and other costs – supplied by the administration – and were added manually. However, the system already working was set up and run exclusively by the quality department, without much participation from other departments.

Following the usual routines, the experimentation was divided into two stages. However, unlike the previous case studies, in SIL the first stage consisted in the identification, measurement and analysis only of environmental costs. Simultaneously there was a study on ways of the insertion of environmental costs in the existing quality costing system. All possible improvements of the quality cost system have been pointed out: the existing system was in fact a good one, but unfortunately it was not shared with other departments. Furthermore, in this system only a limited range of quality costs was monitored.

Moreover, the system to identify quality costs was in a stage of transition, with the administration department introducing a number of revisions.

In the second stage it was therefore decided to set up a work group to improve the system for measuring quality and environmental costs and to correct the overlaps and errors from the first stage. This group involved the various heads of departments and AIB.

Since the firm was updating its accounting and IT systems, the work group has aided in its revisions.

The first stage of the AIB experimentation therefore gave a snapshot of the environmental cost representing 0.26 per cent of sales.

These costs are quantified in the year of ISO 14001 certification and their composition reflects the environmental situation found during the preliminary environmental analysis.

The largest portion is represented by costs for waste (42%), followed by the expenses for air (29%). “General expenses” necessary to implement the environmental management system represent 16 per cent of total environmental costs. A small portion (4%) is attributable to prevention of accidents (for example the purchase of containment tanks for possible spillages).

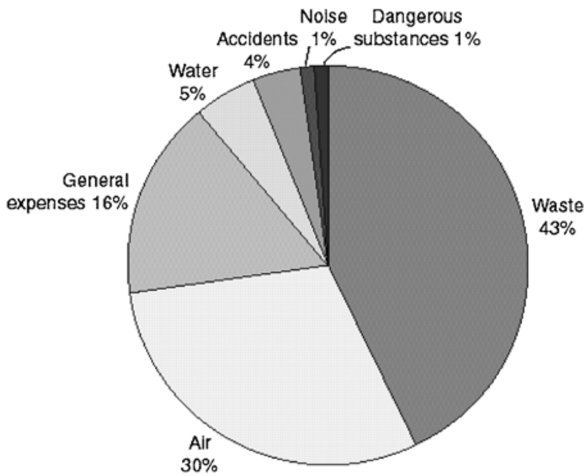


Figure 14. *Environmental costs by impacts areas: 2001*

3.3.2 From quality costing to EMA

The work group tried not to duplicate the items already present in the existing system and to characterise them with a letter “Q” (Quality) or “E” (Environment), depending on their area. For example the following items are valid both for Quality and Environment:

- planning and coordination of management system
- training
- communication
- audit
- training of suppliers
- …other

For costs that are typical of the environmental area new items were inserted in the system:

- environmental maintenance
- waste taxes
- waste management
- environmental analysis
- measures to waste recycling or reduction of environmental impacts
- etc.

It should be noted that at the start of 2002, the company adopted a new information system instead of the existing“AS 400”

The company used to calculate the cost of products by adding the costs of raw materials to direct personnel costs, to other direct costs and to direct amortisation costs. Indirect costs were attributed to the product on different allocation bases, calculated by the administration.

Through the new information system and modifications adopted, SIL is now equipped for real cost accounting. Indirect costs will be allocated to the right product, will be possible to distinguish between “after market” and “original equipment“ costs and even among the various customers (Opel, BMW, etc).

Furthemore, the new system will permit the insertion of actual spent hours of persons not involved directly in environmental work instead of previous estimates. This change improved precision

- in quantifying costs and
- in attributing activities to the relative product or client.

For quality and environmental costs these modifications have not made a great difference, as the time of indirect personnel for quality and environment was seldom attributable to a particular product or client.

The company produces about 700 different types of pumps, so these changes were decidedly appropriate.

On the other hand, costs other than personnel time, which were previously fed into the system manually, are taken automatically from other databases, with the result that the insertion, previously sporadic and subject to error, is now correct and total quality and environmental costs are reliable.

In the existing accounting system it was necessary to introduce only one account for the environment – Environmental Consulting – as the company has adopted a system to identify costs at the time of order through the name of suppliers. At the same time a further cost centre was created to group all the environmental items: the cost centre “Environmental Expenses”.

SIL still has to improve the possibility of allocating more precisely some environmental costs – for example the costs of waste – directly to the departments of origin. These improvements will be applied when the system is s established.

Unlike other companies, SIL has also set up a software for extracting statistics from quality and environmental data, with subdivisions and comparisons among cost centres, activities, specific codes, etc. This software is turning out to be very useful in preparing reports on costs to management.

It is not possibile to give a representative Gantt diagram for this company, as there were a lot of meetings (above normal) both in the first and in the second stage to verify the effecftiveness of the AIB check lists for environmental and quality costs and to analyse the existing accounting system. Furthemore, SIL was the first company to join AIB experimentation on EMA.

SIL represents perhaps the more advanced stage of EMA implementation using the quality cost model among the companies involved. SIL has in fact set up:

- the insertion of environmental costs into quality costs;
- the connection – within the same system – with all the databases (accounting, production, purchase, personnel);
- the possibility of attributing time of an activity to a specific product;
- a software for the analysis of data.

4 CONCLUSIONS

This paper has presented three cases of SMEs which had no system for measuring and analysing environmental costs. Under the guidance of AIB, these companies have set up an EMA starting from zero: at the beginning these companies were not able to quantify their environmental costs and some did not have a suitable accounting system to record them. More in general, from experience it seems that local small and medium-sized companies have an accounting system with no specific focus on environmental costs.

The AIB project demonstrates that one of the benefits of adopting an EMA in a small or a medium-sized company consists of identifying and monitoring costs that were previously not evident, thus making these visible and ensuring the correct allocation of environmental costs. Furthermore, one could conjecture that this would lead to an improvement of overall management of the company through better decision-making based on an analysis of environmental costs together with quality costs.

It should be noted that the objective of the project has not been to introduce EMA "at all costs", but to provide the company with an opportunity for organisational improvements. It should be noted that companies involved are SMEs, usually family-run, where the same person covers many roles. It is interesting to note that in the companies involved in the implementation of environmental management systems (object of the main project) none had an environmental manager with only this function. The environmental manager usually also covers the role of quality or safety manager, when it is not the case that works also in the production or in the information system departments.

In this type of company the meetings and the work in connection with the AIB project were the occasion to revise both overall management and aspects which before were undervalued or even ignored. In this way the duties of the various persons, for example, have been better assigned (sometimes not well known); the criteria to record invoices were re-defined; employees were involved in activities before overlooked, etc.

The three cases described represent the best in class among the companies involved, as only in a few firms has it been possible to implement a systematic environmental management system (six out of thirtheen) and to show the benefits. This chance has been offered also thanks to the very close relationship between AIB and the companies.

During 2003 AIB staff will assist the companies involved in the project and monitor developments in the firms that have already implemented an EMA, as the three that have been illustrated.

It should be noted that AIB propose to implement an EMA within a wider project on implementation of integrated management systems.

Only practical experience in the field in a significant number of companies can highlight the real benefits of EMA application and increase interest, at the moment very slight, of SMEs in such systems.

It seems in fact still premature to think about a general diffusion of these systems in small local companies, without external support.

The experimentation has produced a lot of data on environmental costs and on the different modifications of the accounting systems adopted from the companies in order to implement periodic monitoring of these costs.

It would be interesting to address the research also in other directions such as, for example, toward the development of a "best practice", a sort of guideline, to implement an accounting management system (with the indication of suggested modifications).

NOTES

* The authors wish to thank the manager of "ECO 90" Office - Andrea Gandellini - for his support.

1 Associazione Industriale Bresciana (AIB) with its 1,500 associated members is one of the most important industry associations in Italy. AIB is located in Brescia, which is the second largest city of Lombardy, with about 200,000 inhabitants, The Province is one of Italy's most important industrial centres, with over 90,000 companies employing half a million people.

2 For a discussion of the development of operative check lists to identify and quantify environmental costs see Venturelli and Pilisi (2003).

3 About two years ago the Associazione Industriale Bresciana (AIB) started to apply environmental accounting systems (EMAs) in ten small and medium-sized companies. In the book Environmental Management Accounting: Purpose and Progress [see Bennett et al. (2003) pp. 309-332] the preliminary stage of this research project is described, as well as the methodology adopted in the firms involved to identify environmental costs, together with practical consequences. First results in ten small and medium-sized companies (SMEs) have been presented.

4 The Project has the following partners: the Brescia Chamber of Commerce, the local universities (in particular the Faculties of Engineering, Physics for the Environment, and Medicine) and the Fondazione Eni Enrico Mattei. They operate within an organisational check list coordinated by AIB. Furthermore, some of the most highly-qualified consultants in the Brescia area collaborate under contract with AIB staff for the practical implementation of management systems.

5 Data source: ISTAT (1996).
6 Companies with fewer than 10 employees are not included.
7 For a detailed list of environmental cost items analysed in the companies involved see Appendix.
8 For the background of the check lists for quality costs see: American Society for Quality Control (1987,1995); Dale Barrie and Plunkett (1999); Harrington (1987) and Saita M (1971,1991). For environmental costs see: Bartolomeo (1997), Bartolomeo et al. (1999); Bennett et al. (1998); Bouma (1998); Diependaal (1994); EPA (1995); Eurostat (1994); Gray (1993); Schaltegger et al. (1996, 2000).
9 The authors wish to thank these three companies – Rubinetterie Bresciane SPA, Ghidini Illuminazione Srl and Industrie Saleri Italo SPA for their willingness to participate in the project.
10 The company already had an authomatic system to record time of direct (production) and indirect personel: both in manufacturing and in other departments everyone assigned his own time, through a personal code and with a special machine, to a specific activity (e.g. production and updating documents for EMS) or to a specific cost centre.
11 For the difficulties in involving companies see the paper of Pilisi and Venturelli in Bennett et al. (2003) p. 292.

REFERENCES

Bartolomeo, M. (1997), *La contabilità ambientale d'impresa*. Milano: Il Mulino. Available only in Italian.

Bartolomeo, M., Bennett, M., Bouma, J.J., de Walle, F., Heydkamp, P., James, P. and Wolters, T. (1999), *Eco-management Accounting*. Boston/Dordrecht/London: Kluwer Academic Publishers.

Bennett, M. and James, P. (1998), *The Green Bottom Line. Environmental Accounting for Management. Current practice and future trends*. Sheffield: Greenleaf Publishing.

Bennett, M., Rikhardsson, P.M. and Schaltegger, S. (2003), *Environmental Management Accounting: Purpose and Progress*, Dordrecht: Kluwer Academic Publishers.

Bouma, J. (1998). Environmental management accounting in the Netherlands. In: Bennett, M. et al. (eds.) *The green bottom line,* pp. 139-152. Sheffield: Greenleaf Publishing.

Dale, B. and Plunkett, J. (1999), *Quality costing*. Brookfield: Gower Publishing.

Diependaal, M. and de Walle, F. (1994), A model for environmental costs for corporations (MEC), Waste *Management and Research 12*: 429-439.

EPA (1995), *An introduction to environmental accounting as a mananagement tool. Key concepts and terms*. Washington DC.

Eurostat (1994) *Environmental Protection Expenditure. Data Collection Methods in the Public Sector and Industry*. Luxembourg: Office for the Official Publications of the European Commission.

Gray, R. (1993), *Accounting for the environment*. London: Chapman.

Harringyon, H.J. (1987), *Poor Quality*. Milwaukee: ASQ Quality Press.

ISO 14001 (1996), *Environmental Management – Systems Specification with guidance for use*. Genève.

ISO 14004 (1996), *Environmental Management Systems – General Guidelines on Principles, Systems and Supporting Techniques*. Genève.

ISO TR 10014 (1998) *Guidelines for managing the economics of quality*. Genève.

ISTAT (1996), *Censimento intermedio dell'industria e servizi*. Available only in Italian from Internet URL at http://cens.istat.it/menu.htm.

Saita, M. (1971), *I costi della qualità nelle imprese industriali*. Milano: Isedi. Available only in Italian.

Saita, M. (1991), *Economia della qualità: strategia e costi*. Milano: Isedi. Available only in Italian.

Schaltegger, S., Muller, K. and Hindrichsen, H. (1996), *Corporate environmental accounting*. New York: John Wiley & Sons.

Schaltegger, S. and Burritt, R. (2000), *Contemporary environmental accounting. Issues, concepts and practice*. London: Greenleaf.

Venturelli, A. and Pilisi, A. (2003), EMA in SMEs: Ten Italian Case Studies. In: Bennett, M., Rikhardsson, P. and Schaltegger, S. (eds.) (2003), *Environmental Management Accounting: Purpose and Progress*. Dordrecht: Kluwer Academic Publishers.

APPENDIX: TABLE A. THE COST ITEMS FOR ENVIRONMENT [TABLE EXTRACTED FROM BENNETT ET AL. (2003)].

Prevention Costs	**Monitoring Costs**	**Failure Costs**
A1 EMS planning/co-ordination	B1 External audits	C1 Legal expenses
A2 Production and updating documents	B2 Internal audits	C2 Penalties/fines
A3 Training/information	B3 Inspections by customers	C3 Environmental insurance
A4 Staff training on legislation compliance	B4 Inspections to suppliers	C4 Operational costs of aspiration and abatement systems
A5 Communication	B5 Control instruments: maintenance and calibration	C5 Operational costs of boilers and vapour generators
A6 Suppliers information/updating groups	B6 Purchase of control instruments	C6 Operational costs of co-generation
A7 Expenses for environmental accounting systems	B7 Monitoring of waste water	C7 Operational costs of waste water system
A8 Customer/market analysis	B8 Monitoring of emissions to air	C8 Emission to air testing and monitoring bookkeeping
A9 Qualifying new suppliers	B9 Waste analysis	C9 Collection and waste management
A10 Administration	B10 Noise measurement	C10 Rent of rubbish ships
A11 Environmental R&D	B11 Soil, subsoil, and aquifer analysis	C11 Disposal
A12 Purchase/installation of machines, plants with lower impact (environmental part)	B12 Reporting to control authorities	C12 Waste treatment
A13 Modifications of machines/plants that reduce environmental impact (environmental part)	B13 Monitoring/measurements of electromagnetics and ionising radiation	C13 Off-site waste transport
A14 Plant closure/decommissioning (environmental part)	B14 Optimisation of utilities, e.g. water, electricity & gas supplies	C14 Waste taxes
A15 Waste recycling or reduction of environmental impact		C15 Sewage fee
A16 Modifications to rubbish ships		C16 Waste bookkeeping
A17 The management and more correct use of dangerous substances in the departments and laboratories		C17 Environmental contribution for CONAI
A18 Studies for emergency procedures		C18 Decontamination of soils
A19 Preventive measures for accidents, excluding fires		C19 Expenses for accidents (except decontamination of soils)
A20 Improvements in transportation of hazardous waste off-site		C20 Anti-noise measures
A21 Fire prevention		C21 Environmental measures after excavation
A22 Green zones around industrial site		C22 Utilities, e.g. monitoring water, gas & electricity use
A23 Measures (different from green zones) for improvement of the site's visual impact		
A24 Measures for road improvements		
A25 Sponsorships and contributions and similar		
A26 Expenses for voluntary agreements		

SECTION 3

NATIONAL EXPERIENCES IN IMPLEMENTING EMA

CHAPTER 12

ENVIRONMENTAL ACCOUNTING GUIDELINES AND CORPORATE CASES IN KOREA:

– IMPLICATIONS FOR DEVELOPING COUNTRIES –

BYUNG-WOOK LEE, SEUNG-TAE JUNG AND JEONG-HEUI KIM

Sustainable Management Division of LG Environmental Strategy Institute (LGESI), Korea

bwlee@lgesi.re.kr, iready@lgesi.re.kr, jerrykim@lgesi.re.kr

Abstract. Since the 1990s environmental accounting has spread rapidly as an effective tool for environmental management. Leading global companies, especially in Europe, North America and Japan, have applied environmental accounting to enhance their eco-efficiency and resource productivity.
Moreover, increasing external pressure from stakeholders like financial institutions, SRI (Social Responsible Investment), the government, and local communities has forced companies to show an active interest in environmental accounting.
Compared to advanced companies in developed countries, however, most companies in developing countries are still far behind in understanding and applying environmental accounting techniques and methods.
As a wide range of Korean stakeholders has been interested in corporate environmental performance and its disclosure in annual reports since the mid-1990s, a number of leading Korean companies have started to introduce environmental accounting. Also, in the late 1990s the Korean government made efforts to disseminate environmental accounting into the industrial sector to promote sustainable development. The Korean Ministry of Environment (KMOE) developed the "Environmental Accounting Guidelines" to disseminate information about environmental accounting into the corporate world[1]. Also, *LG Environmental Strategy Institute (LGESI)* is carrying out an EMA (Environmental Management Accounting) project to develop corporate EMA cases; these are funded by the Korean Ministry of Commerce, Industry and Energy (KMOCIE).

P.M. Rikhardsson et al. (eds.), Implementing Environmental Management Accounting, 239-255

Based on these projects, we first introduce the Korean environmental accounting guideline (draft) and corporate cases in Korea. The case studies are a part of the outcomes from the EMA project carried out by LGESI. Second, this paper discusses main issues to be considered to adopt environmental accounting successfully into companies in Korea as well as in developing countries[2]. Drawing on experience in Korea, this paper proposes implications of the introduction and promotion of environmental accounting in Korea and developing countries.

1 INTRODUCTION

Since the 1990s, environmental accounting has spread rapidly as an effective tool for environmental management. Leading global companies, especially in Europe, North America and Japan, have applied environmental accounting to enhance their eco-efficiency and resource productivity. Also, recently increasing external pressure from stakeholders such as financial institutions, SRI (Social Responsible Investment), the government, local communities has sparked companies' interest in environmental accounting.

In line with this trend, the rapid increase in environmental costs has caused companies to integrate environmental aspects into managerial decisions at all levels. However, measuring and reporting environmental financial performance is still in its infancy in spite of the development of a number of techniques and methods. In this context, environmental management accounting has recently come to be considered as one of the significant tools in adopting successful environmental management. This is reflected in the fact that traditional accounting, which regards most environmental costs as overhead costs, is inadequate when it comes to supplying decision makers with managerial information for environmental management.

Shifting from traditional profit-focused management to progressive environmental management, environmentally sound and sustainable development has become the key factor in strengthening corporate competitiveness in today's business paradigm.

Leading global companies have come to recognize that environmental accounting can play an important role not only in preventing and restricting its negative environmental response but also in facilitating its positive and proactive response.

Compared to the advanced companies in developed countries, however, most companies in developing countries still lag far behind in understanding and developing environmental accounting.

This paper reviews the overall status of environmental accounting in Korea, presents the environmental accounting guideline and some case studies of outstanding Korean companies. Through case studies, we diagnose the current issues and discuss problems to be solved for the development of corporate environmental accounting in Korea.

2 OUTLINE OF ENVIRONMENTAL ACCOUNTING IN KOREA

The interest in corporate environmental performance of a wide range of stakeholders such as shareholders, financial institutions, the government and local communities has since the mid-1990s made some Korean companies discuss the introduction of environmental accounting. As a result of the emergence of green-consumerism, environment Non-Governmental Organization (NGOs) activities, and international trade barriers related to environment, environmental investment and costs have boomed in Korea.

Especially the increasing external pressure from stakeholders such as financial institutions, SRI (Social Responsible Investment), the government and local communities will boost companies' interest in environmental accounting. Financial institutions such as banks and insurance companies begun to take an interest in appraising corporate environmental risk and performance when they lend money, invest or cover corporate risk. These changes compelled Korean companies into finding cost effective means to enhance the environmental performance and to lower environmental risk.

In the process, they begin to realize the importance of a proactive environmental management strategy and of reporting environmental performance.

Because environmental costs increase rapidly as shown in Table 1, some leading Korean companies such as POSCO, Hanwha Chemicals, Samsung Electronics, LG Chemicals, began to consider environmental costs at the managerial decision level.

Table 1. *Corporate Pollution Control Expenditure in Korea*

(USDm)

Field	*1993*	*1997*	*2002*
Air	876	1,351	1,620
Water and Soil	856	1,094	1,302
Waste	782	1,105	450
Noise and Vibration	86	66	89
Others	92	105	340
By-product sales in waste treatment (-)	10	17	346
Sum	2,682	3,703	3,466
Index	100	138	129

Note: ( ) This figure means compared value to sum of the base year (1993)
Source: Bank of Korea, Pollution Control Expenditure in Korea

In line with this trend, the Korean Ministry of Environment (KMOE) published environmental reporting guidelines in 2002 to encourage disclosure of corporate environmental information. Furthermore KMOE made an "Environmental Accounting Guideline (draft)" in 2003; at the moment the guideline is in a feedback process from the industrial sectors. KMOE is planning to announce the "Environmental Accounting Guideline" in 2004 to propose guidance on measuring and reporting environmental costs, including environmental benefits[3].

From October, 2002 to September, 2004 LGESI has implemented the EMA project to develop EMA cases and to disseminate EMA into Korean industry. The project was supported financially by the Korean KMOCIE.

The Korean companies that took part in the EMA project include the following: POSCO (Steel), LG Chemicals, Hanwha Chemicals (Chemicals), Samsung Electronics, Hynix (Electronics & Semiconductor), Korea Gas Corp. (Gas), Korea Water Resources Corp. (Water), Yuhan-Kimberley (Paper & Healthcare), Korean Airline, Asiana Airline (Airline), SK (Oil), Aekyung (Homecare), Hyndai Motors (Auto).

The aim of this project was to develop a useful method to measure corporate environmental costs more precisely and to disseminate best practices into Korean industrial sector.

3 OVERALL DEVELOPMENT OF ENVIRONMENTAL ACCOUNTING AND GUIDELINES IN KOREA

3.1 Overview

The guideline (draft version) was developed in 2002 for measuring environmental costs and to enable the KMOE to disclose environmental accounting information for Korean companies.

Sixteen case studies documented in 2003 and seven case studies are progressing.

The quantitative management of environmental conservation activities is an effective way of achieving and maintaining sound business management. In other words, in carrying out environmental conservation activities, a company can accurately identify and measure investments and costs related to environmental activities.

So, the guidelines suggest an activity-based environmental costing approach for the company; environmental costs are classified according to environmental activities.

The guidelines define environmental costs as resources which are consumed by activities to minimize environmental impact and to maximize eco-efficiency in a given period of time. There are four categories of environmental costs: pollution treatment activity costs, pollution prevention activity costs, stakeholder activity costs and environmental compliance and remediation activity costs. The guidelines suggest that companies disclose environmental costs as shown in Table 2.

Table 2. *Disclosure Format of Environmental Costs (draft)*

Activities	*Air*	*Water*	*Waste*	*Soil*	*Others*	*Total*
1. Pollution Treatment Activities						
1.1 Operation of Pollution Treatment Facilities						
Depreciation						
Personnel						
Utility						
Maintenance						
External Contract						
Others						
2. Pollution Prevention Activities						
2.1 EMS Implementation						
Staff Personnel						
Monitoring and Others						
2.2 Resource Saving and Recycling						
Depreciation						
Personnel						
Utility						
Maintenance						
External Contract						
Others						
2.3 R&D						
Process Improvement						
Eco-Product Development						
2.4 Others						
Afforestation						
3. Stakeholder Relation Activities						
3.1 External Relation						
Donation and Support						
Partnership Program (Local Community)						
3.2 Others						
Env. Protection						
Env. Communications						
4. Legal Compliance and Remediation						
4.1 Legal Compliance						
Tax and Levies						
Penalty						
4.2 Pollution Remediation						
Remediation and Compensation						
Others						
Total Environmental Costs						

Note: This format was drafted by LGESI

3.2 Categorizing environmental costs

3.2.1 Pollution treatment activity costs

Pollution treatment costs are the costs related to end-of-pipe solutions, facilities or end-of-production equipment. This category includes compliance costs for complying with regulations. In other words, the costs incurred to comply with existing regulations.

- Costs for air/water/noise pollution treatment
- The depreciation costs of environmental facilities
- Costs for waste disposal
- Costs for other types of pollution treatment
- Operation costs, including labour, electric power, water system, fuel as well as sewer fees
- Costs for equipment and facilities used for waste treatment and environmental measurement costs, materials, repair costs, etc.

3.2.2 Pollution prevention activity costs

Pollution prevention costs are related to the reduction of the environmental impact of production facilities. The type of costs that induces improvement both in production and environmental friendly products are called clean technology costs. This subcategory includes recycling facility and equipment costs, as well as equipment leases, depreciation, operation and associated labour costs.

- Costs for establishing and implementing an Environmental Management System, as well as costs of external certification of the management system.
- Costs for recycling, resale and proper disposal of used products.
- Costs for saving energy, materials, and water.
- Costs for training employees on environmental issues.
- R&D costs in connection with the development of eco-products for minimizing environmental impact.
- R&D costs to curtail environmental impact at the product manufacturing stage.

3.2.3 Stakeholder activity costs

These costs are incurred in order to build up and maintain good relations with outside stakeholders such as investors, creditors, regulators, communities, consumers and environmental activist groups. By maintaining good relations with its stakeholders, a company can avoid unnecessary conflicts. Building up an image of a ‘green’ enterprise can contribute to the creation of future profit opportunities.

- Costs related to donation or financial support of environmental groups.
- Costs for disclosing environmental information and environmental advertising.
- Costs associated with various social activities, such as the financial support of a local community's environmental conservation activities.

3.2.4 Environmental compliance and remediation activity costs

These costs are covered by compliance costs and legal fees, fines and penalties. In other words, when waste materials are discharged into the environment without adequate prior treatment, they are likely to cause damage to nature or people. Environmental damages have to be restored, and any damage to health, life and property should be compensated.

- Fines and penalties for non-compliance with environmental regulations
- Compensation to third parties as a result of loss or injury caused by past environmental damage and pollution
- Environment tax and levies

4 CORPORATE EMA CASES IN KOREA

As mentioned above, Korean companies have become increasingly interested in environmental accounting, and a few leading companies have actually introduced environmental accounting. This chapter describes two company cases, POSCO and Hanwha Chemicals. Both have participated in the EMA project and have generated information on environmental costs.

4.1 POSCO

4.1.1 Company profile

Founded in 1968 as a public corporation, Pohang Iron and Steel Corporation (POSCO) is one of the world's largest steel-makers with an annual production capacity of 28 million tons. It operates two steel works in Pohang and Kwangyang. The company produces hot-rolled sheets, cold-rolled sheets, wire rod, electrical steel, and stainless steel. In 1999, POSCO employed around 20,000 people and had a turnover of KRW 10,696 billion (or USD 9.5 billion).

Since the outset, the company has recognized that environmental preservation is one of the most important aspects of doing business. Therefore, it enacted the 'POSCO Environmental Policy' in 1995 and adopted an internal environmental management system based on ISO 14001 standards in 1996. Furthermore, POSCO hopes to achieve sustainability on economic, environmental and social performance. POSCO expects these efforts to earn stakeholders' respect and global leadership.

POSCO has recently switched its environmental policy from the conventional passive monitoring activities to a proactive strategy aimed at minimizing environmental impact and constantly enhancing resource productivity.

At POSCO, environmental investment has veered from facility installation for pollution treatment to blocking pollution generation at the source. Since its foundation, POSCO has spent KRW 2.4 trillion on environmental investments, amounting to 9.1 per cent of its aggregate facility investments. In 2002, environmental facility investments ran into KRW 176.7 billion, a 66.5 billion increase from the previous year, representing 11.7 per cent of total facility investments in 2002. As for environmental costs, including facility operation costs and depreciation, KRW 518 billion was spent in 2002. Facility operation costs for air pollution prevention occupied the greatest portion of the total environmental costs, namely 34 per cent. This covered electricity, material, wages, maintenance and repair, and depreciation of dust collectors. Facility operation costs for water pollution prevention mainly entailed the maintenance and repair of wastewater treatment and recycling facilities, at 15 per cent. By-product treatment, covering transporting, processing and recycling represented 26 per cent of the total environmental costs.

4.1.2 Project process and result

POSCO has generated information on environmental costs since the 1990s, but the information was limited to operation and maintenance costs related to pollution treatment at 'end of pipe'.

So, the company participated in the EMA project to refine its standards for environmental accounting as well as to develop environmental accounting systems that could be linked to POSCO ABM (Activity Based Management) Systems.

For the project, a TFT (Task Force Team) was set up comprising the staff of the Environment & Energy Team, ABM team members, and environmental accounting experts from LGESI. The project was implemented in the following five stages.

1. Defining environmental activities within the business and identifying resource driver-linked environmental activities
2. Identifying environmental costs which are hidden in overhead costs by cost driver resources
3. Measuring environmental costs and allocating these to responsible cost centres based on relevant cost drivers
4. Establishing evaluating guidance of environmental benefits related to environmental activities
5. Integrating environmental accounting information into various managerial decision-making such as performance evaluation

Initially, the company defined environmental costs as follows:

Environmental costs are direct or indirect costs related to activities to abate or prevent environmental impact. Moreover, they include costs for disposing or recycling resources and for other environmental activities related to stakeholders.

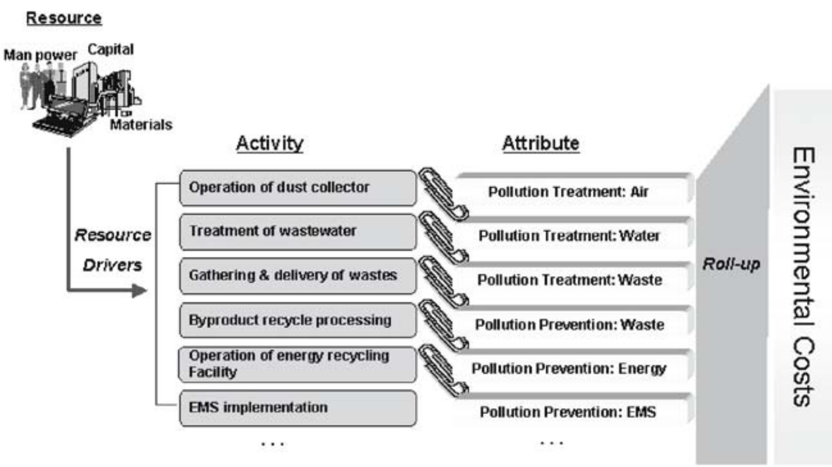


***Figure 1**. Basic Structure of Environmental Costs in an ABM System*

***Table 3**. Relationship of Environmental Activities and Cost Items at POSCO*

Category		Activities	Cost Items
Pollution Treatment Activities	Internal	- Operating & maintenance of environmental facilities related EOP - Waste collection, delivery & disposal	Depreciation, maintenance, labor, materials, external contracts, chemicals, etc.
	External	- Legal compliance - Env. Remediation & compensation	Env. improvement charges, clean water charges soil remediation, compensation for damage, etc.
Pollution Prevention Activities	Internal	- By-product processing for recycling - Energy recovery (gas, heat, steam, hot water) - Water recycling - R&D for eco-product and process innovation - Implementation of EMS	Depreciation, maintenance, labor, materials, R&D external contracts, training, audit, etc.
	External	- Nature conservation in surrounding vicinity - Disclosure of environmental information and advertising - Env. donations and partnership of local communities	Publish of report, advertisement, partnership program, donation, etc.

The basic structure of ABM system-related environmental accounting is shown in Figure 1, among these are the various activities of the manufacturing department and staff and TFT-defined environmental activity. And then following the guideline, TFT roll ups the environmental activities and sums up the environmental costs with cost drivers.

TFT reviewed the linkage of environmental activities and the related cost items. The overall result of the review is shown in Table 3.

Environmental activities are mainly divided into two dimensions. Firstly whether they concern pollution treatment or pollution prevention, and then whether they concern internal or external objects. This classification is designed according to the KMOE guideline.

Environmental activities can be broken down into a third level as shown in Table 4.

In the course of the project, one of the hard tasks is sorting the environmental facilities into the asset inventory.

Because environmental costs are mostly incurred from operating environmental protection equipment or facilities, it is necessary to define conceptual characteristics and scope of environmental assets before calculating environmental costs. It was, however, difficult to define the scope of the environmental assets due to complex facilities. After several meetings, POSCO decided on a definition of environmental assets drawing up a detailed guide. The definition of environmental assets is as follows:

> Environmental assets are all equipment and facilities operated for abating and preventing environmental pollution.

According to this definition, when certain equipment or facilities are purchased mainly for the purpose of environmental protection, the company recognizes them as an environmental asset. In general, however, much equipment or facilities are operated with multiple purposes or functions. In such cases, it is very difficult to decide whether a certain piece of equipment is an environmental asset. When certain equipment or facilities are installed, if the main purpose (over 50 per cent) of installation is for environmental protection, the company determined to recognize them as environmental assets. The 50-per cent rule is actually somewhat arbitrary, but can be a useful method for the sake of practical application.

After having defined environmental assets, POSCO re-arranged the coding structure of the company's total assets to recognize environmental costs incurred from operating environmental assets through its computerized costing process.

Table 4. *Classification of Environmental Costs in POSCO (Revision)*

Environmental Costs			KMOE Guideline
1st Level	2nd Level	3rd Level	
Pollution Treatment Activity	Air Water Waste -	Air Treatment Wastewater Treatment Gathering and delivery Waste disposal	Pollution Treatment Costs
	Legal compliance - Env. damage Remediation	Tax & Levies Penalty Remediation Env. Compensation	Legal Compliance & Damage Costs
	Others - -	Soil Toxic chemicals Others	Pollution Treatment Costs
Pollution Prevention Activity	Air Water Waste Mgt. & Resource recycling - - Energy Recycling - - Afforestation	Fuel Replacement Water Recycling Waste Reduction Slag Recycling By-product Recycling Others Electricity Steam Gas Hot water Afforestation	Pollution Prevention Costs
	Env. Reporting & Public Activities	Env. Reporting External Relations	Stakeholder Costs
	R&D EMS Activities etc.	R&D EMS Activities etc.	Pollution Prevention Costs

Lately, at the fourth stage, POSCO is trying to set up the guideline for measuring environmental benefits from activities. Also, they are reviewing their utilization of environmental accounting information through the ABM System ("POSPIA" to be called).

POSCO expects that "POSPIA" will measure environmental costs and benefit more accurately and support efficient internal decision-making. POSPIA will be completed in November, 2004.

4.2 Hanwha Chemical Corporation

4.2.1 Company profile

The Hanwha Chemical Corp. is broadening its markets targeting not only Korea but also Southwest Asia and Africa by being the first Korean producer of PVC, Polyethylene (LDPE, LLDPE) and ChlorAlkali (CA). In 2002, Hanwha Corp. earned USD 1,363m and is currently operating with 1,815 employees in Korea.

Hanwha Chemical Corp., which foresaw the importance of environmental management, has carried out an ECO-2000 Environmental Preservation Campaign since 1991. Hanwha has raised its campaign level to include the ECO-YHES management policy that integrates responsibilities of corporate citizenship in the environmental field. This has been given high priority by top management and has been a success.

Hanwha Chemical Corp., a leader in the petrochemical industry, has consolidated its eco-friendly management, which is demonstrated in the "Sustainability Report 2003".

Hanwha Chemical Corp. is planning to utilize an environmental cost system as a decision-making means that unites the aspects of environment and economy, not wanting to analyse only pre-treatment costs, post-treatment costs, costs of interested parties and costs for laws and regulations required to reduce environmental impact on production costs, but also environmental benefits.

Table 5. *Hanwha Chemical Corp.'s environmental costs (by traditional classification)*

(USD Thousand)

Classification	*1999*	*2000*	*2001*	*2002*	*2003*
Amount invested	7,487	5,432	7,902	7,510	9,483
Operation costs	6,425	6,297	6,470	6,863	7,038
R&D costs	1,521	1,737	1,679	993	1,043
Total	15,433	13,466	16,051	15,367	17,495

This case study focused on environmental costing at the Yeosu Plant in Korea. The Yeosu Plant was established in 1980. In 2002, this plant earned USD 916 million and a total of 780 employees are working at the plant.

4.2.2 Project process and result

Scope and Target

The Project Team, composed of members of the environmental team, the technical team, the accounting team, the production team and the Hanwha Environment research centre, considered several perspectives on accounting environmental costs. After several meetings, they chose to trace environmental costs to products, especially EDC (ethylene dichloride) and VCM (vinyl chloride) in the Yeosu plant.

The Project Team decides the target of the project:

- Identifying environmental costs hidden in overhead costs
- Calculating environmental costs and allocating these
- Classifying environmental facilities

Definition of environmental costs

Environmental costs are direct or indirect costs related to the prevention or reduction of environmental aspects in the production of EDC/VCM products.

The classification of environmental costs is designed to accord with the KMOE guidelines.

Result of collecting environmental costs

The environmental costs of EDC/VCM products are shown in Table 6. Pollution treatment costs turned out to be higher than other costs. This means that up till now a larger part of the environmental costs have been spent on end-of-pipe treatment rather than cleaner production.

Table 6. *The environmental costs of EDC/VCM production at the Yeosu Plant*

(Unit: USD Thousand)

Classification	*Air*	*Water*	*Waste*	*Others*	*Total*	*Ratio*
Pollution Treatment	982	1160	54	283	2,182	96.7%
Pollution Prevention	6	1	-	29	36	1.4%
Stakeholder	-	-	-	18	19	0.7%
Compliance/ Remediation	1	30	-	-	31	1.2%
Total	989	1,191	54	336	2,567	100%

On the other hand, EDC/VCM's environmental cost ratio compared with the total manufacturing costs is 1.48 per cent. However, if material costs are excluded from total manufacturing costs, total environmental costs amount to 11 per cent of these costs.

Table 7. *EDC/VCM: The environmental cost/manufacturing cost ratio*

(Unit: %)

Product	*Air*	*Water*	*Waste*	*Others*	*Total*
EDC & VCM	0.57	0.69	0.03	0.19	1.48

4.1.3 Future direction

At the current stage, calculation of environmental costs has been performed only at plant level. Developing an environmental accounting system with an ESH solution at the company level should be one of the most urgent issues to be pursued in the near future.

Second, the current calculation system at the Yeosu plant does not provide detailed information for company decision-making purposes. To meet the needs for more information, detailed guidelines for calculating environmental cost and effects must be developed at the company level. Also the strategic importance of environmental cost information for the decision-making process should be emphasized and fully understood by top management.

5 IMPLICATIONS

The Korean companies that participated in the EMA project have introduced environmental accounting for the following common goals.

- To identify precise environmental costs hidden in indirect costs
- To evaluate performance of their environmental management
- To review environmental investments more efficiently
- To communicate with external stakeholders

In general, the companies mainly focused on measuring environmental costs. Most of them managed environmental costs related to pollution treatment, but did not cover costs for pollution prevention such as resource savings and recycling, cleaner production investment, fuel replacement, and so on.

After tracking environmental costs, the companies have made plans to seek evaluation of environmental benefits related to their environmental activities. Also, they are going to disclose environmental accounting information through their environmental reports or web sites.

Through the EMA project, several key factors for introducing and implementing the EMA were discovered:

1. Senior managers' commitment to EMA
Carrying out the EMA project, we realized the importance of senior managers' commitment to the project. Without the interest and support of internal decision makers, implementation of the EMA project would confront substantial challenges and difficulties. In order to gather the necessary EMA information, this project required the participation of various departments. At the early stages of the project, we had an opportunity to present an outline and stress the importance of EMA to senior managers thereby enhancing awareness among them. These efforts induced senior managers' interest and support.

2. Building cooperation between departments
Generally, information on environmental costs has been produced only by environmental departments, which have no professional knowledge on accounting practices. In Korea, accounting departments don't actually have a correct understanding of environmental accounting, and heads of accounting departments generally maintain conservative positions about changing practices to include environmental accounting.

However, to effectively measure and allocate environmental costs, it is necessary for environmental departments to cooperate closely with accounting and production departments. Accordingly, the TFT had to encourage accounting departments to be actively involved in the EMA project.

3. Effective constitution of the TFT and sharing the goal
Usually, the better a TFT is organized with responsible members, the better the performance of the EMA project. Particularly, frequent turnover of members was fatal to the implementation of a project. It is important to have a consistent team and for all members to share the project goal. An ideal TFT is one where environment, accounting, and manufacturing departments participate as TFT members.

4. Enhancing the awareness of EMA and various utilization
To successfully utilize information on environmental costs, it is necessary for a company's management to have a common understanding of its importance and usefulness.

At the outset of projects, conducting an EMA training program would be an effective way to obtain common awareness. And it is necessary to set up a detail plan how to utilize environmental management accounting information.

5. Linkage of the environmental accounting system and existing information systems
Until now, most Korean companies have not measured environmental costs systematically but by their environmental staff's manual tasks. Consequently, measuring and allocating environmental costs required considerable time and was a hard work-

load for the environmental staff. This problem arises once a year when compiling the annual report.

Therefore, if at all possible, EMA information should be produced through existing information systems. It is crucial to minimize the manual load and to harmonize the existing accounting systems.

6 CONCLUSION

Korean companies are at a basic stage as regards environmental management accounting. However, they have great potential to establish and develop environmental management accounting. Also, Korean governmental efforts and policies give useful implications to developing countries that try to promote EMA. Owing to external pressure from the government, international standards and NGOs, it is important that companies in developing countries implement environmental accounting now.

The corporate cases and issues suggested in this paper seem to be a good starting point to show an effective way for applying environmental accounting in developing countries.

REFERENCES

Lee, B.W. (1998), *Studies on International Trends of Environmental Accounting and Policy Options*, Korea Chamber of Commerce & Industry.

Lee, B.W., Kim, J.D., Jang J.I., Jung, S.T. and Chun, Y.O. (2001), Environmental Accounting Systems and Environmental Performance Indicators, Korean Ministry of Environment, World Bank.

Lee, B.W., Jung, S.T. and Chun, Y.O. (2002), *Environmental Accounting in Korea: Cases and Policy Recommendations, Environmental Management Accounting: Information and Institutional Developments*. Kluwer Academic Publishers.

LGESI (2003), *Environmental Cost Accounting Guideline (Draft)*, Korean Ministry of Environment.

Schaltegger, S. and Burritt, R.L. (2000), *Contemporary Environmental Accounting: Issues, Concepts and Practice*, Sheffield: Greenleaf.

CHAPTER 13

ENVIRONMENTAL MANAGEMENT ACCOUNTING: CURRENT PRACTICE AND FUTURE TRENDS IN ARGENTINA

GRACIELA MARÍA SCAVONE

Buenos Aires University, Argentina

gscavone@cibernes.com.ar

Abstract. This paper considers environmental management accounting (EMA) techniques in projects carried out in Argentina, South America, in which the focus is on reflecting environmental factors in order to make a substantial contribution to both business success and sustainable development. The adoption of a Cleaner Production strategy in combination with EMA adds value for assessing environmental impacts which become a significant cost issue for business. It is considered that although environmental issues are a considerable challenge to business performance, they also offer a significant opportunity for the region. In the developing World, the introduction of cleaner technology will drive for new product concepts, new production processes and logistic solutions. The interim results of the projects on Cleaner Production, cleaner technology substitution assessments and EMA carried out with the support of the government are also discussed. This study describes and analyses the efforts of the Cleaner Production and the EMA group to integrate economic, social and environmental issues with business strategy and operations; outlines the main characteristics of the projects; and evaluates the preliminary conclusions. Key consideration is given to the benefits and barriers of co-operation between local government and the private sector. As final reflections, it recommends focusing efforts on integration where value is created in the organisation

P.M. Rikhardsson et al. (eds.), Implementing Environmental Management Accounting, 257-277

1 INTRODUCTION

A proactive environmental strategy can reduce a company's business cost and improve its position in the marketplace. This concept has been installed in the Argentine business community over the last few years. There has been a growing understanding of the damage to the environment due to economic activities. For business to be able to efficiently and effectively manage the environmental consequences of their economic activities, considering both present and future, they need to use environmental accounting decision tools. The information generated from this source can affect the companies' decisions and improve the environment. The method, which has been applied to pilot projects in Tucumán and Misiones Provinces, Argentina, has combined Cleaner Production strategies and environmental management accounting (EMA) procedures and principles.

The Cleaner Production methodology has helped to identify the opportunities of reduction, recycling or savings within the companies involved in the project analysed. EMA methodology was applied to measure in monetary terms the different environmental impacts identified. In view of many environmental impacts, commensurableness on a monetary scale was not treated as self-evident due to numerous problems related to the monetary valuation of non-market damage. In addition, the externalities, especially those affecting the Salí-Dulce basin, must be assessed taking into account the companies' reduction levels committed in the project. It is considered of extreme importance that the decision-makers understand and accept how the reality has been expressed in the "language" of managers and which issues have been left without valuation and why. In this respect, the boundaries and assumptions made must be clearly reported.

2 THE TUCUMÁN CASE. A PILOT PROJECT IN ARGENTINA

2.1 The project background

The industrial situation in the north-western region of Argentina, where the Tucumán province is located, is characterised by economic growth accompanied by high levels of environmental impacts. There is an adequate legal framework to control pollution but the enforcement is not strong enough to make companies avoid dirty practices.

Decision-makers are faced with complex decisions which share many of the following aspects: they have multi-dimensional impacts, many of which are difficult to quantify; stakeholders often seem to have contradictory requirements; the final decision could face regulatory or public scrutiny.

Experience from different contexts has shown that situations like the one mentioned above can improve by the adoption of adequate strategies (Bennett and James, 1998, Fronti de García et al., 2001). Environmental Management Accounting and capital investment analysis for environmental improvement are the approaches that firms need to use to capture the true costs of waste and pollution in current processes, compare them to the true costs of Cleaner Production alternatives, and make accurate financial decisions using appropriate tools of analysis.

The drivers of measuring for government authorities are regulation and compliance. Management has to elaborate strategic planning and has to identify benefits and market opportunities. The project leader needs to know the funding level for establishing and conducting measurement activities in order to achieve the main goals.

Environmental Performance Indicators to help decision-makers have been evaluated as a tool for every company to assess environmental and economic associated aspects. The purpose is to show the developments in environmental protection and allow for benchmarking over time. In addition, the indicators serve as an early warning system. Environmental performance indicators supply top management with required information. They may link with traditional controlling systems allowing for the monitoring of environmental risks, performance and detection of profitable improvement opportunities. An indicator matrix made to show in what way absolute indicators in combination with meaningful reference units has been used to obtain useful relative indicators. Eco-intensity indicators and percentage ratios are also calculated for certain process, products and/or groups of products.

One of the most challenging goals from the governmental perspective is to assess environmental externalities created by industrial processes and to quantify them. Although it is an estimation, which has many variables and possible methods to be applied, it is necessary to analyse it in order to improve the contamination problem of the Salí-Dulce river basin. The cost cutting potential revealed in the companies in this pilot project is expected to constitute average profit increases of over 20 per cent.

2.2 General project features

Some of the principal geographic and economic features of the Salí-Dulce basin are:

- Area: 89,936 km2
- Location: 26º00 y 27º30 South 64º30 y 65º00 West
- Altitude: 800 meters a.s.l. in the western area
- 350 meters above sea level in the eastern area
- Infrastructure: paved roads, fuel stations, telephones, post offices, hospitals, and shopping districts.
- Principal economic activity: sugar cane agriculture and manufacturing of sugar and alcohol; citrus fruits, especially lemon; soy, corn and beans are also produced. Cotton, wheat, sorghum and cattle have a minor production.

Since typically several sugar mills and the rest of the industries involved share the same river basin where environmental values are observed, pollution by these industries can be treated as a pollution problem.

During a period of approximately one year before the project was launched, training courses took place in Tucumán. They consisted in the diffusion of Cleaner Production and EMA concepts. They were implemented by the National Government in order to install the interest in these subjects in the Tucumán community. The project began at the end of 2002. Twenty-one firms from different industries have joined the project and have been trained as to the importance, in terms of results, of these types of strategies and tools.

The project has innovative features, and is the first of its type in Argentina. The main important goal of the project is to reduce contamination in the Salí-Dulce River basin. In order to support the actions against pollution, a Cleaner Production Centre was also created.

The three main parties involved are:

1. The National Government, which administrates the financial resources for the consulting work on Cleaner Production and EMA,
2. The Provincial Government, which has made the project a local priority (Decree 1526/3 September/02) and play a very important role in the development of the actions
3. The private sector, which has joined the project voluntarily.

The parties (National Government; Local Government; Private Sector) involved in the project have different obligations that can be summarised as follow:

2.2.1 Private Sector

The companies, which have voluntarily joined the project, have to assume specific obligations. Some of them are mentioned below:

- To comply with the legal framework.
- To commit themselves to reducing pollution by adopting specific environmental actions.
- To propose actions which will take place over a period of three years.
- To sign an agreement with the local government to commit themselves to carry out certain actions according to a pollution prevention plan.
- To give information about the whole experience for later diffusion.
- To receive periodical inspections from the governmental authorities for verifying the progress of the project.

Written agreements have been signed by twenty-one companies. They are from different industry segments. Their distribution is shown in figure 1.

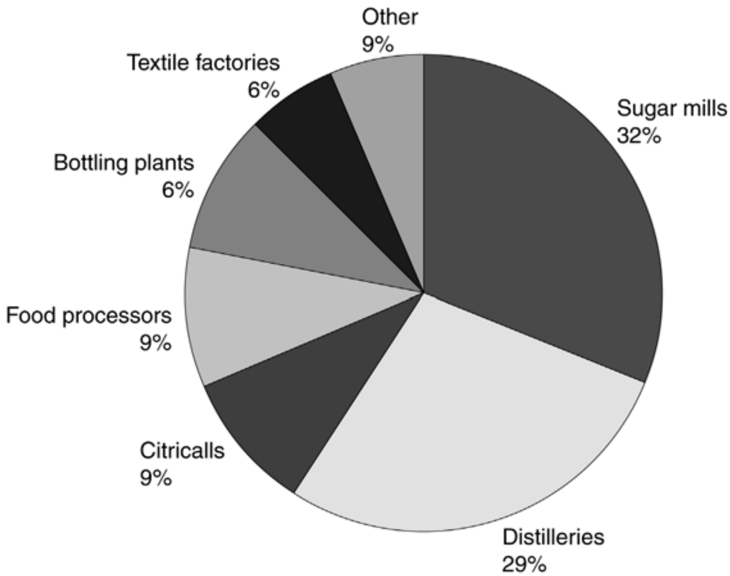


Figure 1. *Project distribution percentage of companies by sector*

More companies joined the project at the end of 2003. They did not enter the project at the beginning due to uncertainty among their managers about its benefits. In order to catch up with the rest of the companies already in the project, they need to go through preliminary and waste audits to determine environmental and business opportunities to elaborate the action programmes. The project has generated morphostatic and morphogenetic organisational reactions against "Environmental disturbances" (Gray et al., 1995, Laughlin, 1991). At least none of the companies that have joined the project seem to transit this experience without organisational changes.

Participating companies receive technical assistance from the Cleaner Production and EMA group in exchange for mandatory participation of one administrator and one technical manager.

2.2.2 Local Government

The local authorities, which are aware of the great importance of the project because it is an essential tool regarding legal obligations and the preservation of the environment, have to follow the development of the actions by carrying out several obligations such as:

- To grant education and consultancy on Cleaner Production and EMA through the Cleaner Production Centre formed by nine engineers and four accountants.
- To give information about the legal framework to help companies to comply with the legal framework.
- To be responsible for expenses on analysis needed to assure data quality.
- To monitor the development of company actions.

2.2.3 National Government

The funding for the project has been obtained from a loan granted by the World Bank and the National authorities, which supervise the development of the project and administrate it. Government programmes and initiatives aim to influence a target group's behaviour towards Cleaner Production and EMA. Identification of the relevant parties has been considered crucial for effective government programmes.

It is expected that the Tucumán initiative can be extended to other geographic regions. Workshop and courses for future initiatives are prepared to support them, based on written materials diffused by United Nations (PNUMA, 1998).

2.3 Objectives

The functions and responsibilities of Tucuman's local government lead to an important goal that is to diminish the significant contamination in the Sali-Dulce River basin. In addition, the local government has a general duty to care for the sustainable development of its jurisdiction. According to these goals, the EMA tool within the project is seen as supporting and clarifying initiatives that promote adoption by industries of environmental reporting. Furthermore, it is considered as a tool to enhance the prospects of greater transparency and accountability within a strategic significance in raising the nation's environmental performance.

Therefore, reviewing, understanding and prioritising environmental actions to be taken by companies involved in the project have been the first steps on the road to achieve the objectives which are summarised below:

- To identify environmental impacts and to prioritise actions based on estimated economic and environmental results
- To measure cost and benefits by reporting total amounts of environmental costs incurred and associated benefits arisen.
- To identify internal environmental costs and to allocate them to processes, products, projects or budgets.
- To develop an environmental performance indicator matrix and eco-efficiency ratios to show the environmental impacts of companies and their associated economic performance.

2.4 Tracking, Analysing and Interpreting Information

Measurement and accounting for waste and emissions are necessary for a Cleaner Production and EMA project. In fact, experts agree that most organisations do not know how much they actually spend to produce waste and to manage it (Schaltegger and Burritt, 2000): Therefore, they do not know how much money they can save with Cleaner Production and EMA tools.

The methodology of Mass Balance has been applied to get data in physical and economic terms. This method tracks specific chemical or input material quantities as they move through various steps and processes at a facility. The method is based on the principle of "conservation of mass", where total weight of inputs equals total weight of outputs. Transformations of the input into other product, output and waste quantities are tracked. Mass Balance requires rigorous data collection and attempts to identify any degree of difference in the input/output quantities, including accumulations and losses (e.g. solvent evaporation, etc.).

One of the main objectives has been to design a useful and viable set of metrics that will drive future improvement rather than just measure performance. Focus on minimising the total number of individual metrics while maximising the value of the information has been strong. Furthermore, frequency of data gathering has been considered, keeping in mind that the range of timing needs for data gathering may vary from metric to metric, level of automation, or other factors. It is important to emphasise the need for improved consistency between physical and monetary data and adequate treatment of contingent costs for the assessment of investment decisions.

In addition, it has been considered of extreme importance to gather historical accounting data to make a baseline. Unfortunately, sources of historical accounting data for industrial facilities were not easy to come by at the beginning of the project. Insufficient training on EMA prevents most of the companies from giving the Cleaner Production group access to utility bills, purchasing records, annual reports, etc.

The steps for the developing of an effective environmental measurement system are briefly summarised below:

The first step is to determine what is needed in order to satisfy the reasons for measuring. The group has been trained in the strategic importance of measuring not everything but only what the objectives require.

All the actions identified during the preliminary and waste audits had been classified as quantifiable or qualitative improvements in environmental practices. To quantify reductions in material and resources used, waste streams and releases, is important to justify additional investment in environmental programs.

Specific, measurable targets which will indicate or confirm progress toward plans and objectives have been set. Special attention has been paid to the effects of biochemical oxygen demand, chemical oxygen demand, total suspended solid content concentration, high pH, nitrogen and phosphorous concentrations, increased temperature, air pollution through sulphur dioxide, warm wastewater, waste of energy through leakage in pressurised airnet. So far, 164 actions have been identified. The distribution of the actions is shown in figure 2:

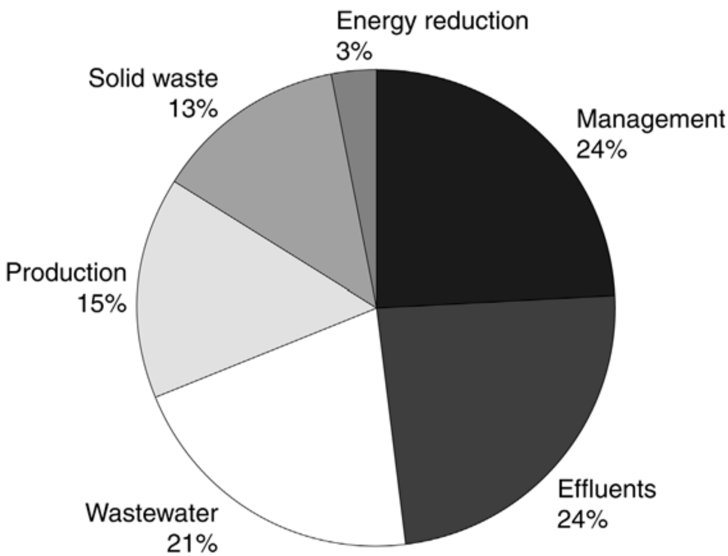


Figure 2. *Actions distributed by type*

The quantitative environmental target demanded by the Local Government has been a reduction of approximately 25 per cent of contamination produced by each company. Up till now only 41 per cent of the actions have been accurately valued. In monetary terms, 61 per cent of the amount of savings is due to production improvements.

Additional qualitative target examples include: – training and motivating all employees or suppliers to practice environmental conservation; changing policy and culture regarding purchase of sustainable products and materials. The clue found to avoid conflict in measurement has been to communicate how the measures are determined. The natural trend is to assign value to final results. According to Furthwengler the features of effective performance appraisals must be quantifiable, easy to understand, equilibrated, easy to track and frequently communicated. (Furthwengler, 2002). Two problems have to be faced: 1. not all the results can be measured. 2. occasionally, useful measurements are not considered. For example, increasing employees' devotion to their work is difficult to measure. Their reactions against a proposal made by the company may be analysed, but there are other factors which may influence their behaviour. On the other hand, quantifiable actions must be evaluated in numeric terms, for example, number of failures, absenteeism, costs, benefits, etc.

Certain metrics may be useful in assessing progress towards more than one target. An important point to consider is the source of data and the level of measurement required (organisation, process, and product). It is important to consider efficient approaches that permit the evaluation of intermediate steps. Each success gets the working team closer to the final goals and gives them confidence to achieve them more quickly.

Data acquisition and tracking systems vary from one company to another. Sometimes a handwritten log sheet has been the only source of data. Fully automated relational databases with direct data input from monitoring equipment have been found only in a few of the better organised companies. That is why tracking and quant-ifying the effectiveness of environmental activities have different levels of difficulty and, in some cases, complete data have not yet been obtained. Analysis or interpretation of the data and information, once they are successfully obtained the data is simple and useful for comparing reduced environmental impacts over time.

It is also important to know what indicators of performance should be established. In addition, an environmental performance indicator system has been considered as the basis for a Balanced Scorecard, which is a useful tool for decision-making. Although, as a general rule, the use of too many metrics has been avoided. Collecting, evaluating and reporting metrics requires time, personnel and money, and the more metrics that are used, the greater the resource requirements.

It has been important to assure that the data are sufficient enough and of high enough quality so as to be relevant and credible. Sometimes, one measure may not fully answer one question or objective, but it should be accurate and representative enough to be credible. Close attention has been paid to variability of ranges and collection and sampling methods in order to produce quality data, collected and tracked in a time and cost-effective manner. An example of the definition of an action is shown in Table 1.

Table 1. *Data structure of an action*

#	*Impact* / *Problem*	*Contamination/waste*	*Proposed action*	*Quantifiable /Non quantifiable*	*Valuation*	*Metrics* *Technical*	*Economic*
5	Syrup filtering (wet mill plant)	Filtering pellets + syrup	Rotary filter installation for syrup retention and filtering material recuperation	Filter investment Syrup savings Quantifiable	Filter cost Daily savings per TN	Mgr COD/ Hour syrup	USD/ Kg recovered

It has also been evaluated whether costs and benefits of the proposed measurement system are perceived as necessary to get information which is worth the investment The importance of testing and refining the system has been emphasised to achieve a continuous improvement. The evaluation criterion has been to simplify the tracking of data. It is believed that the best tracking system is the one which allows self-evaluation by employees and the frequent communication of results.

Plain language has been used to help the stakeholders understand, use and communicate the data in order to make better use of the information. In addition, statistical analysis, or other analytical methods on the raw data may be necessary to translate measured results into further action.

Reporting achievements and others improvements to employees, government, etc. is one of the project challenges, although it goes beyond EMA. A good measurement system must be easy to understand. Understanding environmental performance fosters greater problem-solving initiative. In addition, it expresses the organisational behaviour regarding the environmental impacts (Belkaoui, 1976, 1980).

2.5 The accounting method

The existing accounting systems in the companies, in some cases, have the majority of the data needed. In better-organised companies, they refer both to material flows and inventories as well as including other relevant data. They have been used as a basis for calculating the quantities, values, and costs assigned to a flow model.

The data systems have been checked with respect to their consistency. Flow cost accounting may reveal that a measure designed to raise efficiency on production systems leads not only to lower costs in the actual materials but also to lower costs in materials handling and waste disposal (Strobel, 2000). Jasch also strongly affirms the importance of these concepts (Jasch, 2001) This approach has been promoted in a number of companies of varying size and from different sectors.

In some cases an activity-based costing approach has been considered for costing of pollution prevention. As Schaltegger et al. (Schaltegger and Müller, 1997) described, applying this approach can improve economic performance as a consequence of improved environmental protection, avoiding product pricing distortions and non-quality information for investment decisions.

The flow accounting approach is more adequate to provide data regarding the costs of materials than conventional accounting and waste approaches. Some companies participating in this pilot project can find new ways of increasing overall efficiency by identifying which materials leave the company unproductively as waste, and how much this waste costs in terms of material process and disposal.

The limitations found in some companies have been that materials management systems do not provide comprehensive data. As material value orientation is the core of flow cost accounting efforts in those cases have been made to obtain relevant material costs. For the purposes of calculating the material values and costs, one needs detailed knowledge of the physical quantities of materials involved in the various flows and inventories.

The word "material" is used as generic for materials and energy. Energy flows can be thought of in the same way as material flows, especially since it is often in material form that energy first enters a company. The company can be defined as a material flow system; this includes, on the one hand, the classical material flows along the value-added chain, from incoming goods, by way of various processing stages, towards the product dispatch to the customer.

It also includes all the material losses incurred at various positions along the logistics chain (e.g. rejects, destruction of expired items or damaged goods), which then leave the company as environmentally and economically undesirable residue (solid waste, effluent, exhaust). Such outgoing delivery and final disposal costs include payments to external third parties. All costs incurred in ensuring that material leaves the company, i.e. not only transport costs for products but also the external costs for disposing of waste, the fees for wastewater and effluent, are also included.

A *matrix* has been made to show the outgoing material flows. This is a particularly useful and meaningful form of results presentation and reporting. The flow cost matrix can be used to describe the development of a particular company site over several years or to benchmark different sites within the company more reliably and exactly. It can also be used to compare different companies in the same industry in terms of their respective flow cost structures.

Growing calls for strategies and policies to promote the development of more inherently benign industrial processes, and to promote the introduction of production and consumption patterns that reduce the flow of matter and energy per unit of economic activity exist in the global World. Such "dematerialization" strategies (Schmidtbleek, 1993, von Weizsacker, 1994) would reduce environmental impacts and would also give rise to the development of new technologies. It needs to develop industries characterised by high levels of innovation and of information content, and by principles of advanced design, management and control. It is questionable to what extent dematerialization could reduce total environmental impact in societies where basic needs are still widely unsatisfied, and where sustained economic growth will be needed to achieve this. Considerable thought needs to be given to the employment implications of an economy characterised by increasing dematerialization, and the capacity of social systems to accommodate such changes. Nevertheless, the strategic implemented by the Tucumán project seems to offer a significant potential for integrating the ecological and economic imperatives. Environmental issues are also a significant opportunity for the region, the introduction of cleaner technology will drive for new product concepts, new production processes and logistic solutions.

The configuration of integrated information systems (i.e. materials management, production planning and control, financial accounting, cost accounting, and controlling) is the final goal as regards environmental accounting issues. The existing conventional accounting systems are not able to provide sufficiently precise data regarding the costs of materials.

As Jasch affirms (2001), flow cost accounting performs an important function in revealing starting points for actions, economic and ecological oriented, to prevent environmental damage and improve efficiency. The actual material costs, in production companies, constitute one of the largest costs incurred. That is the reason why the companies have been told to create databases containing physical units like numbers, kg, m^3, kWh etc and all the other costs incurred by the company in maintaining the material flow system (e.g. personnel costs, depreciation).

Based on the mass balance, the course taken by material values entering a company can be determined in order to identify which material costs are considered into the product value and which of them leave the company as waste. The decisions taken in the companies participating in the project regarding these aspects often lead to reduce materials input successfully and to achieve new measures for increasing overall efficiency. The attempts to reduce the quantities of materials and energy used lead to positive ecological effects and environmental improvement, even though this was not the company's conscious intention. Practical experience shows that this can truly bring about changes in a company's way of making decisions.

Sharing and verifying Jasch's opinions (2001) and adapting them to the companies participating in the project, the positive potential benefits from introducing flow cost accounting are:

- Cost-cutting and environmental relief because of improving material efficiency (e.g. avoiding residual waste and reduced use of materials per product),
- Innovation incentives to develop new products, technologies, and procedures thanks to the improved database used for accounting,

- Enhanced quality of the information system thanks to consistency testing and the flow-oriented development of data structures,
- Development of the structural and procedural organisation thanks to company-wide uniform reference to the material flow system,
- Inter-departmental, material-flow-related communications and streamlining instead of insular fixations inside company divisions (departments, cost centres, etc.),
- Higher levels of motivation in staff and management regarding the comprehensive structuring of material flows, and
- Focus on raising material productivity instead of attempts to slim down the workforce.

2.6 Communicating and Presenting the Results

The benefit of information showing the status of an organisation depends to some extent on the audience. Managers, employees, and other stakeholders should know as much as possible about how their environmental efforts and participation have an impact on an organisation and the environment as Fernandez Cuesta suggests (2001).

A single process or product line may only require a few metrics to help understand the inefficiencies or waste in the process. Measuring the effectiveness of a company-wide environmental program requires many parameters, including both outcome and activity measures. For the working group, understanding the audience, which will be using the results, is a great challenge. Tailoring the information toward the audience is a main objective. In this project the accent is on both internal and external information.

Furthermore, as it is stated from a regional or global environmental perspective that understanding the health of a basin, or the entire ecosystem, requires a collective set of indicators that are under the scope of this project. Meaningful and effective environmental measurement begins with strategic planning and periodic plan updates (Wennberg and Asa, 1998).

As the employees seem to have a positive reaction to the project, and they have readily become involved in the pollution prevention practices, it has been decided to integrate environmental, social and economic information. Both voluntary and regulatory reporting leave flexibility in how information is reported. As accountability is not just a top-down concept, it has been important that management allow business units to participate in the development of their environmental performance criteria.

Reporting or presenting information in terms that are meaningful to the target audience has been considered a main objective. Business managers need to know whether changes will improve competitiveness and increase profits and how they should conduct future efforts. On the other hand, government authorities want to be assured that the project against pollution is a success. Technical assistance providers want to see that their efforts are leading to beneficial behaviour changes. – Employees and the community want to know how their participation is making a difference.

Non-technical audiences don't understand complicated environmental issues. Graphic illustrations, statistical charts, layouts or process map, and other graphics have been included to help management understand the details of an operation keeping them as simple and self-explanatory as possible.

2.7 Benefits derived from the applied methodology

A working definition developed in the project is that EMA is a tool for transforming physical and financial measures of environmental data into information for decision-making to judge environmental performance. However, the project goes beyond EMA to include related accounting efforts to measure change in ecosystem conditions in the Salí-Dulce River basin.

The kind of pollution prevention project analysed in this paper provides additional benefits of measuring environmental performance which can be summarised as follow:

- Giving a reasonable idea on what is working and what is not, in the companies.
- Creating company awareness of the importance of Cleaner Production and legal compliance.
- Giving proof of progress toward sustainability, environmental goals and environmental quality.
- Creating an essential learning mechanism to support management decisions and effectively apply investments in environmental improvement.
- Promoting market effectiveness and new opportunities.
- Developing a sense of better prioritisation.
- Stimulating motivation and behavioural changes by translating the measured information into meaningful messages that help the People understand how their environmental efforts make a difference.
- Controlling environmental costs.
- Reducing waste, emissions, discharges, and accidents.
- Updating environmental practices at each facility.
- Understanding the effectiveness and environmental benefits of investments.
- Reporting environmental (stakeholder reports, regulatory requirements, publicity, etc.) more easily.
- Improving public image.

There are some additional benefits that are obtained by the public authorities. They are of the following type:

- Influencing policy development by communicating actions and results to policy-makers.
- Justifying continued funding or staffing for including more companies in the project.
- Sharing and/or aggregating information with other provinces or regions about pollution prevention metrics and programs.
- Making voluntary environmental initiative work.

2.8 Challenges and successes

The development of the project has faced several obstacles that sometimes produce delay in the actions and reduce the expected performance. These problems can be summarised as follow:

- Scattered and incomplete data, specially related to the economic value of environmental impacts.
- Lack of information on cost items related to environmental activities.
- Insufficient knowledge of companies about Cleaner Production and EMA. Both the technical assistance activities and training have revealed a general lack of knowledge on the basic concepts of Cleaner Production and EMA.
- Limitations in data collection capabilities and in quantifying benefits of good environmental performance in monetary terms.
- Changes in the working team.

Company environmental accounting may meet not only internal management needs but also those regarding the external supply of information. Integrate environmental results and successes into the annual report are a challenge that it is expected to be achieved in future. Annual Reports have become the preferred vehicle for communication to stakeholders regarding environmental matters. The growing use of these documents is to be seen within the context of a greater willingness on the part of companies to make a wide range of environmental information available to the public. Corporate responsibility and accountability are increasing and indicators are needed in order to report as concisely and accessibly as possible the results of environmental policies. Identifying and calculating potential environment-related financial liabilities are focus subjects for auditors. Business management, understandably, prefers to leave external costs unquantified.

The next steps to carry out are:

- To improve accounting systems (more detailed accounts and increased role for physical measures).
- To enforce internal audits on actions which the companies have promised to carry out.

- To carry on with input-output analysis of material flows on the company level, process flow charts, site and risk assessment to achieve continuous improvement.
- To monitor the development of the environmental and economic achievements.
- To improve uses made by managers of EMA information.

The interest and support from the local government and the voluntary participation of the companies have been main achievements. A lesson learned from the project is that the practical implementation of EMA is a process that requires the involvement of personnel from several different organisational units both horizontally and vertically. Furthermore, one should avoid being overambitious too early, but rather allow the process to develop. There is often a lack of organisational incentives to advance EMA at the beginning because the benefits may require commitment to sustainable development and enhanced environmental performance (Scavone, 2002).

The project produces unique empirical materials that demonstrate how companies can use Cleaner production and EMA techniques to support management decision. It also produces a framework that allows integration of theory and project findings into one coherent body of knowledge that shows issues and areas for further research.

3 THE SAWMILL INDUSTRY CASE. A CLEANER TECHNOLOGY SUBSTITUTION ASSESSMENT

3.1 Project background

The Argentine forest sector has a significant potential for development due to its high rates of growth, which is attributed to ready availability of adequate land. As a result trees can be planted at a low cost. Additional advantages are climate, soil and species diversity, well-developed silviculture services, important labour availability in forestry areas, specialised research centres (INTA – *Agro-technology National Institute*, INTI – *Industrial-technology National Institute*, etc.) and forest industries built in strategic places. Furthermore a National Law for cultivated forest investment grants fiscal stability for thirty years and different subsidies for industrial forest production.

The forestry industry provides important cases for environmental and ecological economics and for corporate environmental management, because of the large quantities of flows of material and energy that are derived from the natural ecosystem. Within the National Cleaner Production strategy framework, a cleaner technology substitution assessment was conducted for the sawmill industry. The leading cases were industries that process pinewood in the Province of Misiones.

3.2 Features of the forestry sector

According to industrial survey made in 2000 by the Misiones Province Ministry of Ecology and Renewable Natural Resources, there are 732 industries. Most of them (95.63%) are small and medium-sized companies that produce up to 600 m^3 of serrated wood monthly. Large companies are only 0.41 per cent of those industries and produce 3500 m^3 of serrated wood monthly. In the above classification no distinction is made between native and exotic processed wood.

The mentioned study was focused in medium-sized companies which are sawmills processing an average rate of 800 m^3 of serrated wood monthly, and with a labour force ranging from 20 to 40 employees.

3.3 Identified problem

The sawmill process has an efficiency rate of 40 to 44 per cent. That is to say that from 100 TN of wood entering a company, about 56 to 60 per cent is classified as disposable, 10 to 16 per cent of this portion is used as energy to fuel up boilers, and the rest is burnt in the open air.

It is presumed that in the Province of Misiones, approximately 500,000 tons of saw dust and the rest of serrated wood which could have been used in the saw mill process, are burnt annually. It is also known that machines break down frequently due to working with bark covered trunks which break machine blades. This is an important factor in the growth of production cost.

Alternative ways of reducing the volume of burnt waste have been assessed in order to find out whether it could be used for the development of sub-products. It is estimated that approximately 40 per cent (720 m^3) of the pinewood, which currently enters the plant, is burnt as waste. This pinewood could, in fact, be reused to produce wooden chips to serve as raw material for the paper industry. To achieve this option, which would also mean a higher efficiency level and environmental improvement, it would be necessary to incorporate new technologies and adapt production infrastructure for its best functional advantage.

3.4 Identified substitution

The technology best suited to succeed in improving the process of sawmills in fact consists of two machines: one which removes the bark from the trees, and another which makes wooden chips. Accessories and building improvements to optimise machine functioning were also considered. The suggested equipment optimises the use of the resources and reduces environmental, social, labour and market risks.

It was found that the best available machines are from Finland which were therefore selected to be incorporated as new substitutive technology. Equipment prices, plus accessories and building improvements are valued approximately at USD

122,966. – The project figures were calculated using EMA techniques to obtain data in order to prepare a cash flow assessment for defining the approximate amount of benefits. In addition, less tangible benefits were also evaluated. The project evaluation was held in a prospective way considering the potential savings obtaining from the substitution technology and the disbursements caused by the machine investment option. A Present Value assessment showed that the investment could be repaid in a five-year period.

3.5 Benefits generated from the substitution project

Benefits can be shown in at least three dimensions:

1. Economic: the investment payback period is estimated at 3.8 years, which are regular terms for the sector. Machine purchases, accessories, building improvements and sub-product income are considered in the calculation.

After disbursing funds for the new technology, the savings produced by the reduction of waste volumes and their related processing and handling cost, coupled with the additional income produced by the selling of new sub-products as raw material for the paper industry, will yield a profit of USD 28,380 annually. This represents 24 per cent of the current annual income.

2. Social: the sawmill industry will demand a greater labour force and will lower the health risk of workers by reducing air contamination produced by smoke and ashes.

3. Environmental: there are 1.7 million hectares of native woods in the Province of Misiones, with 450 thousand hectares considered protected natural areas (16% of provincial surface). According to the suggested substitution evaluation chip production for paper industry will lower the paper industry pressure for obtaining pinewood from monospecie plantations. Furthermore, air contamination will be reduced due to less quantities of waste.

3.6 Additional comments

According to the evaluations made, if only fifteen companies were to incorporate the substitutive technology, the sector improvement impact would be of a great importance both from the economic and environmental point of view.

The overall assessment of the substitution technology results in additional annual savings of approximately USD 400,000, by avoiding the burning of about 12,000 tons of wood waste. Obviously, the impact will grow if more companies enter this project.

Of a potential universe of 50 to 60 sawmills there are already fifteen that are interested in joining the project. The success of the project, in this step, depends on the possibility of getting monetary resources. In order to offer the complete group the opportunity of achieving the substitution technology and its potential benefits, it is necessary to have access to financial loans or receive co-operation from national or international institutions, including financing from the country providing the technology.

4 FINAL REFLECTIONS

Another important facet of information interpretation and reporting is to verify, to the extent possible, whether the resulting impacts and positive changes can be attributed to environmental efforts. In certain circumstances this can be difficult, especially for facilities that have frequent process or material changes, and for authorities where the results are due wholly or partially to efforts initiated by clients or businesses.

Communicate pertinent results with employees, customers, and suppliers is deemed useful and/or motivational to each audience. For any environmental or social phenomenon, there are many variables that cloud direct cause-and-effect relationships. There must be a demonstrable link between the program's achievement and the advertised result.

A measurement system will most likely need to evolve and adapt to maintain utility. Changes may be needed as the learning curve flattens, and as plans and strategies change over time

Financial analysis for Cleaner Production differs in several ways from typical project analysis: it uses a significantly larger cost inventory, including costs of waste and emissions and regulatory compliance. The time horizon is typically longer because new and pending environmental regulations need to be considered. Furthermore, as Cleaner Production almost always reduces risk, a lower discount rate should be used for estimating the net present value of future cash flows. This means that the future savings will be worth more.

Anyone who treats environmental issues as a solely rational matter misses an essential truth. Pollution prevention is not only cerebral, it is emotional; it touches both the heart and the head. The challenge is how environmental issues are introduced in the business community and how a company is moved from intellectual assent to conviction. The answer to these questions considers opportunity and method.

Another question that must be answered is who profits from environmental prevention strategies. The experience has let us know that many actors profit: employees of corporations that focus on environment have greater control over their own work lives and have more satisfying jobs; customers of these corporations receive greater value for their money than they would have if they had chosen a lower-priced competitor; experiences in different contexts have already shown that companies receive a worthy return on investment for environment-related expenditures. It must be taken into account that profits are not always in monetary terms, the actors gain in intangible ways as well. It is a matter of awareness and attitudes that accompany the actions.

Environmental protection is an international concern with universally applicable solutions. The true evaluation of an organisation's commitment to service environment is the way the company responds when things go wrong. Measurements are used to track progress. They also can be used to assign blame. Just because a measurement can be taken does not mean it should be or that it makes sense. Variability is unavoidable. Using measurement tools aids companies in lessening its impact. Furthermore, it is considered that taking irrelevant measurements is destructive to morale and can produce negative results. EMA applied consistently during consecutive periods helps to achieve meaningful results and to obtain integrated information that creates value for the organisations.

REFERENCES

Belkaoui, A. (1976), The Impact of the Disclosure of the Environmental Effects of Organizational Behavior on the Market. *Financial Management* Winter: 26-31.

Belkaoui, A. (1980), The Impact of Socio-Economic Accounting Statements on the Investment Decision: An Empirical Study. *Accounting. Organisations and Society* 5: 263-283.

Bennett, M. and James, P. (1998), *The Green Bottom Line. Environmental Accounting for Management. Current Practice and Future Trends*. Sheffield: Greenleaf Publishing.

Fernandez Cuesta, C. (2001), Sistemas de Gestión Ambiental en la Empresa. *Revista Partida Doble* 12: 49.

Fronti de García, L. et al. (2001), *Impacto ambiental: sus posibilidades de captación y control a través de la información contable*. Proyecto de Investigación UBACyT. Facultad de Ciencias Económicas, Instituto de Investigaciones Contables "Profesor Juan Alberto Arévalo" (available only in Spanish).

Furtwengler, D. (2000), *10 Minute Guide Performance Appraisals*. USA: Macmillan

Gray, R. et al. (1995), *The Greening of Enterprise: An Exploration of the (non) Role of Environmental Accounting and Environmental Accountants in Organizational Change*. Dundee University and Heriot-Watt University. Academic Press Limited.

Jasch, C. (2001), *Environmental Management Accounting Procedures and Principles* – Prepared for the Expert working group on "Improving the Role of Government in the Promotion of Environmental Managerial Accounting" UN Division For Sustainable Development, New York.

Laughlin, R. (1991), Environmental disturbances and organisational transitions and transformations: some alternative models. *Organisational Studies* 12 (2): 209-232.

PNUMA (1998), *Programa de Naciones Unidas para el Medio Ambiente – Industria y Medio Ambiente*. ¨Producción más limpia: Un Paquete de Recursos de Capacitación¨ (available only in Spanish).

Scavone, G. (2002), *La dimensión Económica y Ambiental en el Gerenciamiento Estratégico* – XVII Jornadas Profesionales de Contabilidad, XV de Auditoria y IV de Gestión y Costos. Colegio de graduados en Ciencias Económicas, Buenos Aires (available only in Spanish).

Schaltegger, S. and Burritt, R. (2000), *Contemporary Environmental Accounting. Issues, Concepts and Practic*e. Sheffield: Greenleaf Publishing.

Schaltegger, S. and Müller, K. (1997), *Environmental Management Accounting: Current Practice and Future Trends*. Geographic Focus: Global "Calculating the True Profitability of Pollution Prevention". Greener Management International, GMI 17.

Schmidtbleek, F.(1993), Toward Universal Ecology Disturbance Measures. Basis and Outline of a Universal Measure. R*egulatory Toxicology and Pharmacology* 18 (3): 456-462.

von Weizsacker, E. (1994), How to Achieve Progress Towards Sustainability. In: *Norwegian Ministry of Environment, Sustainable Consumption,* Report of a Symposium held in Oslo, 19-20 January, 1994, Oslo, pp. 50-59.

Wennberg, U. and Skillius, A.. (1998), *Continuity, Credibility and Comparability*. International Institute for Industrial Environmental Economics. Lund University, Sweden.

CHAPTER 14

ENVIRONMENTAL MANAGEMENT ACCOUNTING IN THE FRAMEWORK OF EMAS II IN THE CZECH REPUBLIC

JAROSLAVA HYRSLOVÁ* AND MIROSLAV HÁJEK‡

**University of Pardubice and ‡Ministry of the Environment, Czech Republic*

jaroslava.hyrslova@upce.cz, hajek_miroslav@env.cz

Abstract. Environmental management systems are broadly implemented in enterprises in the Czech Republic. The Eco-Management and Audit Scheme (EMAS) consists in voluntary activity of the enterprise, intended to control the environmental impact of enterprise activities and to provide the relevant information to the general public and other interested parties.

The Czech Republic has included requirements on implementation of environmental management accounting in the framework of EMAS. If an enterprise is attempting to implement EMAS, then an essential part of the system consists in the obligation to establish and maintain procedures for tracing of environmental costs in order to implement environmental management accounting (EMA).

The paper deals with requirements on EMA implementation in the framework of EMAS as well as reporting of environmental costs and revenues. The paper includes some of the results acquired from a qualitative study of the state of preparedness of enterprises, registered in the EMAS, to implement EMA.

P.M. Rikhardsson et al. (eds.), Implementing Environmental Management Accounting, 279-295

1 INTRODUCTION

Industrial enterprises in the Czech Republic are well aware that their approach towards environmental protection is one of the important factors in attaining business success and that they must comply with conditions following from the laws in the area of environmental protection. Often, the costs of achieving compliance with these regulations are very high. The environmental performance of a company and environmental costs could significantly affect the economic results of a company and its financial position (Hyrslová and Böhmová, 2003). The financial consequences of the attitude of the company towards the environment are of interest not only for the company management, but also other stakeholders (investors, creditors, owners, employees, customers, suppliers, competing companies, state bodies, the public, the media and environmental movements and initiatives). These facts lead to the need to employ environmental management accounting and environmental management systems.

Environmental accounting is a significant component of environmental policy in the Czech Republic. It is employed both at the governmental level and at the company management level and is an irreplaceable instrument in enforcing integration of economic aspects into environmental policy (Hájek, 2002). Increased knowledge of its potential and especially use in decision-making processes is important for implementation of individual measures leading to achieving of the targets of environmental policy.

The first attempts to employ environmental management accounting (EMA) were made in the Czech Republic at the beginning of the 90's in connection with approving a number of environmental laws, which significantly affected the economics of the business sector and it was necessary to analyse the impacts of these laws. As no uniform national methodology was available, simplified environmental accounting was mostly employed in the individual enterprises, consisting in tracing the main elements of costs related to environmental protection and reflected in the accounting of the enterprise (Czech Environmental Management Centre, 1993). Basically, two approaches, which can be employed separately or jointly, were employed. Depending on the employed methodology, impacts caused by environmental investments were traced or the impact of increased operating costs was assessed (e.g. also including environmental charges). Tracing of operating costs was based methodically on environmental accounting, which concentrated on tracing of all costs (and payments such as the above-mentioned environmental charges) and revenues or savings related to environmental protection.

Attempts to control the environmental impacts of activities appeared in Czech enterprises simultaneously with the first attempts to introduce EMA. The enterprises decrease the detrimental impact on the environment by introducing environmentally-friendly technologies. Preventative approaches are preferred (preventing waste generation) rather than end-of-the-pipe measures (removal of wastes). The viewpoint of environmental protection is gradually becoming an integral part of decision-making. Enterprises are aware of the necessity of improving the material and energy exploitation. A further approach leading to a decrease in environmental damage consists in environmentally-suitable product innovation and awarding of "Environmentally-Friendly Product" quality labels since 1994. The Czech Republic continues to employ voluntary initiatives and activities in environmental protection to a great degree, especially implementation of environmental management systems (EMS).

2 IMPLEMENTATION OF ENVIRONMENTAL MANAGEMENT SYSTEMS IN THE CZECH REPUBLIC

EMS is finding increasingly extensive applications in the Czech Republic. As of June 2003, 480 organizations had implemented EMS[1]. (Czech Environmental Institute, 2003).

In 2002, in the framework of work on research and development projects[2], an analysis was carried out concerned with the main reasons for introducing EMS in Czech enterprises (Fedorova et al., 2002). The research was carried out by the University of Pardubice and the Brno University of Technology through a questionnaire survey and interviews with the managers of selected enterprises. 208 enterprises, which had introduced EMS at the time of the survey, were addressed. 89 companies participated in the survey (43% response). Companies of various sizes in various branches were represented in the test sample.

The companies gave the following main reasons for introducing EMS:

- Permanent interest in protecting the environment (82% of respondents),
- Improved position on the market (74% of respondents),
- Customer requirements (37% of respondents),
- Pressure from laws and standards (31% of respondents) and
- Cost reduction (19% of respondents).

It thus followed from the questionnaire survey that the main reasons why companies decide to introduce EMS include especially permanent interest in protection of the environment and attempts to improve the position of the company in the market. It is thus apparent from the results of the survey that companies are aware of the increasing pressure from stakeholders (especially state bodies, the public and business partners) in a responsible approach to the environment, particularly in the sense of a transition from a passive approach (end-of-the-pipe technology) to an active approach (cleaner production)[3]. Simultaneously, the laws in the area of protection of the environment are gradually becoming stricter. Most enterprises include environmental targets in their company strategies.

The survey also encompassed the benefits that the companies expected from implementation of EMS and whether they were realized (see Table 1).

Table 1. *Benefits of EMS implementation (Hyrslová and Böhmová, 2003)*

Benefits of EMS implementation	*Expectations*	*Fulfilment*
Compliance with the environmental protection laws	90%	89%
Better management	90%	90%
Respecting of the principles of sustainable development	81%	73%
Improving of supplier-consumer relations	78%	65%
Better negotiations with banks, insurance companies, state authorities	74%	63%
Increasing of the market share	62%	40%
Reducing of costs	44%	40%

90 per cent of the enterprises expected that the introduction of EMS would lead to comply with the environmental protection laws and an improved system of management of the enterprise. The survey demonstrated that this expectation was also met. It was unambiguously confirmed that "improved order" in the company is one of the great benefits of EMS. In the framework of implementation of EMS, activities are identified that have a detrimental impact on the environment, and important environmental aspects and environmental impacts of the company activities, products and services are revealed. The greatest attention is focused on ensuring compliance with the valid laws and standards in the area of environmental protection. Environmental policy and environmental objectives are established. Because of the main target of EMS – a continual improvement in the system – an improved environmental performance of the enterprise is achieved in accord with the environmental policy of the company. The enterprise is thus also prepared for stricter environmental laws in the future and is capable of rapidly adapting to them.

More than 70 per cent of companies also expect that introduction of EMS will lead to respect for the principles of sustainable development (i.e. sustainable use of natural resources, creation of environmental awareness of all employees), improved supplier-consumer relations (it means better image of company or enterprise, dissemination of responsible approach to the environment between contractual partners) and an improved position for negotiations with banks, insurance companies and state authorities (it means an increase of credibility for banks and insurance companies and widening of possibilities in an area of public orders and business support). However, these expectations were not met to the same degree as in the previous case.

A significant difference between expected benefits and their fulfilment was seen by enterprises mainly in the area of an increased market share.[4] 62 per cent of companies expected that the introduction of EMS would be beneficial from the standpoint of increasing their market share. However, only 40 per cent of companies confirmed that expectations were met.

The enterprises saw also a benefit of environmental management in the area of decreased material and energy consumption, a decrease in further operating costs, savings of fines related to environmental damage, decreased environmental protection payments, maintenance of cooperation with business partners and increased satisfaction and performance of employees.

3 ECO-MANAGEMENT AND AUDIT SCHEME – EMAS

The government of the Czech Republic supports the introduction of EMS in the long term, especially based on the Eco-Management and Audit Scheme (EMAS) programme, in accordance with the European Union. EMAS is understood to be a voluntary activity of the enterprise that is intended to improve the environmental performance of the enterprise and provide the relevant information to the public and other stakeholders. Council Regulation (EEC) No. 1836/1993 was approved in the Czech Republic as the EMAS Programme in Resolution of the Government of CR No. 466/1998 of July 1, 1998. Further, the EMAS Programme based on Regulation No. 761/2001 of the European Parliament and of the Council (EMAS II) was updated in Resolution of the Government of CR No. 651 of June 19, 2002 – the Updated EMAS Programme (Ministry of the Environment of the Czech Republic, 2002b).

Basic documents were approved in connection with the Resolution of the Government of the Czech Republic on introduction of EMAS of 1998.

- The Statute of the Council of the EMAS Programme as the body responsible for EMAS in the Czech Republic;
- The Rules of Procedure of the Council of the EMAS Programme as the body responsible for EMAS in the Czech Republic;
- The Statute of the EMAS Agency;
- The National Programme of introduction of the Eco-Management and Audit Scheme (Updated EMAS Programme);
- The Rules for introduction of the Eco-Management and Audit Scheme;
- Methodical instructions for certifying environmental verifiers.

Czech companies can obtain support for introduction of EMAS from three possible sources.

- The "TRH" Programme of support for small and medium-sized enterprises, administered by the Czech-Moravian Guarantee and Development Bank – is guaranteed by the Ministry of Industry and Trade. Support corresponding to up to 50 per cent of demonstrated costs can be obtained for obtaining a certificate.

- Support from the State Environmental Fund is provided to partly cover costs connected with certification and introduction of EMAS in an amount of up to 60 per cent.
- The Regions may also provide support within their competence. This means of support is currently oriented towards enterprises with up to 50 employees.

The Czech Republic was the first of the candidate countries to introduce a fully functional EMAS system. As of June 30, 2003, the register of companies with introduced EMAS contained 480 industrial enterprises and service enterprises, of which nine organizations has registered EMAS (Figure 1).

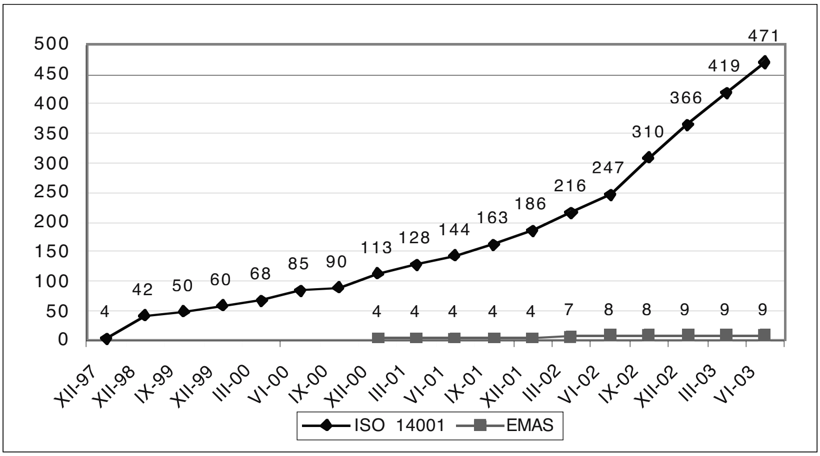


***Figure 1**. Trends in the number of companies with ISO 14001 and EMAS in the Czech Republic (Czech Environmental Institute, 2003)*

EMAS has not found such broad application in the Czech Republic as environmental management systems based on the ISO 14 001 standard. Nonetheless, the number of enterprises with validated EMAS is the highest of all the countries preparing for accession to EU (Figure 2).

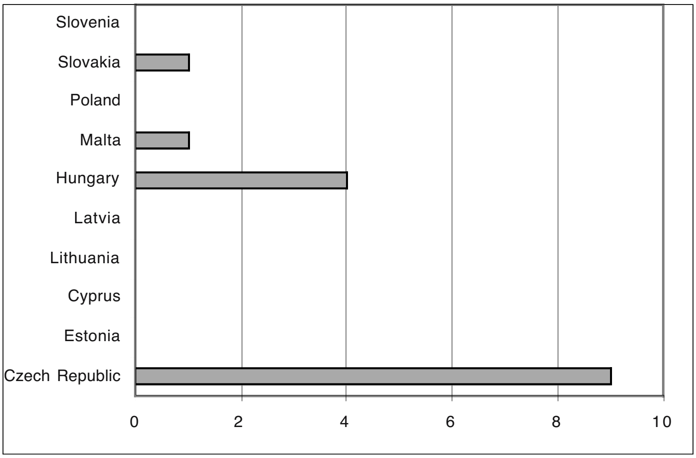


Figure 2. *Number of enterprises with introduced EMAS in the new EU member states (Czech Environmental Institute, 2003)*

4 ENVIRONMENTAL MANAGEMENT ACCOUNTING IN THE FRAMEWORK OF EMAS II

The Czech Republic has included requirements on tracing and tracking of economic impacts, caused by the environmental impacts of the enterprise activities, in EMAS II. If an enterprise is attempting to implement EMAS II, then an essential part of the system consists in the obligation to "establish and maintain procedures for monitoring of environmental financial flows in order to implement environmental management accounting" (Updated EMAS Programme).

In connection with this requirement, the Ministry of the Environment prepared the "Environmental Management Accounting Implementation Guideline" (hereinafter Guideline), which came into effect on January 1, 2003 (Ministry of the Environment of the Czech Republic, 2002a). The Guideline was created on the basis of the results of the Environmental Management Accounting Working Group, which was established at the Ministry of the Environment in 2000. Representatives of the Ministry of the Environment, enterprises, universities, the Czech Environmental Institute and other experts concerned with the subject of protection of the environment work in the framework of the working group.

The concept of EMA is based on interconnecting information on material and energy flows (in physical units) with information in monetary units. Emphasis is placed on the importance of knowledge of the material and energy flow values (material and energy flows are money flows). The EMA system not only provides information on the material value on entering the enterprise, but is also a source of information on the costs of processing this material in the individual stages of production. Thus, a gradual increase can be seen in the value of the material that, through work in process and semi-product becomes a finished product intended for the customers. During this process, material is lost (wasted) or degraded, and non-product outputs can be created. The EMA system provides the users with information, not only on costs expended to produce products intended for customers, but also on the material purchase value of non-product outputs and processing costs of non-product outputs. It is possible to trace and track activities and places where losses and wastes occur and non-product outputs are created. On the basis of this information, measures can be proposed that lead to an increase in the efficiency of the use of materials and energy, a reduction in the environmental impacts of the activities, products and services of the enterprise, a reduction in environmental risks and, in the final stage, an improvement in the economic results of the enterprise.

The Guideline facilitates implementation of EMA both at the level of the enterprise as a whole and at the levels of the individual company processes, divisions, operations, etc. This means that it is fully within the competence of the enterprise to choose the variant that is suited to the management requirements.

The important step for implementation of EMA is preparation of material, water and energy flow balances (Hyrslová, 2003b). This forms a basis for improving the environmental performance of the company (Jasch, 2001). The boundaries for the balance can thus be the entire enterprise, or the individual workplaces, facilities, centres, processes, products, etc. It is useful to select the boundaries for implementation of EMA so that the information obtained can be used to support the decision-making process in the enterprise (i.e. for instance to select plants with significant environmental aspects). Simultaneously, it is useful to also take into consideration the existing system of management accounting, in order to be able to obtain the relevant monetary information. The Guideline enables preparation of material and energy flow balances for only several selected important materials and kinds of energy or for all the material and energy used in the enterprise (in the system). It is always necessary to take into account that the objective of the balancing process is to trace and track how the materials and energy pass through the enterprise (system).

Consequently, in the framework of EMA implementation, it is necessary to analyse the individual activities and processes that proceed in the enterprise (system), to prepare a balances of material and energy flows, to consider waste flows and their impact on the environment and to obtain the waste, waste water and air emission disposal (Hyrslová, 2003b). The material and energy flows are then expressed in monetary units. Information determined from the balances form a starting point for measures that should lead to an improvement in the economic results of the enterprise and its environmental performance (Hyrslová, 2003b, Jasch, 2001).

Information on environmental costs is of great importance for determining the economic consequences of company approach to environmental protection (Hyrslová, 2003b). Identification of environmental costs is based on the balance of material and energy flows.

The Guideline defines environmental costs as follows:

- costs expended for protection of the environment – i.e. costs connected with company measures (activities) intended to decrease and/or compensate for detrimental environmental impacts of the enterprise, and
- costs related to environmental damage.

Environmental costs are further divided into the following categories:

- The first category of environmental costs consists in costs related to management of waste, waste water and air pollution. These include all costs for treatment of the wastes, waste waters and air emissions and costs for disposal.
- The second category of environmental costs consists in costs related to prevention and environmental management.
- The third and fourth categories of environmental costs consist in the costs of wasted material (material purchase value of non-product output) and the costs of processing.

It is apparent from the definition that environmental costs are not conceived only as the costs of protection of the environment, but that a significant component of environment costs are considered to also consist in costs related to non-product outputs (wastes). Waste is ineffective not only because the enterprise must deal with the waste in a suitable manner (dispose of it), but primarily because each waste has its “value”. This "value" includes the costs of wasted material (i.e. the purchase value, for which the wasted material was acquired) and the costs of processing this material, which has not become a product for the market but constitutes an “undesirable” output. The Guideline is thus based on the concept of environmental costs, which was conceived by a group of experts working in the framework of the UN Division for Sustainable Development (Jasch, 2001). This definition of environmental costs is of great importance for the needs of environmentally-oriented management. It permits separate evaluation of the environmental protection costs, how much the enterprise expends on waste disposal (either through operation of its own environmental facilities or through payments to external companies) and separate reporting of the value of non-product outputs (i.e. what the enterprise loses through the wastes). The utilization of this approach in the framework of the decision-making process in the enterprise assists significantly in accepting measures that are not only friendly to the environment and constitute a very significant step towards sustainability, but also are, in the final analysis, economically advantageous to the enterprise.

For correct evaluation of the economic effects of the attitude of the enterprise towards the environment, it is also necessary to concentrate on environmental revenues (Hyrslová, 2003b). Environmental revenues include, e.g. revenues from recycling of materials, sale of wastes, subsidies and awards. They also include other earnings, related to elements of environmental costs.

In the framework of the Guideline, the requirements on tracing environmental costs and revenues are also specified. The Guideline is limited to only certain recommendations. It is not intended to identify all environmental costs and revenues, but rather to concentrate on important elements. Elements that are a consequence of important environmental impacts/aspects and that attain significant values should be considered to constitute important environmental costs and revenues[5].

According to the Guideline, environmental costs and revenues should be assigned to the individual environmental media. This allocation enables a further view of environmental costs and revenues. It is important for evaluating the impacts of enterprise activities on the individual environmental media and demonstrates their economic effects.

Information on environmental costs and revenues are ordered in a statement of environmental costs and revenues (given in simplified form in Table 2).

Table 2. *Statement of environmental costs and revenues*

Category of environmental costs and revenues	*Air, climate*	*Waste water*	*Waste*	*Soil, ground water*	*Noise, vibration*	*Biodiversity, landscape*	*Rddiation*	*Other*	*Total*
1. Management of waste, waste water and air pollution									
2. Prevention and environmental management									
3. Material purchase value of non-product outputs									
4. Processing costs of non-product outputs									
TOTAL ENVIRONMENTAL COSTS									
TOTAL ENVIRONMENTAL REVENUES									

It is apparent from the above that the EMA system provides users with very important and valuable information that is not available in the framework of the existing systems of management accounting. Management accounting systems in most enterprises are concerned primarily with information that is of importance for management at the levels of centres and products. However, it is useful to support the decision-making process in the enterprise by information on flows of materials and energy and the value of these flows.

In the implementation of EMA, it is recommended that enterprises progress from the bottom (divisions, activities, processes, products) upwards (enterprise). It is necessary to analyse the individual activities and processes that take place in the enterprise, prepare a balance of material and energy flows, examine waste streams and their environmental impacts, map means of management of waste, waste water and air pollution, identify important environmental equipments and activities related to environmental protection and prevention of pollution. On the basis of this knowledge, it is possible to determine important environmental costs that can be assigned to the individual divisions, processes (activities) and products, and environmental costs important from the standpoint of the enterprise as a whole.

5 IMPLEMENTATION OF ENVIRONMENTAL MANAGEMENT ACCOUNTING IN ENTERPRISES IN THE FRAMEWORK OF EMAS II

As incorporation of EMA into the environmental management system constitutes a quite new obligation, in the first half of 2003, the University of Pardubice carried out a qualitative study of the state of preparedness of enterprises, registered in the EMAS Programme, to implement EMA (Hyrslová, 2003b, Kurová, 2003). The main objective of the study was to determine the existing state of tracing and tracking of environmental costs in selected enterprises and how they will proceed during compliance with requirements, imposed by the Guideline. The study was carried out through personal interviews in selected enterprises that were registered in the EMAS Register as of December 31, 2002. Of the total number of registered organisations (nine companies were registered in the EMAS Programme as of December 31, 2002), four agreed to participate in the study (Peguform Bohemia Liberec – Liberec and Liban divisions; Frantschach Pulp & Paper Czech Steti and AQ-test Ostrava). Questions were posed in the framework of interviews with representatives of top management, with employees responsible for the area of environmental protection and with employees of financial sections and controlling sections.

The study yielded the following results:

- The enterprises are acquainted with the Updated EMAS Programme and are of the opinion that it will not be difficult to comply with the newly established requirements. They are aware of the obligation to trace financial flows related to the environment, as newly imposed by the Updated EMAS Programme. However, the concept of EMA is not entirely clear to them. Environmental management accounting is conceived in a very narrow sense – as reporting environmental costs.

- They consider information following from EMA to be beneficial especially to employees responsible for environmental protection in the enterprise; this information enables assessment of the efficiency of the environmental management system.

- Representatives of the studied enterprises stated that they will manage to implement EMA through their own resources and that they will thus not require the services of external consulting companies. Employees of the sections concerned with environmental protection in the enterprise and employees of the controlling sections will participate in implementing the system.

- The enterprises are not aware of the possibility of selecting boundaries for the EMA system; they assume that the boundaries will consist in the entire enterprise.

- Requirements on preparing material and energy balances following from the Guideline can be met. In all the studied enterprises, the balances of raw materials and energy have already been completed and are used in management of the enterprise. Utilisation of material and energy balances has brought the enterprise a number of significant savings in the past. The enterprises do not expect that it will be necessary to establish new records of materials, energy or waste to meet the requirements of the Guideline.

- At present, none of the studied enterprises have created a system of tracing and tracking environmental costs and revenus. They consider the definitions of the individual categories of environmental costs and revenues in the Guideline to be comprehensible. In identifying environmental costs and revenues, they will proceed as follows:
  - the starting point for identification will consist in the material and energy balances from which the waste streams unambiguously follow,
  - in the next step, important elements of costs and revenues related to these waste streams will be pinpointed,

   - following identification of important elements, their amount will be determined; in relation to some elements, a modification in the accounting system will be necessary to ensure that their amounts can be determined directly from the accounting system.

- The enterprises consider the classification of environmental costs in the Guideline to be useful; it corresponds with classification of the costs of quality, with which they have experience. The enterprises consider that "costs related to non-product outputs" to be a problematic element, both from the standpoint of inclusion in environmental costs and from the standpoint of determining their amount.

- The enterprises do not expect that tracing of environmental costs and revenues will be incorporated into their accounting system (because of the amount of work involved in restructuring the already functioning information system). It is thus apparent that statements of environmental costs and revenues will contain estimated information; employees of the sections concerned with environmental protection and with controlling will participate in these estimates.

- The enterprises do not expect problems in allocating environmental costs and revenues to the individual environmental media. This is considered useful especially by employees responsible for environmental protection in the enterprise.

It followed from the study that the definition of cost elements that the companies consider to be environmental costs is a problem. Environmental costs are conceived in a very narrow manner (incompletely). Costs connected with the acquiring, installation and operation of end-of-the-pipe technology (waste water treatment plants, incinerators, etc.) and costs incurred as a consequence of environmental pollution (payments for environmental protection) are considered to be environmental costs. Some enterprises also include costs connected with remediation of the undesirable environmental impacts incurred as a consequence of accidents (costs of removal of spills of petroleum or other substances into the soil, costs of reclaiming), costs connected with monitoring of environmental impacts, payments to consulting and certification organizations connected with introduction, certification and recertification of EMS and payments to external organizations for training of employees in the framework of environmental management to be environmental costs. However, in this approach, a large part of environmental costs remain hidden in summary elements of costs (e.g. costs associated with non-product outputs). These hidden environmental costs are not taken into account in a suitable manner in decision-making.

Another problem consists in incorrect allocation of environmental costs to the products, centres and processes that cause them (Schaltegger and Burritt, 2000, Hyrslová, 2002). Environmental costs are part of overhead and are allocated on the basis of the basis of apportionment used for the relevant type of overhead amongst all the bearers of costs. However, for instance "dirty" products cause more wastes and require better equipment for disposal of pollutants than environmentally-friendly products. Unsuitable allocation of environmental costs enables products that damage the environment more to attain higher profits than correspond to fact. On the other hand "green" products are damaged by this manner of allocation, because they must bear costs that they did not cause. Incorrect allocation of environmental costs (especially in cases, when environmental costs constitute a substantial part of costs) can thus lead to erroneous decisions by management.

Thus, the existing systems of management accounting are inadequate and unsuitable because of the decisive part of environmental costs in total costs and because of the increasing importance of the environmental performance of the company (Hyrslová, 2003a). The existing system of management accounting does not provide sufficient information for environmentally-oriented management. Management accounting is directed primarily towards information that is important for cost management at the levels of products, centres and processes (product-oriented management accounting, responsible management accounting and process-oriented management accounting). However, information on material and energy flows, such as data concerning the exploitation of resources and waste generation in the broad sense (e.g. the volume and type of emissions discharged into the air or the amount and composition of waste waters) is important for correct decision-making in the area of environmentally-oriented management. Most companies trace information in the area of material and energy flows separately from the accounting system. For example, the individual kinds of wastes, their volumes and management thereof are usually monitored in enterprises in a separate system, which is created so as to comply with the requirements of the state authorities in the area of external reporting. However, there is the problem in the fact that the information on material and energy flows is not interconnected in the accounting system. Simultaneously, it is obvious that, for environmentally-oriented management, it is necessary to utilize monetary information and information on material and energy flows in mutual interrelationship. Only in this way is it possible to propose and implement measures that lead to an improvement in economic results and to a decrease in the environmental impacts of the company activities, products and services.

The study confirmed that implementation of EMA (in the narrowest sense as a system of tracing and evaluating environmental costs) does not constitute a major problem for the enterprises. However, the attitudes of some employees (especially employees of controlling sections) indicate a lack of willingness to introduce any (even partial) changes in the already functioning information systems. These employees argue that the information systems used in the enterprise do not permit incorporation of tracing of economic impacts caused by the environmental impacts of enterprise activities into the accounting system.

The Ministry of the Environment, which prepared the Guideline, provides the companies with information on EMA, the potentials for its use and its benefits, through seminars and courses[6]. A working group concerned with this subject is active at the Ministry of the Environment. Representatives of enterprises and the experts are invited to meetings of the working group. Scientific conferences were held on EMA in 2001-2003, attended by experts from the Czech Republic and representatives of Poland, Hungary and Slovakia. For example, specific applications of EMA in Czech enterprises were prepared under the auspices of the Ministry of the Environment. In 2002, two case studies of implementation of EMA in a chemical enterprise and in an enterprise manufacturing foodstuff additives were prepared. A study with the name "Use of environmental accounting in dealing with decision-making tasks in a company" was elaborated in 2003. Experience gained in the framework of preparation of studies is discussed by the working group. All case studies have also been published so that all interested parties can become acquainted with them.

6 CONCLUSIONS

Following years of preparation, at the beginning of 2003, the Czech Republic managed to incorporate the EMA system into EMAS II and simultaneously to offer use of the Guideline to further enterprises. Only the future will show whether enterprises will appreciate the importance of information that can be obtained in the framework of the EMA system, and employ this to support decision-making processes. In any case, in the meantime, it will be demonstrated that the established way to application of EMA under the conditions in the Czech Republic is beneficial in general and not only for companies employing EMAS.

NOTES

1 From the viewpoint of individual sectors, a majority of enterprises were from the processing sector and from the construction sector. The subsectors of production of electrical and optical devices and production of metals and metalworking products had the largest share in the framework of the processing industry.

2 Project of the Grant Agency of the Czech Republic „Information on Environmental Costs for Environmental Management" (Registration No. 402/02/0092).

3 Creative approach of companies to environmental protection based on conformance with explicit systematic rules has a significant preventive character (ISO, 1996, Mikolás and Moucha, 2004). Passive role of enterprise as a polluter is changing.

4 Results of the research have shown that enterprises consider acquisition of an ISO 14001 certificate or registration in the EMAS programme as the significant tool to the strengthening of the competitiveness. Enterprises relate the implementation of EMS to the improvement of their image, with increasing credibility for investors and creditors (and due to this with a better access to capital), with widening of possibilities in the export sphere and in an area of public orders. But we observe that in some areas contributions are not displayed in such a measure as companies expected (i.e. some financial institutions in the Czech Republic do not give on environmental profile of company sufficient emphasis,

environmentally-friendly approach is not in some cases considered a significant criterion during selection of trade partners and the like).

5 Information is material if its omission or misstatement could influence the decisions of users taken on the basis of the statements. Materiality depends on the size of the item or error judged in the particular circumstances of its omission or misstatement. Thus, materiality provides a threshold or cut-off point rather than being a primary qualitative characteristic that information must have if it is to be useful (ASB Statement of Principles).

6 Representatives of approximately 30 organizations participated in training courses. First of all these organizations were companies in various implementation stages of the system of tracing and tracking of environmental costs.

ACKNOWLEDGEMENT

This work was supported by the Grant Agency of the Czech Republic under project No. 402/02/0092.

REFERENCES

Czech Environmental Institute (2003), *EMAS Agency* [online] [cited 20 June 2003] Available from internet URL <:http://www.ceu.cz/EMAS/>.

Czech Environmental Management Centre (1993) Analysis of Profitability at Vítkovice Prague, CEMC (available only in Czech)

Fedorová, A. et al. (2002), *Information on Environmental Costs for Environmental Management Brno*, Brno University of Technology and University of Pardubice (available only in Czech).

Hájek, M. (2002), Ways towards more efficient environmental policy. In*: Proceedings from the Conference of Charles University Prague The Consolidation of Governance and Entrepreneurship in the Czech Republic and the European Union. Part IV – Environmental tax reform – Optimal fiscal policy or efficient environmental policy?* Prague: Matfyzpress , pp. 44-61.

Hyrslová, J. (2002), *Allocation of Environmental Costs in Enterprises of Chemical Industry*. Scientific Papers of the University of Pardubice, Series A, Faculty of Chemical Technology 7.1, pp. 251-259.

Hyrslová, J. (2003a), *Deficiencies of the Existing Systems of Management Accounting for the Needs of Environmentally-Oriented Management and their Prospects*. Scientific Papers of the University of Pardubice, Series A, Faculty of Chemical Technology 8.1, pp. 225–231.

Hyrslová, J. (2003b), The State of Preparedness of Czech Enterprises for Environmental Accounting System Implementation in the Framework of EMAS II. In: *Proceedings from the Conference Economic Aspects of Environmental Protection Pardubice*, University of Pardubice, pp. 44–49.

Hyrslová, J. and Böhmová, S. (2003), Impacts of the Environmental Performance of an Enterprise on its Financial Health. In: *Proceedings from the Conference. Financial and Logistics Management in the Context of Accession of the Czech Republic to the European Union*. Ostrava, VSB – Technical University of Ostrava, pp. 63-67 (available only in Czech).

ISO (International Organization for Standardization) (1996). *ISO 14001: Environmental Management Systems – Specification with Guidance for Use*. London: ISO.

Jasch, C.H. (2001), *Environmental Management Accounting Procedures and Principles*. New York: United Nations Publication.

Kurová, V. (2003), *Implementing of Environmental Management Accounting in Enterprises*. Pardubice, University of Pardubice (available only in Czech).

Mikolás, J. and Moucha, B. (2004), *Your Enterprise and Environment at Access to the European Union*, Prague, Ministry of the Environment (available only in Czech).

Ministry of the Environment of the Czech Republic (2002a), *Environmental Management Accounting Implementation Guideline* [online] [cited 20 June 2003]. Available from internet URL

<:http://www.env.cz/www/zamest.nsf/defc72941c223d62c12564b30064fdcc/70b5154b8f004b08c1256d6e00288c14?OpenDocument>.

Ministry of the Environment of the Czech Republic (2002b), *Updated EMAS Programme (Basic documents)* [online] [cited 20 June 2003]. Available from internet URL <:http://www.ceu.cz/EMAS/>.

Schaltegger, S. and Burritt, R. (2000), *Contemporary Environmental Accounting Issues, Concepts and Practice*. Sheffield: Greenleaf Publishing Limited.

CHAPTER 15

THE ROLE OF GOVERNMENT IN PROMOTING AND IMPLEMENTING ENVIRONMENTAL MANAGEMENT ACCOUNTING: THE CASE OF BANGLADESH

ABDUL HANNAN MIA

Department of Management Studies, University of Dhaka, Bangladesh

hannan@dhaka.agri.com

Abstract. This paper aims at describing the roles of government in promoting and implementing environmental management accounting (EMA) in the light of the benefits in developing countries in general and in Bangladesh in particular. The promotion and implementation of EMA can gear up its benefits such as increase in fund, improve environmental performance, contribution to sustainable development, effective decision-making, increase market share, develop environment-friendly industrial sector, etc. Nowadays, external reporting aspect of EMA has created the awareness of the government to play its due role in promoting and implementing EMA. The government can play a role in promoting and implementing EMA through a variety of measures: formulating a policy package regarding EMA promotion and implementation, developing guidelines for the companies regarding the process of EMA reporting and for the government agencies regarding implementation of EMA etc. for example. There are available policy options encouraging companies to practice EMA. These are information policy instruments; self-regulatory policy instruments, incentive base policy instruments, and direct regulatory policy instruments. The government can also formulate policy options at different levels as on a hierarchical basis for the implementation of EMA. The regulatory agencies of the government at various levels like the security exchange commission, financial institutions including banks, stock markets and insurance companies can also play a vital role in implementing EMA by being very strict in assessing the impacts before various financial and non-financial support is provided to the enterprises. Finally based on the available literature, the mentioned government practices of EMA; a suitable model for easy promotion and implementation of EMA in the developing countries is suggested. This paper will benefit a number of parties including the government of developing countries as to how EMA can be implemented. The researchers in this field can use the study as a reference material or as a source of further research ideas generation. The study will also benefit the academicians, practitioners and the professionals in the field of environmental accounting in general and EMA in particular.

P.M. Rikhardsson et al. (eds.), Implementing Environmental Management Accounting, 297-320

1 THE PRELUDE

Environmental Management Accounting (EMA) is broadly defined as the identification, collection, estimation, analysis, internal reporting and use of physical flow information, environmental cost[1], and other monetary information for both conventional and environmental decision making within an organization. The main focus of EMA is not to assess the total environmental cost but to assess the production cost on the basis of materials flow. Poor quality materials or chemicals used in manufacturing/the production process pollute the environment and cause harm to society. Previously this pollution of the external environment was never internalized. It is believed that once organizations are made accountable for these societal costs, they would be compelled to minimize the potentially harmful effects of such activities. So organizations require that the potential environmental impact of their activities can be forecasted and accordingly the contingent liabilities and creating provisions for environmental risk be estimated. The growing concern for global environmental management for sustainable development has given a rise in the development of ISO 14000 that focuses on the design and standardization of sustainable industrial culture in general, efficient operation by the use of best environmentally sound technology, continuous improvement in environmental performance, environmental system auditing etc., among others, in particular.

Environmental management accounting has emerged based on the following premises: Firstly, the growing concern for environmental issues has given a rise in the need for effective environmental management by business and other organizations. Secondly, accounting and financial management techniques can help to support mutual benefits of both the organization's environmental management functions and its accounting and finance functions. Environmental management accounting is understood here as environmental accounting specifically addressed to supporting the information needs of the organization's own management.

A UN conference on human environment, which took place in Stockholm back in 1972, addressed environmental deterioration around the globe. The conference was an impetus to the government of most of the developing countries including Bangladesh. The Government of Bangladesh promulgated the Water Pollution Control Ordinance in 1973 based on which an environmental pollution control project was undertaken. This project, which was carried out in 1985, facilitated setting up the Department of Environment Pollution Control that was restructured in 1989 with full setup as the Department of Environment. Since then lots of rules and regulations have been framed.[2] Bangladesh is primarily an agrarian economy. But nowadays its industrial sector is making a significant contribution toward the GDP of the country. The contribution of this sector to GDP is 19.54 per cent (GOB, 2002) including both the contribution of large and small industries. The country's recent industrial policy, government fiscal policy etc. are congenial towards foreign investment and thereby industrialization. But industrialization pollutes the environment. The Department of

Environment (DOE) of Bangladesh, among others, has got some mandate related to industrial activities as stated in the later sections. DOE identifies seven (7) industries[3] that pollute the environment (Reazuddin, 2002).

2 OBJECTIVES OF THE STUDY

The broad object of the study is to identify the role of the government in promoting and implementing environmental management accounting. The specific objectives are to

1. Identify various policy roles of the government in promoting and implementing EMA
2. Identify various roles of the various government bodies in promoting and implementing EMA
3. Develop a model for promotion and implementation of EMA.
4. Provide suggestions to the government for the promotion and implementation of EMA.

To achieve these objectives information was collected from various secondary sources including government agencies, bodies, published and unpublished books, magazines, reports, etc., from home and abroad. Besides electronic media, web sites etc. also have been used to collect supplementary information.

For the purpose of EMA promotion and implementation the role of the government lies in following phases:

- The government must recognize the benefits that can be derived from EMA
- The government should be convinced about these benefits
- It must communicate these benefits to various government and non-government organizations
- Should take several courses of action to implement EMA through various government machineries.

3 ARGUMENTS FOR GOVERNMENTS IN PROMOTING AND IMPLEMENTING EMA

This section accommodates the reviews of major literature in the field of environmental accounting and environmental management accounting with a view to presenting arguments delineating the need for and opportunities of EMA for its promotion and implementation in Bangladesh. Bangladesh is a developing country. Promotion and implementation of EMA can speed up economic growth through various benefits and opportunities.

Environmental management accounting is not a subject to be kept in the academic exercise, as it brings many financial and non-financial benefits to organizations and society as a whole. The government should promote EMA for a number of practical benefits as described below:

1. Increase in funds

Business logic for environmental consciousness has given a rise in operational, technical and bottom up pollution prevention programs. These types of concerns on the managerial level could save billions of dollars (Hart, 1997). The dramatic expansion in socially-responsible investment in Australia – assets of SRI managed funds grew by 86 per cent between 2000 and 2001 to USD 1.3 billion – is just one example of how green business practice can reap economic rewards. The practice of EMA helps to increase the fund in several ways.

Firstly, pollution prevention programs increase safety, and security of the operational and technical-level employees makes their working environment more productive. The productive environment augments production volume which in turn increases the company's funds. The working capital of MSA spinning mills Ltd. increased by 24 per cent in 2002 over the previous year after introducing a pollution prevention program in the factory (Annual Report, 2002).

Secondly, discharge of social responsibility has direct, positive influence on augmenting funds by popularizing the organization among the citizens. That is to say, citizens will prefer the company's products or services when the company exhibits increased social responsibility. The case of Dutch-Bangla Bank can be given as an example. The total amount available for investment in this bank increased by 39 per cent, reserve funds increased by 50 per cent and total assets increased by 25 per cent in 2002 over 2001 (Annual Report, 2002). This was the result of the bank's investments in social responsibility like sponsoring cricket, providing medicare to the poor, giving scholarships to poor but meritorious students, etc.

Thirdly, investment in pollution control devices is subject to depreciation. Charging depreciation on the equipment increases the funds in two ways. Non-cash expenses like depreciation are a direct source of funds. Apart from this, depreciation minimizes the profit thereby minimizing the tax amount thus maximizing the funds or cash flow.

2. Improve environmental performance

EMA helps large and small enterprises in any sector to improve both their environmental performance and profitability. EMA uses costing tools that generate a win-win situation for both the environment of the country and a company's profit performance (Mia, 2003). The reporting and disclosure of environmental information seems positively associated with the environmental lobby group concern about firms' environmental performance within a particular industry (Deegan, 1996). The costs incurred either for operation, maintenance or capital in nature usually have been found to have favourable impact on the performance. This is also true for developed countries (Skipworth et al., 2001) although there are findings that voluntary reporting does not measure the firms' true environmental performance (Fekrat et al., 1996, Freedman and Wasley, 1990). Apart from these, EMA involves disciplines like accounting, environmental protection, industrial production and business management etc. Thus EMA can be used both for tracking environmental change and for assessing corporate environmental performance.

3. Encourage the financial sector to contribute to sustainable development

EMA complements a range of initiatives that the government of developed and developing countries are trying to introduce to encourage the finance sector to contribute to sustainable development with due focus on the environment. Financial sectors all over the world channel their investment in various industries. If EMA is practiced the individual firm or sector will be at an advantageous position in getting funding from financial institutions. Some banks, especially foreign banks, joint venture banks and financial institutions, top-rank firms top if their environmental performance is better although other factors remain constant. In view of the sustainable developments, ecopreneurs always receive the highest attention of the financiers. The leading financial institutions in Bangladesh started practicing preferential treatment to enterprises that have Department of Environment clearance as well as a positive environmental inspection report (Financial Express, 27 October 2003).

4. Effective Decision Making

EMA facilitates deciding the best courses of action. EMA makes financial sense as it leads to organizations adopting cleaner production processes or be more resource efficient. It identifies the opportunities in the accounting system to build the business case for change. Environmental management accounting assists companies to identify the full range of environmental costs and benefits within traditional accounting systems and may, in some cases, lead to improved decision making. Availability of environment-related information, tools and techniques for allocating environmental cost, etc. increases the decision-making competency of the enterprises. EMA helps in effective decision making not only at the company level but also at the national government and international organization levels. The goals and the information needed for the various levels or functions differ quite a lot. While EMA is primarily an internal management tool for companies, it may also serve to improve information flows from companies to other levels of decision-making. Although previously, environmental accounting was generally taken to cover only material flows, new approaches are making closer linkages between production processes and financial accounting methods, integrating both monetary and ecological measures. Thus EMA information will not help make effective decisions at the company level only, but at the national and international level as well. Besides, the stakeholders (shareholders, credit rating agencies, customers etc.) of the enterprises can also use the EMA information for their effective decision-making, and the various levels within an enterprise, i.e. production level and top management, can use EMA information for effective decision making at various operational and hierarchical levels. The range of decisions affected by environmental costs of one type or another is generally on the rise. Thus, EMA is becoming increasingly important not only for environmental management decisions, but for all types of routine management decisions like product and process design, cost control and allocation, capital budgeting, purchasing, supply chain management, product pricing etc. (Wilmshurst et al., 1998). The question of effective decision making in developing countries, including Bangladesh, has received great attention from corporate managers. Lack of updated, relevant information has been the main cause of decrease in the recovery ratio of government banks (Aleem, 1999, Chowdhury et al., 2003).

5. Increase market share

Green management reporting ensures higher output while using lower input; it generates less wastage with more effective use of raw materials in production eventually resulting in cost minimization. EMA minimizes costs and maximizes revenues, which eventually can increase market share (Welford et al., 1996). There are various possibilities that the practice of EMA increases the number of customers of the company Companies that did not practice and implement EMA experienced abnormal negative returns (Mughalu et al., 1990, Hamilton et al., 1995, Bosch et al., 1998) or low sales and margin just after the announcement of the court decision regarding non-compliance of environmental performance of the enterprises under consideration. This causes customers to withdraw their patronization ultimately decreasing the market share of the company; the reverse being true in case of voluntary environmental reporting (Belal, 1997).

6. Increase market value of the stocks

Environmental management accounting increases the market value of the share. Although there are several findings on the impact of EMA, environmental reporting etc. the increase in the value of the share was found to have been influenced by the practice of EMA and reporting of environmental facts. Cormier et al. (2001) confirmed that the level of voluntary environmental disclosures is related to the market value of the share. He also found that the pollution level in excess of a standard is associated with a firm's share value. It was found that the return on equity share in successful firms with social disclosure was higher than those companies without (Richardson et al., 2001). Although there are no study findings in Bangladesh regarding the impact of environmental reporting on the market price of the share, there are some findings that the share price or returns of the firms are being positively influenced by corporate reporting and disclosure of environmental information (Lancaster, 1999, Richardson et al., 2001).

7. Assessing risk

EMA tools have been developed to predict the risk associated with environmental hazard. Organizational, operational and informational risks together with the risk associated with physical structure are directly or indirectly linked with environmental risk. Individual organization can develop tools and techniques to assess and thereby minimize the environmental risk. Scholars identified that the risk is associated with the external environment (Schaltegger et al., 2003) as well as the internal environment (Bala, 2002) of the organization. The EMA model can help management understand this risk when making managerial decisions.

8. Developing an Environment-Friendly Industrial Sector

EMA helps management understand potential hazards that result from non-performance of environmental management in organizations. Practicing EMA highlights the sources from which organizational risk emerges, how these risks can be minimized or eliminated. Exercise of EMA thus helps the organization be risk-free for the society, and the acceptability of the organization to the stakeholders increases. A comprehensive framework for environmental management accounting provides information relevant to the decision maker. Correct decisions help the organization to be environment friendly (Burritt et al. (2002).

9. Potential Benefits of EMA to Government

The industry's promotion and implementation of EMA can also benefit government in various ways.

First, the more industry is able to justify environmental programs on the basis of financial self-interest, the lower the financial, political, and other burdens of environmental protection on government.

Second, industry's implementation of EMA should strengthen the effectiveness of existing government policies and regulations by revealing to companies the true environmental costs and benefits resulting from those policies and regulations.

Third, the government can use industry EMA data to estimate and report financial and environmental performance metrics for government stakeholders such as regulated industries or the industry partners in voluntary programs.

Fourth, industry EMA data can be used to update government programs and policy design. The government can use industry EMA data to develop metrics for reporting the financial and environmental benefits of voluntary partnership programs with industry, innovative approaches to environmental protection, and other government programs and policies. Industry EMA data can be used for regional or national accounting purposes.

Finally, government organizations can implement EMA to reap the following benefits:

- Government EMA data can be used for environmental and other decisions within govern ment operations, e.g. purchasing, capital budgeting, and federal facility environmental management systems.
- Government EMA data can be used to estimate and report financial and environmental performance metrics for government operations.

10. Potential Benefits of EMA to Society

EMA enables the more efficient and cost-effective use of natural resources, including energy and water. It enables the cost-effective reduction of pollutant emissions and reduces the external societal costs related to industry pollution, such as the costs of environmental monitoring, control, and remediation as well as public health costs. EMA provides information for improved public policy decision-making. It provides industrial environmental performance information that can be used in the broader context of evaluations of environmental performance and conditions in economies and geographic regions.

Apart from the benefits described above, the government can also realize the value of the opportunity that EMA can further through its promotion and implementation. Opportunities are the situations that arise with new dimensions; usually they exist for a short period within which the situations are to be exploited to obtain monetary or non-monetary gains. The global concern for the environment and sustainable development has identified some concepts – areas in both the developed and developing countries that open up corridors and windows to a variety of parties, professional bodies etc. EMA provides opportunities to make the total environment very friendly, conducive to cost minimization, product quality development, research and innovation, elimination of wastage. etc. This would give rise to a favourable investment climate and consequently economic development of the country.

From the above discussion it can be concluded that the government should realize the need for promoting EMA. The financial and non-financial benefits discussed above would help the government take steps in promoting EMA in a developing country like Bangladesh. Once the government understands and realizes the benefits of EMA it should play its due role in its promotion and implementation.

4 THE ROLE OF GOVERNMENT IN PROMOTING AND IMPLEMENTING EMA

This section describes the roles of various organs of the government in promoting and implementing EMA in Bangladesh. The government can play diversified roles for the promotion and implementation of EMA in two phases: first, at the start-up phase of the firm and second, at the survival and development phase of the firm. Irrespective of development phases of the enterprises, the government can develop policies and implementation guidelines as described below.

1. Government Policies

The government can develop congenial and industry-friendly policies which will play an important role in encouraging and motivating enterprises to adopt an EMA system to ensure that materials and production cost, with specific identification of environmental cost becoming fully inventoried, are properly allocated and clearly articulated. The government should circulate by gazette notification to all potential and existing entrepreneurs and all financial institutions that the project feasibility report, among other things, must reveal that the project is environment-friendly. No environment-unfriendly project would be financed; rather the government will penalize the institution for sanctioning financial or non-financial supports. The government can help promote and implement EMA through formulating policy packages as stated below.

2. Information Policy Instruments

The government may develop information policy instruments for the promotion and implementation of EMA. An information policy instrument is the mechanism of identifying, collecting and disseminating information to the concerned parties regarding the benefits, opportunities etc. of practicing EMA. In order to promote and implement EMA, the government can – through its respective ministries – circulate newsletters highlighting the benefits of promoting and implementing EMA. Development of EMA-related software also would be advantageous for the industries that wish to promote and implement EMA. Provision for training and counselling regarding EMA is important for the promotion and implementation of EMA. In collaboration with the Ministry of Trade and Commerce the Ministry of Information and Technology exercise these responsibilities.

3. Self-Regulatory Policy Instruments

The government must develop detailed guidelines and mechanisms to control the environment-related activities of enterprises. This policy instrument will identify and tie up the regulators at various levels so that the implementation of EMA will automatically be regulated and implemented. A variety of self-regulatory policies can be exercised for the implementation of EMA. For example, working with ISO, EMAS, GRI, accounting associations, banks and other financial and industrial organizations etc. are self-regulatory policy measures can be exercised for the promotion and implementation of EMA.

4. Incentive Base policy instruments

An incentive base policy instrument deals with various types of monetary and non-monetary motivational instruments that help energize mental drive towards the promotion and implementation of EMA. Declaring cash prize, subsidize tax, import /export subsidies, differential duties, preferential tax structure, availability of low interest loans, and other preferential treatment to the best EMA performers may help develop motivation to promote and implement EMA. Issuing certificates, appointing environmentally important person (EIP), inviting them as special persons at various public and strategic meeting, seminars, for technical assistance etc., are the non-financial incentives to help promote and implement EMA.

5. Direct Regulatory Policy Instruments

The mechanism that directly regulates promotion and implementation of EMA can be said to be a direct, regulatory policy instrument. Government machinery that directly detects and controls illegal utility connections, raw materials supply source, etc. will directly intervene the non-performance of EMA. The government can develop policies regarding the inspection of any site, plant, equipment, machinery and other processes, material or substances for the purposes of improving the environment, pollution control and mitigation and give necessary directives to appropriate authorities or persons to meet such purposes.

The government should formulate all policy options for the implementation of environmental management accounting at different levels on a hierarchical basis. For example, all policy instruments of the Department of Environment regarding EMA will be subordinate to the policy instruments set by the Ministry of Environment. Similarly, policy instruments of the security exchange commission should be subordinate to the policy instruments of the Department of Environment.

6. Developing Policy Guidelines

Apart from policy formulation, the government can develop guidelines to promote the implementing EMA. The government can develop guidelines for a variety of aspects as follows:

Establish EMA guidelines
The Ministry of Environment will develop and establish EMA standards and guidelines. In the course of time the Ministry will revise the standard in accordance with the ISO 14000 guidelines based on which the government can develop guideline for individual industries based on which enterprises' environmental performance can be measured.

7. EEEco Reporting
The government can develop a guideline to submit an EEEco report at a certain frequency and in a prescribed format. EEEco stands for effectiveness, efficiency, and economy report. The effectiveness report will measure whether the enterprise is doing the right thing, the efficiency report will measure whether the enterprise is doing the things right, and the economy report will measure whether the enterprise is doing things at the right costs.

Minimum Environmental Investment
The government can develop a guideline as to the percentage of total investment to be invested for environmental protection. The government can develop a schedule that will contain the minimum percentage classifying the enterprises into various categories on a spectrum ranging from environment-friendly to environment-unfriendly. For example, in the case of textile industries investment for environmental protection should not be less than 10 per cent of the total balance sheet figure.

8. Impact Assessment (EIA) Guideline
In some countries the government defines an environmental impact assessment (EIA) guideline and issues environmental permits to any organisations as well as the general public that intends to set-up an industry or undertake any development projects. The impact of the environment should be assessed using the guideline developed by the government otherwise the assessment will give a different picture which will lead to state of mis-conclusion regarding the performance of the enterprises.

9. Inspection Guideline
Guidelines regarding the preparation of report after the inspection of any site plant, equipment, machinery and other processes, material or substances should be developed so that appropriate action for the implementation of EMA can be taken.

10. Corporate Strategic Guideline
The government can also develop guideline in which environmental concerns play a role in organizations in developing and implementing a corporate strategy for implementing EMA. In view of this, the government can develop the following guideline.

Managing regulatory compliance: is concerned with how organizations would develop environmental management programs in response to increases in both external pressure and internal awareness.

Achieving competitive advantage: deals with how organizations focus on cost management through realising that efficient use of resources can offer them a competitive advantage.

Completing environmental integration: outlines how organizations will accept and fully integrate environmental considerations into corporate life, and how organization will recognize environmental performance as crucial to survival in a competitive world economy, and that long-term economic growth must be environmentally sustainable.

From the above discussion and description, following concluding remarks can be made

1. Issuing an environmental clearance certificate by the Ministry of Environment without which no company can start their business.
2. Giving or issuing directives to provide for environmental aspects in the financial part of the business plan.
3. Issuing directives to provide information regarding risk assessment out of environmental factors and provision for measures thereof in the business plan
4. The government can work with industry, associations, and NGOs to support voluntary programs for the implementation of EMA.
5. Develop an environmental checklist.
6. Setting up environmental legislation and mandatory accounting standards.
7. Hold seminars to make accountants aware of their contribution in promoting environmental sensitivity within the organization and its implication both in society as well in the organization.
8. Use of economic instruments to internalize the externalities, norms, eco-taxes, environmental tradable permits, etc. may be introduced (Burritt et al., 2002) to promote and implement EMA.

9. The government can continuously pressure for cleaner production. Enterprises could be put under pressure by various regulatory bodies to submit various reports addressing societal and environmental concerns. For this purpose the government can develop a framework/guideline for the corporate environmental reporting to ensure cleaner production.

5 REVIEW OF ROLE CURRENTLY PLAYED BY THE GOVERNMENT FOR THE PROMOTION AND IMPLEMENTATION OF EMA

At present the Government of Bangladesh is using the following approaches for the promotion and implementation of EMA.

1. Issuing environmental certificates

Back in 1995 The Government of Bangladesh formulated the policy of issuing environmental clearance certificate. This policy introduction was a time-demanding step of the Government of Bangladesh but could not be materialized effectively. The officers and other concern inspectors of the Ministry of Environment or Department of Environment sometimes issue certificate even without physical verification, without going through the environmental income statement and balance sheet that contains information about environmental investment.

2. Inspection policy

Inspectors sometimes visit the industrial site controlling that the company actually has the environmental certificate which confirms that the industrial undertaking is environment friendly.

The government of developing countries including Bangladesh is developing the sense of being environment friendly. Closing down industries producing for instance synthetic shopping bags, is an example of such concerns. Though the approaches used at present are evidences of the government's concern; however, unfortunately no EMA practice is found in Bangladesh. There are some reporting mechanisms found in the Philippines, India, Sri Lanka and Korea. The government of Bangladesh are yet to understand and materialize the concept of EMA.

6 MODEL FOR THE PROMOTION AND IMPLEMENTATION OF EMA

The EMA promotion and implementation model is a logical and physical structure that facilitates promotion and implementation of EMA. It includes a number of tools and mechanisms used in operating business activities that help management in assessing the environmental effect on business decision making and thereby business performance.

The government has various interrelated and interdependent wings by which it can better promote and implement EMA to build up a green industrial society.

The promotion and implementation of the philosophy of EMA can be geared up by a number of parties. In a developing country like Bangladesh, the government can promote and implement the philosophy through its various administrative machineries. The actors in various administrative hierarchies may initiate roles to promote thereby implementing this philosophy. The Parliamentarian Committee of Public Accounts, concerned ministries, related administrative authorities, can play an awareness-creation role as regards EMA. The related and concerned authorities, once the philosophy of EMA and its benefits are conceived, can play an administrative role on their subordinate organizations to follow the environmental code of conduct by showing them the benefits of the practice of EMA. Developing environment awareness programs, implementation policies, directives and framing related guidelines etc. constitute the process of playing roles for the promotion and implementation of EMA. The authorities not directly under the guidance of the government, but indirectly being influenced by the government machineries or influence the government authorities, can also play supportive roles for the same pursuit. A brief account of the various units of the government as well as other stakeholders that can promote EMA is given below:

1. Ministry of Environment

The Ministry of Environment can take a range of measures in order to promote and implement EMA. The Ministry of Environment is one of the important actors in this regard by

- Issuing environmental clearance certificates without which enterprises cannot start their operations.
- Issuing yearly environmental clearance certificates to justify that the materials' physical flow through the existing plant and machinery will not produce undesirables.
- Issuing environmental clearance certificates that will justify that any addition, replacement of plant and machinery will not hinder smooth and efficient flow of raw materials.
- Formulating and enforcing policies regarding EMA implementation.
- Defining Environmental Impact Assessment (EIA) guidelines.
- Introducing incentives for the companies whose environmental performances are satisfactory.

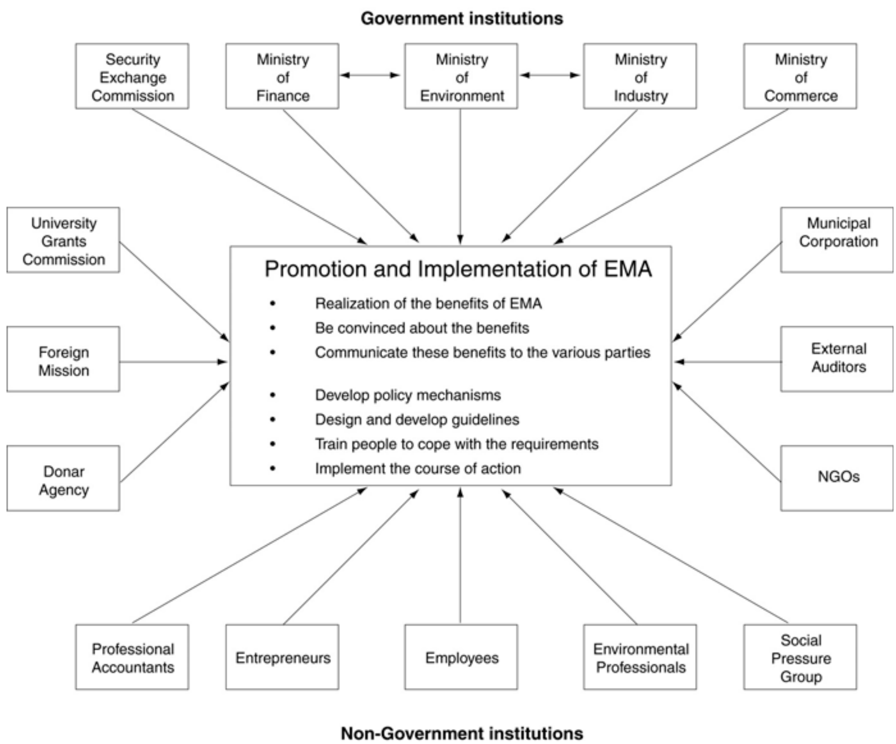


Figure 1. *Government and Non-government units in implementing EMA*

2. Ministry Commerce and Trade

Being one of the main regulatory bodies, the Ministry of Commerce and Trade, can play a vital role by using a range of measures as follows.

First, the commercially important persons are required to renew their CIP certificate on a periodic basis. In Bangladesh, among others, the issuing of a CIP certificate is dependent on the performance of the enterprises that the CIP certificate applicants own and manage. The measurement of this performance can be based on the environmental income statement, balance sheet and environmental reports of the organization. If the green entrepreneurs, technically called eco-preneurs, are given the preference in issuing CIP certificates then it will promote EMA.

Second, the Ministry and its various machineries can take restrictive measures in issuing or renewing trade licenses. The Ministry can impose a minimum restriction that an environmental clearance certificate from the Ministry of Environment or from the Department of Environment is one of the prerequisites for obtaining or renewing a trade license.

Third, the ministry can announce various incentives or preferential treatment to the eco-preneurs who are in the real sense working for sustainable development.

3. Ministry of Industry

Through its various wings the Ministry of Industry performs various tasks in order to develop the industrial base of the country. Development of industrial estates, developing the list of encouraging industry, announcing and providing incentives to the industrial units, allowing tax holidays, preparing and publishing industrial policies etc. are in the hands of the Ministry of Industry. The Ministry may spread the flavour of EMA in its various activities by which the entrepreneurs are either directly or indirectly affected. The Ministry can develop some persuasive measures through which enterprises will develop their consciousness to be environmentally compliant.

Firstly, the Ministry and concerned authorities can impose the restrictions of maintaining an environmental code of conduct on the entrepreneurs who would like to establish their industrial units in a government industrial estate.

Secondly, the Ministry can include those industrial units in the government list of industries that are less harmful to the environment, more environment friendly, environmentally more sustainable.

Thirdly, it can frame a rule that the industrial units cannot enjoy any incentives including tax holidays if the enterprises are not environment friendly, does not maintain environment codes, etc.

Finally, the Ministry can pursue the entrepreneurs, citizen, and concerned authorities through advertisements that influence them to be more environment friendly.

4. Registrar of Joint Stock Companies

The Registrar of Joint Stock Companies is one of the most important actors who can definitely help the promotion and implementation of the EMA being able to impose the restriction on registration of industrial units.

First, submission of an environmental clearance certificate can be made mandatory. No application for registration will be entertained if an environmental clearance certificate is not submitted.

Second, the renewal of the registration can be made conditional on the basis of an environmental report made by the company and the environmental audit report prepared by inspectors from the Department of Environment.

Third, the registrar can an issue circulars and monitor that registration will be cancelled if the enterprise cannot meet environmental requirements.

5. Municipal Corporation

The municipal corporation being one of the legitimate actors in the field of industrial development can play a variety of roles in the promotion and implementation of EMA.

First, the corporation should impose prerequisites to be satisfied to get a trade license. For example, a trade license will not be issued without an environmental certificate. Since Municipal Corporation holds the authority of issuing trade licenses; it must strictly follow the rules and regulations while issuing trade license.

Second, the corporation should provide a vigilant inspection team. It can occasionally arrange to send an inspection team for comprehensive or token inspection.

Third, the Corporation should hold seminars, symposia, workshops and rallies to mobilize opinion in favour of green environmental management and environment-friendly industries.

6. Ministry of Finance

Like other countries, the Ministry of Finance in Bangladesh is one of the most important actors that can help promote and implement the concept of EMA as a lot of administrative bodies are working under its control.

- Should not give clearance for e.g. initial public offerings on the stock market unless environmental clearance is obtained.
- Should regulate the financial and capital market through the issuing of various circulars to the concerned financial institutions that form the financial and money markets.

Since the Finance Ministry is a very powerful government authority, it must come forward in understanding and realizing the benefits of EMA for a developing country like Bangladesh in a competitive age.

7. Security Exchange Commission

- The Security Exchange Commission (SEC) can develop a policy guideline that no companies will get the permission for initial public offering if the certified financial statement does not contain an environmental audit report. The projected financial statements should reveal provisions for environmental costs both in the income statement and in the balance sheet. Calculation of breakeven point, ecological Internal Rate of Return and Net Product Value should be included in the projected financial statements.

- The Security Exchange Commission can issue directives to the enterprises that securities cannot be publicly traded if the environmental auditing report does not satisfy minimum standards.

8. University Grants Commission

- The University Grant Commission can ask the universities, especially the business schools, to incorporate environmental courses so that the graduates will promote and implement EMA.
- Development of guidelines for business education courses including environmental accounting, environmental management accounting, environmental management etc.
- Accountants and environmental experts could pool their skills to form a multidisciplinary team to address environmental issues of significance to the organization and to recommend appropriate remedial actions.

9. External Environmental Auditors

- The government can make external environmental audit compulsory. The government must realize the bottlenecks of not conducting external environmental audits. This might decrease the flow fund coming through foreign direct investment.
- Impartial certification is expected from the external auditors. SEC can ensure legal certification. Recently SEC seized the auditing authority of some listed financial auditing firms due to not maintaining the code of ethics.
- Supply audit (Aziz, 2000) can be made mandatory for companies for the sake of their operational efficiency. The sources of materials and the supply path of the output must be ensured to facilitate smooth production and sales. Supply audit can help ensure the performance of materials and output flow (Whaley et al., 2001).
- Energy and waste audit should get priority before financial audit is completed. Use of electricity, gas and other energy in the industrial sector should have a unique defined standard. For example, because of non-availability of this type of standard MSA spinning Mills Ltd. had to bear a loss of 25 per cent on capital investment resulting from around 18 per cent wastage (MSA, 2002).
- Conducting a quality audit would result in promotion and implementation of EMA in the sense that the term quality includes environmental dimension. Any output of any organizations damaging the environment should not be thought of as a quality product.

Although the non-government organizations are not actually part of the government, the government has some influence on their programs and can to a degree promote EMA through non-government organization.

10. Management of the Enterprises

The corporate managers are responsible for setting and designing organizations' vision and mission. They can develop policy action in line with government mission of creating an environment-friendly society. For this pursuit, management can play the following roles for the promotion and implementation of EMA:

- Management may charge its divisions a fee based on the amount of wastage delivered to a waste landfill called internal waste tax. They also can provide incentives to the good performer who generates minimum wastage.
- Balance scorecard measures can be applied to ensure balanced improvement of the environmental performance.
- Apart from group rewards or penalties, individual incentives may be declared and given for environmental performance.
- Management may develop sustainable green management policies by dint of which operational level managers would take appropriate measures in promoting and implementing EMA.

11. Management Accountants

The cost and management accountants are the sole authority in the field of management accounting in Bangladesh. A significant proportion of these qualified accountants assume responsible chair and serve the government. Another significant proportion of these accountants practice management accounting as independent practitioners and others work in the industrial sector. The management accountants, qualified actors, play an important role in:

- Determining the need for a better and modified management information and financial system
- Isolating and computing individual environmental cost
- Resolving conflicts between environmental management and traditional environmental management
- Determining environmental cost and potential risk of investment that is environmentally hazardous
- Training line personnel in environmental accounting reports
- Assessing the potential cost of failing to undertake environmental activities

- Offering expertise in financial evaluation of environmental litigation and settlement options
- Disclosing environmental information (Gray et al., 2001, Tilt, 2001) including monetary information such as environmental costs, liabilities, provisions and contingencies, coupled with quantitative and descriptive information such as ecological data (for example, physical measurement of environmental impacts), environmental policies, targets and achievements
- Providing environmental reports and information as a means of ensuring accountability to the wider society of the organization's commitment to environmental consciousness (Wilmshurt et al., 2001).

12. Donor Agencies

The donor agencies can play an important role in promoting and implementing EMA. Developing countries like Bangladesh are dependent on foreign aids. About 70 per cent of the annual development budget was dependent on foreign aid (GOB, 2003). The foreign mission and the donor agencies usually give both projected and non-projected aids/loans. In this process, the donor agencies or the other development agencies can play the following roles in promoting and implementing EMA.

First, the donor agencies can impose some restrictions that environment-friendly developments would receive projected grants. So the government will never take any environmentally unhealthy projects.

Second, the donor agency can provide a guideline as to how environmental reporting, especially the accounting aspect, should be included in the report.

Finally, the donor agencies can make it compulsory to appoint a consultant with an EMA background in the development projects.

13. NGOs

Non-Governmental Organizations or NGOs can play a vital role in implementing MEA. NGO Affairs Bureau of Bangladesh controls the NGOs by issuing operational and commencement certificates. NGOs with an ill-designed program will not receive approval from the bureau. NGOs usually receive funds from various foreign missions and donor agencies. The donor agency usually provides projected fund. NGOs can thus channel the investment into environment-friendly activities. Almost 2000 NGOs are working in Bangladesh (GOB, 2002). A significant portion of these NGOs has environment-related programs. NGOs can mobilize and capitalize valuable opinion in promoting and implementing EMA in developing countries either by imposing restrictions or by mobilizing opinions for the friendly environment. Since the government to some extent depends on the NGOs, they possess some political importance and can play a vital role in promoting and implementing EMA.

7 IMPLICATIONS AND RECOMMENDATIONS

This paper on the role of government for the promotion and implementation of EMA will benefit a variety of parties including the government, citizens, industries, enterprises, professionals, and academicians etc. as stated below.

First, the government including its variety of organs can identify some new ideas in order to promote and implement EMA. As a pioneering work, this paper will help the various machineries of the government to think and promote EMA concepts, its socio-economic as well as globalised and international benefits. Accordingly the government can take all initiatives to be an environment-compliant developing country in the national and global arena. The Ministry and the Department of Environment might develop the notion of making the country green. Accordingly they can chalk out an environmental plan and programs to be carried out by the respective industry to be environmental compliant.

Second, the industries and individual enterprises can understand the need for EMA and can develop to implement EMA. They will be very careful in setting new firms and perhaps will never start enterprises without an environmental clearance certificate. They will realize the ongoing incremental effect of the net return on additional investment for environmental protection. They can realize the benefits of increase in funds, sustainable development, market acceptability, incremental shareholder value, increase in the market value of shares etc. emanating from the practice of EMA. They will be able to know about green accounts, environmental required rate of return, environmental efficiencies like eco-efficiencies, environmental IRR, environmental NPV etc. for their project evaluation.

Third, the academicians can use the paper as reference material. Besides they will be able to incorporate this EMA as a special topic or course in the universities. Calculation of ecological payback, IRR, NPV, eco-efficiency etc. can be included in the course curriculum of project management or management accounting. The researchers and professionals in this field can find new avenues to conduct further research facilitating the implementation of EMA in developing country in general and in Bangladesh in particular.

Fourth, the citizen of a developing country can also develop some notion as to how environment pollution is related to the management decision-making procedure. This will help develop public awareness in the field of environment management in a developing country like Bangladesh.

Fifth, the professionals, including the accountants, can develop a notion of promoting and implementing EMA. In the real sense, chartered accountants and the cost and management accountants working in private and public organization can start thinking of EMA. The professional accounting bodies can organize seminars, workshops and conferences on various EMA issues.

In view of the above, the government of developing countries like Bangladesh should develop well thought-out policies for the promotion and implementation of

EMA and should view EMA as the strategy for survival in 21st century. The government can develop a policy that will continuously identify, monitor and implement the EMA process, especially in the organizations connected with environmental aspects. The government should focus and highlight the potential financial and non-financial benefits that would result from the practice of EMA to the manufacturer. Since EMA is in its primitive stage in Bangladesh, the government should hold more seminars, workshops and conferences to promote EMA working environment. In a nutshell, in developing countries like Bangladesh it is the government that can influence organizations to think about the required environmental protection, the investment required, the apparent and foreseeable benefits, financial and non-financial benefits from green accounting practice.

EMA is industry and country specific. That is why the government should develop separate EMA guidelines for small and medium-sized industries. Full accountability of government officers is to be ensured for this purpose. This will help identify the dishonest government officers who sometimes issue false environmental clearance certificates. Incentive policy development will motivate organizations to implement EMA. The good governance of concerned authorities including the Ministry of Environment, the Security Exchange Commission, the Ministry of Commerce and Trade and The Ministry of Industry will best expedite the implementation of EMA. Governmental policies might not help promote and implement EMA as such but enforcement of these policies will ensure the promotion and implementation of EMA. Developing countries are always dependent on international agencies and organizations. Various donor and international agencies can come forward to put the government under pressure for the promotion and implementation of EMA.

For the purpose of promotion and implementation of EMA, the government can initiate some research as chalked out below:

- Research can be conducted to find out the potential benefits on the part of the enterprises if EMA is practiced, so that EMA promotion and implementation will be possible
- Research can be carried out to develop environmental performance assessment guidelines based on industry
- Research can be initiated to assess industry-wise investment for environmental protection in terms of percentage of total investment
- Since EMA is a relatively new concept, implementation of EMA is difficult in developing countries like Bangladesh. Research many be carried out to identify the problems that limit the implementation of EMA.

In a concluding remark it can be said that the government of developing countries including Bangladesh should take a variety of courses of action for the achievement of a single goal – promotion and implementation of EMA.

NOTES

1 The definition of environmental costs typically depends on approaches, information etc. The U.S. Environmental Protection Agency (EPA) is compiled an Environmental Cost Primer which has provided a framework for identifying environmental costs and has assembled them in broad categories. Conventional company costs include costs typically recognized in investment analysis and appraisal, such as capital equipment and raw materials. Potentially hidden costs: result from activities undertaken to comply with environmental law or go beyond compliance. Contingent costs are costs that may or may not be incurred in the future, such as the cost of remedying and compensating future accidental pollution. Image and relationship costs are costs incurred to affect the subjective perception of stakeholders, such as the costs of annual environmental reports. Involuntary failure costs, such as environmental fines, are paid for directly by corporations and are internalized. External environmental costs are cost associated with environmental damage; they include such potential liabilities as the risk of cleanup and damage to natural resources or damage to people and property.

2 Environment policy of 1992; Environmental Conservation Act 1995 (1st amendment 2000, 2nd amendment 2002); National Environmental Management Action Plan 1995; Environmental Conservation Rule 1997 (1st Amendment 2002); EIA Guideline For Industry 1997; Environment Court Act 2000 (1st amendment 2002).

3 The major polluting industrial sectors in Bangladesh includes textile mills, tanneries and leather processing industries, pharmaceutical industries, steel and iron industries, chemical industries, pulp and paper industries, sugar mills, distillery factories, fertilizer factories, cement factories, pesticide industries, rubber and plastic industries.

REFERENCES

Aleem, I. (1990), Imperfect Information Scanning and the Cost of Informal Lending: A Study of Rural Credit Market in Pakistan. *World Bank Economic Review*, 4 (3): 329-349.

Aziz A.M. (2000), Environmental Accounting and Auditing, The Cost and Management. *Journal of the ICMAB*, 4 (2): 18-25.

Bala, A.K. (2002), Corporate Reporting in Publicly Listed Company's in Bangladesh. *Journal of Business Studies*, 5 (2).

Belal, A.R. (1997), Green Reporting Practice in Bangladesh. *The Bangladesh Accountant*, (January-March): 107-115.

Bennett, M., Bouma, J.J. and Wolter, T. (2002), *Environment Management Accounting: Informal and Institutional Development*. Dordrecht: Kluwer Academic Publishers.

Bosch, J.C., Eckard, E.W. and Lee, I. (1998), EPA Enforcement, Firm Response Strategies, and Shareholder Wealth: An Empirical Explanation. *Managerial and Decision Economics*. 19: 167-177.

Burritt, R.L, Hahn, T. and Schaltegger, S. (2002), Towards a Comprehensive Framework for Environmental Management Accounting– Link Between Business Actors and EMA Tools. *Australian Accounting Review*, 12 (2): 39-50.

Chowdhury, M.J.A. and Ahmed, S.S. (2003), Theoretical Overview of Finance and Development in Developing Countries. *Journal of Business Studies*, XXIV (1): 24-30.

Deegan, C. and Gordon, B. (1996), A Study of the Environmental Disclosure Practices of Australian Corporations. *Accounting and Business Research*, 26(3): 187-199.

Dutch-Bangla Bank (2002), *Annual Report, Dutch-Bangla Bank Ltd*. Motijheel, Dhaka, Bangladesh.

Fekrat, M. A., Inclan, C. and Pertoni, D. (1996), Corporate Environmental Disclosures: Competitive Disclosure Hypothesis Using 1991 Annual Report Data. *The International Journal of Accounting*, 31(2): 175-195.

Financial Express (2003), *Environment Friendly Industry Can Save The Country From Natural Calamities*. Daily Financial Express, 27th April 2003.

Freedman, M. and Wasley, C. (1990), The Association Between Environmental Performance and Environmental Disclosure in Annual Reports and 10Ks. *Advances in Public Interest Accounting* 3: 183-193.

Gray, R.H. and Bebbington, K.J. (2001), *Accounting for Environment*, 2nd ed. London: Sage Publications.

GOB (2002) *Annual Report-2002*. NGO Bureau of the Government of People's Republic of Bangladesh.

GOB (2002), *Bangladesh Economic Survey, 2002*. Ministry of Finance, People's Republic of Bangladesh.

GOB (2003), *Bangladesh Annual Development Budget 2003*. Ministry of Finance, People's Republic of Bangladesh.

Hamilton, J. T. (1995), Pollution as News: Media and Stock market Reactions to Toxics Release, Inventory Data. *Journal of Environmental Economics and Management*, 28: 98-113.

Hart, S. (1997), Beyond Greening: Strategies for a Sustainable World. *Harvard Business Review*, January/February: 67-76.

Hines, R.D. (1988), Financial Accounting in Continuing Reality, We construct Reality. *Accounting Organizations and Society*, 13 (3): 251-261.

Mia, M.A.H. (2003), *Environmental Management Accounting and Profitability of the Textile Industries*. Unpublished Research Monograph. University of Dhaka, Bangladesh.

MSA SML (2002), *Annual Report, 2002*. Motijheel, Dhaka, Bangladesh: MSA Spinning Mills Ltd.

Mughalu, M.I., Robison, H.D. and Glascock, J.L. (1990), Hazardous Waste Lawsuits, Stockholder Returns, and Deterrence. *Southern Economical Journa*l, 57: 357-370.

Richardson J.A. and Welker, M. (2001) Social Disclosure, Financial Disclosure and the Cost of Capital. *Accounting, Organizations and Society*, 26 (7/8): 597-616.

Reazuddin, M. (2002), *Save the Earth*. Department of Environment, Bangladesh

Savage. D. (2000), *Policy Options: How Government Can Encourage Adoption of EMA by Industry*, Meeting Report (2000) of Expert Working Group Meeting On Improving Governments' Role in Promoting Environmental Management Accounting. Vienna, Austria, 15-16 May 2000.

Schaltegger, S., Hahn, T. and Burritt, R.L. (2002), Government Strategies to Promote Corporate Environmental Management Accounting. In: Bennett, M., Bouma, J.J. and Wolters, T. (eds.) *Environment Management Accounting: Informational and Institutional Developments*. Dordrehct: Kluwer Academic Publishers, pp.187-198.

Skipworth, P., Cashman, A., Engelhardt, M., Saul, A. and Savic D. (2001), *Quantification of Main Failure Behavior in a Whole Life Costing Approach, to Distribution System Management*, Paper presented at the World Water and Environmental Resources Conference, Orlando Florida, 2001.

Tilt, C.A. (2001), *Environmental Disclosure by Australian Companies: What is Happening outside of the Annual Report*, Proceeding of Asia Pacific Interdisciplinary Research in Accounting (APIRA) Conference 2001 July 15th –17th.

Welford, R. and Baraga, S. (1996), Corporate Strategy and Environment, In: R. Welford (ed), *Corporate Environment Management: Systems and Strategies*. London: Earthscan, pp. 13-32.

Whaley, D. and Johnson, J.K. (2001), Optimizing the Chemical Supply Chain: The trend Towards Chemical Supply Chain Management. *New England's Environment*, 7 (3): Spring. Available from http://www.environews.com/Features/chemical_supply_chain.htm

Wilmshurst, T. and Frost, G. (1998), Environmental Accounting – a Growing Concern? *Australian CPA May 1998*, pp. 20-23.

Wilmshurst, T. and G. Frost (2001), The Role of Accounting and Accountant in Environmental Management System. *Business Strategy and Environment*, 10: p. 135.

CHAPTER 16

ENVIRONMENTAL MANAGEMENT ACCOUNTING PRACTICES IN JAPAN

KATSUHIKO KOKUBU* AND ERIKO NASHIOKA‡

**Graduate School of Business Administration, Kobe University*
‡IGES Kansai Research Centre, Japan

kokubu@kobe-u.ac.jp, nashioka@iges.or.jp

Abstract. Environmental accounting practices in Japan have been led by two governmental initiatives. One is the MOE initiative which emphasized external disclosure. The other is the METI initiative which emphasized the applications of environmental accounting to internal management, namely Environmental Management Accounting (EMA). To characterize corporate environmental accounting practices in Japan, a questionnaire survey was administered to all companies listed in the first section of the Tokyo Stock Market. After a brief review of these governmental initiatives, this paper will examine the survey results. From the results it is found that environmental accounting is still oriented mainly toward external information disclosure, but that the application to internal management (EMA) has increased steadily. The survey results are also used to assess a set of hypotheses regarding factors and conditions important to promoting adoption and maximizing the benefits of EMA. Findings suggest that key factors include: a well-established environment department actively engaged in decision-making across the firm, understanding of environmental accounting concepts by top and middle management, and the use of specialized EMA tools.

P.M. Rikhardsson et al. (eds.), Implementing Environmental Management Accounting, 321-342

1 INTRODUCTION

In Japan two governmental environmental accounting initiatives have been the primary agents for promoting, disseminating and producing those practices for private sectors. One is the Ministry of the Environment (MOE) initiative and the other is the Ministry of Economy, Trade and Industry (METI) initiative. The MOE initiative emphasizes the application of environmental accounting to communication with external stakeholders, and the METI initiative emphasizes internal applications of environmental accounting, which is environmental management accounting (EMA). The MOE initiative precedes the METI initiative; MOE published an interim report in 1999 and environmental accounting guidelines in 2000, whereas METI published its environmental management accounting workbook in 2002. Therefore, external environmental accounting has been more diffused than EMA in this country (see, Kokubu et al., 2003)[1].

The MOE initiative undeniably influenced environmental accounting information disclosure in the form of corporate environmental reports. As Kokubu et al. (2003) showed, environmental accounting information disclosures in corporate environmental reports were heavily influenced in content and format by the MOE environmental accounting guidelines.

On the other hand, Kokubu et al. (2003) revealed that the use of environmental accounting for corporate management purposes in Japan is not so widespread. They argued that the development of EMA was critically important for corporate management. However, the survey of Kokubu et al. (2003) was conducted before the publication of the METI workbook. Before the publication, the environmental accounting knowledge of Japanese companies was restricted to the tools and methods discussed in the MOE guidelines; companies had little knowledge of the specialized EMA tools and methods[2].

The purpose of the paper is to re-examine the Japanese corporate practices of environmental accounting one year after releasing the METI workbook by a questionnaire survey and to analyse some factors to promote environmental management accounting practices. Before discussing the results of the survey we will briefly explain the two governmental initiatives on environmental accounting.

2 GOVERNMENTAL INITIATIVES ON ENVIRONMENTAL ACCOUNTING[3]

2.1 MOE Initiative

MOE started its first environmental accounting project in 1997. It formed an environmental accounting committee and in 1999 published an interim report (MOE, 1999). MOE revised the report and released the environmental accounting guidelines in 2000 (MOE, 2000). These guidelines are not mandatory. Their main purpose is to encourage Japanese companies to disclose environmental accounting information to the public via voluntary corporate environmental reports. While the guidelines refer to the managerial function of environmental accounting, they place much more emphasis on external reporting/disclosure. The MOE issued revised guidelines in March 2002. The revisions were not major, and were mainly concerned with improving classification and measurement of environmental benefits. In addition to the environmental accounting guidelines, MOE published voluntary environmental reporting guidelines in 2001 (MOE, 2001). The environmental reporting guidelines set out the information that should be disclosed in an environmental report; environmental accounting information is one disclosure category.

The core contents of the environmental accounting guidelines concern environmental costs and benefits. The environmental costs addressed by the guidelines are limited to environmental conservation costs and do not include either material costs or social costs. Specifically, the guidelines set out and address seven categories of environmental conservation costs:

1 Business area costs: environmental conservation cost for controlling the environmental impacts that are caused within a business area by production and service activities.
2 Upstream/downstream costs: environmental cost for controlling environmental impacts that are caused in the upstream or downstream as a result of production and service activities
3 Management activity costs: environmental cost in management activities
4 Research and development costs: environmental cost in research and development activities
5 Social activity costs: environmental cost in social activities
6 Environmental damage costs: environmental costs corresponding to environmental damages
7 Others

Regarding environmental conservation benefits, the guidelines classify these into four categories: (1) environmental conservation benefits concerning input resources, (2) environmental conservation benefits concerning environmental impacts and wastes from main business activities, (3) environmental conservation benefits concerning products and services of the company, and (4) other benefits. These environmental conservation benefits are, in principle, to be disclosed as a contrast to environmental costs.

The economic benefits specified by the guidelines are classified into "economic benefits calculated on a credible basis" and "economic benefits based on hypothetical calculation". The former includes some savings and revenues from environmental protection activities. The latter includes uncertain benefits such as risk avoidance benefits. The guidelines require the company to disclose only economic benefits calculated on a credible basis, but leave it open for companies, if they wish, to disclose the economic benefits based on hypothetical calculation without any additional guidance.

The guidelines provide three formats for an environmental accounting statement within a corporate environmental report as follows:

Format A: environmental cost only
Format B: environmental cost and environmental conservation benefits
Format C: environmental cost, environmental conservation benefits and economic benefits

Format C is the most comprehensive option, and is recommended if the company has the capacity to report at this level.

The MOE guidelines have strongly influenced the voluntary environmental reporting practices of Japanese companies. Kokubu and Nashioka (2001)[4] examined the disclosure of environmental accounting information by Japanese companies. They asked all 1,430 companies listed in the first section of the Tokyo Stock Exchange to provide a copy of any corporate environmental report. The study collected 257 reports (18%) published in 2000.[5]. The percentage of the companies publishing environmental reports was not so high. However, among these 257 companies, 184 companies (71%) disclosed environmental accounting information. Furthermore, the authors found that a majority of those companies disclosing environmental accounting information followed the MOE environmental accounting guidelines.

2.2 METI Initiative

METI formed an environmental accounting committee in 1999, the secretariat of which is the Japan Environmental Management Association for Industry (JEMAI). The committee conducted a three-year research project to develop EMA tools suited to Japanese companies. The project was completed in March 2002 and METI published the "Environmental management accounting workbook" in June as the final product of the committee. Whereas the MOE initiative places more importance on the external use of environmental accounting, the METI project focused exclusively on the internal management functions of environmental accounting within companies. After releasing the workbook, METI has continued its EMA work. A new committee on this issue is examining case studies and developing more simplified methods for small and medium enterprises.

The METI workbook is the first book on EMA in Japan. It consists of the following seven sections.

Section 1: A framework for environmental management accounting
Section 2: Environmental capital investment appraisal
Section 3: Environmental cost management
Section 4: Material flow cost accounting
Section 5: Lifecycle costing
Section 6: Environmental corporate performance evaluation
Section 7: For further development

The contents of the main sections of the workbook (Section 2 to 6) will be briefly explained.

Section 2 discusses environmental capital investment appraisal. This section introduces some conventional appraisal tools such as discounted cash flow methods and a payback method in this area, and then integrates economic information and environmental performance information that the investment is expected to achieve. The workbook proposes a new format for environmental investment appraisal including not only cash flow information but quantitative environmental information.

Section 3 is divided into two parts: environmental quality costing and environmental target costing. Regarding environmental quality costing, METI developed the "environmental cost matrix", a new format for capturing environmental quality costing information. The matrix is intended to organize the costs and benefits set out by the MOE environmental accounting guidelines in a clear way, as is expected to be particularly useful in budgeting. Environmental target costing is a method for adding some environmental elements to traditional target costing. This method supports corporate activities of design and development of environmental-conscious products in terms of product costs. The workbook proposed a framework for constructing the methods and provides a number of case studies including Sony, IBM and Canon.

Material flow cost accounting is the main theme of *Section 4*. Material flow cost accounting was originally developed in Germany (Strobel and Redmann, 2001), and the authors of the workbook introduced this tool into some Japanese companies (Kokubu and Nakajima, forthcoming). These pilot efforts were successful, and material flow cost accounting seems to have significant potential in the Japanese context. This section explains the theory of material flow cost accounting as well as the pilot assessments.

Section 5 discusses lifecycle costing. The main purpose of this section is to integrate cost accounting and LCA impact assessment. This section surveys practices for valuing external environmental costs and conducts a case study of lifecycle costing of refrigerators.

Section 6 discusses corporate practices introducing an environmental performance index such as CO_2 emission, quantity of wastes, green product rate and so on into their corporate or divisional performance evaluation system. Those indices are based on corporate environmental policy. This section consists of case studies, including Sony, Ricoh, Canon and Osaka Gas. Those companies have already introduced some environmental performance index into their corporate performance evaluation schemes.

After releasing the workbook, METI held EMA seminars in Tokyo and Osaka. While METI continues to develop new EMA tools, the ministry's focus is promoting diffusion of EMA concepts and practices. While the METI workbook is targeted at larger companies in the manufacturing sector rather than smaller companies, the diffusion of EMA for small and medium-sized companies is perceived as an next important issue of their projects.

3 SUMMARY OF PREVIOUS RESEARCH RESULTS

In 2001 Kokubu et al. (2003) conducted a survey of environmental accounting practices. They sent out questionnaires on environmental accounting to the 216 companies[5] that had disclosed environmental accounting information in their environmental reports and 159 valid responses were received. From this previous study, the following findings are relevant to this paper[6]:

1. Concerning the purpose of environmental accounting, 42.8 per cent of the responding companies considered external reporting the primary purpose of environmental accounting. Only 18.9 per cent saw internal management applications as more important. However, 35.8 per cent of companies emphasized both.
2. Concerning the benefits of environmental accounting, only 35.8 per cent of the companies answered that environmental accounting was useful for internal environmental management. This result suggested that, at the time, the perceived usefulness of environmental accounting for internal management was limited.
3. Concerning environmental accounting for internal use, 42.1 per cent of the companies used the same environmental accounting methods and metrics as they used for external disclosure purposes. 28.8 per cent used somewhat modified versions of these methods and metrics. Only 5.7 per cent of the companies employed some different environmental accounting methods and metrics for internal use than those they used for external environmental accounting.

Based on these results, Kokubu et al. (2003) concluded that Japanese corporate environmental accounting was oriented to external reporting, and that in substantial part this was due to the emphasis the MOE guidelines place on the external disclosure function of environmental accounting. In addition, they pointed out that Japanese companies did not receive significant benefits from the internal use of environmental accounting.

4 THE CURRENT STUDY AND RESULTS

4.1 Research purposes

However, this previous research was conducted before the publication of the METI workbook with its focus on the internal management applications of environmental accounting (EMA). Therefore, a new survey-based study was conducted after the release of the METI workbook to re-examine management practices of Japanese companies.

Specifically, the new study had two purposes:

1. To characterize the current environmental accounting practices of Japanese companies and the motivations and perceptions underlying current practices
2. To identify factors and conditions important to promote the adoption and maximize the benefits of EMA

Concerning the first purpose, the survey was structured to permit comparisons to the results of the previous research while at the same time eliciting more nuanced responses. A significant new focus of the survey questions was the extent to which EMA methods have diffused into Japanese companies. Regarding the second purpose, three hypotheses were proposed and evaluated in light of survey results.

The survey was conducted in April 2003, approximately one year after the publication of the METI workbook. A questionnaire was sent to the environmental departments of all listed companies (1,523 in total, manufacturing: 952; non-manufacturing: 571) in the first section of the Tokyo Stock Exchange. Valid responses were received from 324 companies (manufacturing: 258; non-manufacturing: 66), corresponding to a response rate of 21.3 per cent in total (manufacturing 39.6 per cent; non-manufacturing: 11.6 per cent). Among respondents, 187 companies (57.7%) were introducing environmental accounting either for external disclosure or internal management.

4.2 The purposes of environmental accounting

The purpose of environment accounting is of particular interest in the Japanese context because each of the two key governmental environmental accounting initiatives has emphasized a different application – external disclosure in the case of the MOE initiative and internal management in the case of the METI initiative.

The questionnaire provided the choice of four possible responses on this issue: (1) considerably more emphasis is placed on internal management than on external information disclosure; (2) slightly more emphasis is placed on internal management; (3) slightly more emphasis is placed on external information disclosure; (4)

considerably more emphasis is placed on external information disclosure than on internal management. The results are shown in Table 1.

Table 1. *What is the purpose of environmental accounting (singular answer)*

	No. of Companies	*%*
1. Considerably more emphasis is placed on internal management than on external information disclosure.	19	10.2%
2. Slightly more emphasis is placed on internal management than on external information disclosure.	53	28.5%
3. Slightly more emphasis is placed on external information disclosure than on internal management.	83	44.6%
4. Considerably more emphasis is placed on external information disclosure than on internal management.	31	16.7%
n=186		

Table 1 shows that 38.7 per cent of companies emphasized internal management (1 + 2) and 61.3 per cent emphasized external information disclosure (3 + 4). Since the previous survey by Kokubu et al. (2003) provided the option "emphasize both," a simple comparison to the results of the previous study is not possible (see, Table 6.10 in Kokubu et al., 2003). However, the majority of responding companies continue to emphasize external information disclosure purposes over internal management ones, and we therefore conclude that environmental accounting is still utilized primarily for external information disclosure rather than internal management in the Japanese context.

The next question solicited the perceived benefits that can result from the introduction of environmental accounting. The previous research revealed that environmental accounting was perceived to provide insufficient benefits for internal management. The results of this question were shown in Table 2.

	Very Beneficial		*Somewhat Beneficial*		*Not very Beneficial*		*Little Beneficial*	
	No. of companies	*%*	*No. of companies*	*%*	*No. of companies*	*%*	*No. of companies*	*%*
Useful for internal management	12	6.7%	102	56.7%	59	32.8%	7	3.9%
Improved understanding of the amount of the environmental costs	70	38.5%	105	57.7%	6	3.3%	1	0.5%
Improved understanding of the relationship between environmental costs and performance	31	17.1%	111	61.3%	30	16.6%	9	5.0%
Enhanced awareness of environmental issues within the company	18	9.9%	108	59.7%	47	26.0%	8	4.4%
Improved Awareness of environmental cost reduction within the company	15	8.3%	85	47.0%	73	40.3%	8	4.4%
Improvement of corporate image by information disclosure	32	18.3%	86	49.1%	45	25.7%	12	6.9%
Increasing of sales	0	0.0%	12	6.9%	78	45.1%	83	48.0%
Other	1	0.5%	4	2.1%	2	1.1%	1	0.5%
n=182								

Table 2. *How much benefits do you receive from environmental accounting (singular answer)*

From the results of Table 2, aggregating the responses of "very beneficial" and "somewhat beneficial", 63.4 per cent of companies indicated that the introduction of environmental accounting was beneficial for internal company management. In the previous study, only 35.8 per cent of respondents perceived EMA to be useful for internal environmental management (see Table 6.11 in Kokubu et al., 2003).[7]

However, the perceived benefits of environmental accounting to internal management are less widely held than the perceived benefits in other areas. The following percentages are combined "very beneficial" and "somewhat beneficial" responses in Table 2.

"Improved understanding of the amount of the environmental costs?"	96.2%
"Improved understanding of the relationship between environmental costs and performance?"	78.4%
"Enhanced awareness of environmental issues within the company"	69.6%
"Improvement of corporate image by information disclosure"	67.4%

Furthermore, if only the most stringent measure of perceived benefit is used (the "very beneficial" response), only 6.7 per cent of respondents perceived environmental accounting to be "very beneficial" for management. This is the lowest such response, save only for contribution to increasing sales for which the "very beneficial" response was nil. From these results, it appears that internal management is not the most widely perceived benefit of environmental accounting[8].

4.3 The Diffusion of EMA practice

A particular focus of our survey was to characterize the nature and extent of EMA adoption in Japanese companies. Towards this end, the survey first inquired about the type of the environmental accounting methods, if any, being used for internal management purposes. The results are shown in Table 3.

Table 3. *What type of environmental accounting do you employ for internal management? (singular answer)*

	No. of companies	*%*
Environmental accounting intended for external disclosure and do not use any other	79	42.7%
Environmental accounting intended for external disclosure and those specially designed for internal management	56	30.3%
Environmental accounting specially designed for internal management and do not use any other	18	9.7%
Do not use environmental accounting for internal management	28	15.1%
Other	4	2.2%
n=185		

Companies using environmental accounting oriented to external disclosure for internal management purpose and not using specially designed EMA were 42.7 per cent. On the other hand, 40 per cent of companies used either a combination of environmental accounting for external disclosure and those for internal management (30.3%) or environmental accounting specially designed for internal management only (9.7%). The previous study (see Table 6.12 in Kokubu et al., 2003) revealed that only 5.7 per cent of the companies employed different environmental accounting methods and metrics for internal management use than those they used for external environmental accounting. These results indicate that the use of specialized EMA tools and methods is becoming more widespread[9]. However, it is noteworthy that many companies still employ external environmental accounting tools and methods for internal management purposes.

This finding is of interest because, as Kokubu et al. (2003) argued, external environmental accounting practice in Japan has been strongly influenced by the MOE guidelines. Because the MOE guidelines restrict the definition of environmental cost to environmental conservation costs, applications of externally-oriented environmental accounting to internal management purposes will tend to have a similarly restricted definition of costs. Specialised EMA methods employ a much wider definition of environmental cost that better capture bottom-line impacts of environmental performance. EMA methods are thus likely to have more benefits for business decision-making. This issue is addressed at greater length below.

The awareness and utilization of specific EMA methods were then investigated. The following six methods were explained in the METI workbook and hence all of them were addressed by the survey.

1. Environmental capital investment appraisal
2. Environmental cost matrix
3. Environmental target costing
4. Material flow cost accounting
5. Environmental corporate performance evaluation
6. Lifecycle costing

The results are shown in Table 4.

Table 4. *How much are you aware of the following EMA tools? (singular answer)*

	Totally introduced		*Partially introduced*		*Know about it but has not introduced it*		*Don't know*	
	No. of companies	*%*	*No. of companies*	*%*	*No. of companies*	*%*	*No. of companies*	*%*
Environmental capital investment appraisal	3	1.6%	20	10.8%	91	49.2%	71	38.4%
Environmental cost matrix	1	0.5%	7	3.8%	87	46.8%	91	48.9%
Environmental target costing	3	1.6%	6	3.2%	78	42.2%	98	53.0%
Material flow cost accounting	0	0.0%	12	6.5%	136	73.5%	37	20.0%
Environmental corporate performance evaluation	9	4.9%	12	6.5%	100	54.3%	63	34.2%
Life-cycle costing	1	0.5%	19	10.3%	107	57.8%	58	31.4%

n=185

As shown in Table 4, there was low awareness of the environmental cost matrix and environmental target costing, with 48.9 per cent and 53.0 per cent of respondents respectively replying “don't know.” On the other hand, more than 60 per cent of respondents knew about environmental capital investment appraisal and environmental corporate performance evaluation. Of note is the level of awareness of material flow cost accounting where, despite the novelty of the methods, 80 per cent of respondents replied that they “know about it.” The high level of awareness was probably due to publications and seminars on the topic[10].

The percentage of companies that introduced these EMA methods was relatively low. However, less than a year had elapsed since these methods were properly explained in the Japanese context, the figures indicate substantial effort focused on EMA implementation and adoption.

5 FACTORS FACILITATING THE ADOPTION AND ENHANCING THE EFFECTIVENESS OF EMA

5.1 Hypotheses

Experience has shown that EMA practices are complex to implement because they necessarily involve a set of departments within a firm – not only the environmental department. Therefore, organizational structure and circumstances are acknowledged as critically important factors mediating EMA adoption by the company and the benefits EMA is perceived to deliver once it is adopted. However, the factors facilitating or leading to the adoption of EMA and maximizing its effectiveness have not been studied so far particularly in the Japanese context. In order to examine them the following three hypotheses were constructed.

Hypothesis 1: Well-established environment departments with significant, active engagement in decision-making across departments are most likely to facilitate EMA adoption and maximize the benefits of environmental accounting to internal management functions.

Hypothesis 2: Where top and middle managements are strongly interested in environmental accounting, environmental accounting will provide more benefits to internal management functions.

Hypothesis 3: Where environmental accounting methods specially designed for internal management are employed, environmental accounting will provide more benefits to internal management functions.

The rationale behind Hypothesis 1 is as follows: EMA is a new, cross-functional business tool. Adoption of EMA is thus greatly facilitated by (1) a source of environmental accounting capability and knowledge within the company; and (2) the ability of that source to coordinate effectively with other departments and to secure the time and resources from those departments required for EMA implementation. A well-established environment department is the most logical source of such capability, due to experience with environmental accounting in the production of environmental reports and knowledge of environmental issues generally.

The rationale behind Hypothesis 2 is as follows: EMA is a cross-departmental activity, and cooperation from all departments is essential. Those activities may, therefore, affect manufacturing process, plant and equipment investment and product design. Thus, implementing EMA and deriving benefits from it will be very difficult without top management awareness and buy-in; indeed deriving any management advantage from any management information system requires that management understand the metrics and utilize the information it provides.

The rationale behind Hypothesis 3 is as follows: Even if the environmental department has sufficient capability and cross-functional participation in the firm, and even if top management fully understand the possibility of environmental accounting, environmental accounting tools that are not properly constructed for decision-making purposes and goals cannot yield good results. This is a principle that applies not just to environmental accounting, but to all management information systems. (For instance, environmental accounting based on the MOE guidelines does not consider a set of cost categories critical to management decision-making.) Therefore, environmental accounting specially designed for internal use should provide superior benefits to internal management functions.

5.2 The capability of the environmental department and the usefulness of environmental accounting for internal management

The capability of the environmental department was assessed via two proxies: (1) age of the department; and (2) reported participation of the environment department in decision-making outside the department. The first examination is somewhat indirect, but the second one is based on a more direct question of the survey. The results of each approach are discussed.

First we assumed that the older the department, the more capability it has. While this assumption may not always true, well-established departments have, in general, some history in the firm. Thus, in the questionnaire we asked the year in which the environmental department was established. Then the companies were divided into two groups: companies with environment departments formed before 1994, and companies with environment departments formed during or after 1995. The year was selected because it is one year before 1996 in which ISO 14001 was published. The number and rate of the companies introducing environmental accounting in both groups are shown in Table 5 and the results were examined by Chi-square analysis.

Table 5. *The year in which the company formed the environmental department and the introduction of environmental accounting*

	Environmental accounting has been introduced	*Environmental accounting has not been introduced*
Environmental department formed before 1994	99 (80.5%)	24 (19.5%)
Environmental department formed after 1995	71 (52.2%)	65 (47.8%)

n=259, $\chi2$=22.9, p=0.000

As shown in Table 5, 80.5 per cent of companies which had formed an environmental department before 1994 have introduced environmental accounting. This rate was considerably greater than the rate of 52.2 per cent for companies which had formed their environmental department after 1995. This difference was statistically significant at the 1 per cent level. If older departments have more capability than newer ones, these results support hypothesis 1.

Secondly, reported participation of the environment department in decision-making outside the department was used as a proxy for capability. Again, we divided respondent companies into two groups. The first is the group in which the environmental department concentrates on monitoring other departments to follow environmental legal regulations and corporate action plans. The second is the group in which the environmental department participates in the decision-making for the other departments. Decision-making in this question includes any involvements in the following corporate activities: procurement, design and development of products, improvements of manufacturing process, investments for facilities, sales and marketing, research and development, finance and investments, and corporate strategy.

Then we scored each group according to perceived benefits of environmental accounting for internal management (See first line of Table 2). Responses of "very beneficial" added 4 points to the group score, "somewhat beneficial" 3 points, "not very beneficial" 2 points, and "little beneficial" 1 point. The mean was then calculated for each group as an index of the perceived effectiveness of environmental accounting for internal use. The results are shown in Table 6.

Table 6. *The range of the environmental department authority and the usefulness of environmental accounting for internal management*

	Environmental department only monitoring other departments	*Environmental department participating in the decision-making of other departments*
Usefulness of environmental accounting for internal management	2.53 (n=103)	2.81 (n=63)

n=166, t=2.65, p=0.009 (two-tailed test)

As shown in Table 6, the usefulness of environmental accounting for internal management in the companies where the environmental department participated in decision-making in other departments was significantly greater, at the 1 percent level. These results strongly support hypothesis 1.

5.3 The awareness of environmental accounting among top and middle management and the usefulness of environmental accounting for internal management

To address hypothesis 2, responding companies were divided into two groups. The first is the group of companies whose respondents indicated that the top management was interested in environmental accounting (a category that included the responses of "very interested" or "somewhat interested"). The second is the group of companies whose respondents indicated that the top management were not interested (a category that included the responses of "not very interested" or "little interested"). Each group was then scored as per the procedure that produced Table 6, above. The result was an index for each group measuring "the perceived effectiveness of environmental accounting for internal management". The results are shown in Table 7. This procedure was repeated to measure awareness among middle management in departments other than the environmental department. The results are shown in Table 8.

Table 7. *The awareness of top management and the usefulness of environmental accounting for internal management*

	Top management are interested in environmental accounting	*Top management are not interested in environmental accounting*
Usefulness of Environmental accounting for internal management	2.73 (n=163)	1.94 (n=17)

n=180, t=5.02, p=0.000 (two-tailed test)

Table 8. *The awareness of middle management in other departments and the usefulness of environmental accounting for internal management*

	Middle management of other departments are interested in environmental accounting.	*Middle management of other departments are not interested in environmental accounting.*
Usefulness of environmental accounting for internal management	2.83 (n=109)	2.39 (n=71)

n=180, t=4.60, p=0.000 (two-tailed test)

Tables 7 and 8 show that, as a group, companies characterized by management interest in environmental accounting perceived greater benefit in internal management. These results are significant at the 1 percent level for both top management and middle management. These results support the hypothesis that awareness of environmental accounting among top and middle management is a factor for deriving benefit from environmental accounting for internal management functions. In addition, it should be noted that there is a very high proportion of top management who are reported as being interested (over 90%) compared with the results of middle management of other departments. These results are correspondent to the findings of the previous study that the introduction of environmental accounting was often proposed by senior managements (see Table 6.4 in Kokubu et al., 2003).

5.4 Use of specialized EMA tools and the effectiveness of environmental accounting for internal management

Hypothesis 3 asserts that the use of specialized EMA tools will enhance the benefits of environmental accounting applications for internal management. In order to examine this hypothesis, the responding companies that reported using environmental accounting for internal management purposes were divided into two groups. The first group consisted of companies utilizing only environmental accounting tools and methods developed for/oriented to external disclosure. The second group was those reporting the use of at least some specialized EMA tools and methods (see Table 3 and associated discussion). Each group was then scored as per the procedure that produced Table 6 above. The result was an index for each group measuring "the perceived effectiveness of environmental accounting for internal management". The results are shown in Table 9.

Table 9. *The type of environmental accounting and that usefulness for internal management*

	Using only external environmental accounting	*Using environmental management accounting*
Usefulness of environmental accounting for internal management	2.58 (n=76)	3.00 (n=72)

n=148, t=4.44, p=0.000 (two-tailed test)

Table 9 shows that, as a group, companies using specialized EMA tools perceived greater benefits in internal management than did companies using externally-oriented environmental accounting tools. This result is significant at the 1 percent level. This suggests that specialized EMA tools and methods are important in deriving maximum benefits to internal management.

As noted previously, one of the major differences between external environmental accounting as embodied in the MOE guidelines and EMA as embodied in the METI workbook is the range of environmental costs considered. The MOE guidelines, which strongly influence external environmental accounting practices, only address environmental conservation costs. These costs make up a few percent at most of a company's total costs. In this sense, environmental accounting implementations based on the guidelines may have serious limitations for internal management. For this reason, the range of environmental costs covered by environmental accounting practices within respondent companies was also investigated in the questionnaire survey. Table 10 showed the results.

Table 10. *Environmental costs covered by environmental accounting*

		No. of companies	*%*
1	End-of-pipe environmental conservation cost	183	98.4%
2	Resource recycling cost	180	96.8%
3	Global environmental conservation cost	181	97.3%
4	Upstream and downstream costs shown in the MOE guidelines	163	87.6%
5	Management activity cost shown in the MOE guidelines	173	93.0%
6	R&D cost shown in the MOE guidelines	163	87.6%
7	Social activity cost shown in the MOE guidelines	168	90.3%
8	Environmental damage cost shown in the MOE guidelines	158	84.9%
9	material cost	40	21.5%
10	Energy cost	82	44.1%
11	Overhead cost (waste cost including labour cost and depreciation cost, etc.)	68	36.6%
12	Life-cycle cost after sales of products	37	19.9%
13	Social cost as environmental impact	35	18.8%
14	Other	3	1.6%

n=186

Among the various costs items in Table 10, Nos. 1-8 were included in the MOE guidelines. More than 80 percent of companies include these costs in their environmental accounting implementations[11]. This illustrates the significant influence of the

MOE Guidelines. On the other hand, for costs listed from number 9 and onward, less than half of the companies understood and measured them as environmental costs.

Material costs are particularly important in the domain of EMA. They are both a significant production input cost, and a significant source of the lifecycle environmental impacts of a product or process: materials must be extracted, processed, and transported to the production process. Materials not directly incorporated in the product must be disposed or discharged as waste. For instance, material flow cost accounting, which is a major EMA tool, mainly deals with raw material costs (see, Strobel and Redmann, 2001 and Kokubu and Nakajima forthcoming).

To examine the perceived benefits that companies derive from considering a broader set of costs in their applications of environmental accounting including material costs, respondent companies were again divided into two groups. The first is the group of companies considering only the costs stipulated by the MOE guidelines (Nos. 1-8 in Table 10) in their applications of environmental accounting. The second is the group of companies measuring not only the cost items Nos.1-8 but also other costs including material costs (No. 9). Each group was then scored as per the procedure that produced Table 6 above. The result was an index for each group measuring "the perceived effectiveness of environmental accounting for internal management". The results are shown in Table 11.

***Table 11**. The coverage of environmental costs and the usefulness of environmental accounting for internal management*

	Coverage of environmental costs for environmental accounting	
	Environmental costs Nos. 1-8	*Environmental costs Nos.1-8 + No. 9 + α*
Usefulness of environmental accounting for internal management	2.44 (n=57)	2.9 0(n=39)

n=96, t=3.17, p=0.002 (two-tailed test)
α means any or all or none of items of nos. 10-14.

Table 11 illustrates that the perceived benefits of environmental accounting for internal management was higher for the group of companies measuring a wider range of environmental costs (including material costs) than for the group of companies whose range of costs followed the MOE guidelines. This result is significant at the 1 per cent level. Because the former group is considered to be employing somehow specialized EMA methods, these results also support hypothesis 3.

6 CONCLUSIONS AND LIMITATIONS

From the results of this study, it is clear that EMA is becoming more widespread in Japanese companies, although overall adoption is still relatively low. The application of environmental accounting remains oriented mainly toward external information disclosure, and the practice continues to be strongly influenced by the externally-oriented MOE guidelines. However, the use of environmental accounting for internal management has increased steadily since the previous survey. The increase is probably due to the publication in 2002 of "Environment Management Accounting Workbook" from METI and to various seminars held on the subject. It is particularly noteworthy that even though not much time has passed since its publication, a number of companies have already attempted to introduce EMA methods explained in the METI workbook.

Even more importantly, our research demonstrates that the introduction and employment of specialized EMA tools and methods yields higher perceived benefits for internal management than the use of environmental accounting tools and methods developed primarily for external disclosure. The study also demonstrates that perceived benefits of EMA are higher when top and middle management understand the concepts; we argue that this follows from EMA's characteristics as a cross-departmental activity. Finally, significant, active engagement of the environment department in decision-making across departments, and the capacity of the environment department, are both associated with higher rates of deployment of environmental accounting and a higher level of perceived benefits vis-à-vis internal management functions.

The above findings are subject to the limitations of the survey instrument and the analysis. Only the mean scores were examined without considering other parameters that should be controlled. More accurate examinations would be achieved by controlling other parameters by employing, for instance, a more sophisticated statistical analysis such as multiple regression analysis. In addition, the proxy of benefits of environmental accounting for internal management was based on the answers to the questionnaire and are quite subjective. However, it is very difficult to get any more objective proxy because EMA is essentially internal corporate activities and no available statistical data. These limitations should be challenged by more qualitative research such as case studies based on interviewing.

However, the results of this study do constitute a step forward in the understanding of the state of environmental accounting practice in Japan, and suggest areas of focus for those seeking to promote environmental accounting, particularly EMA, as an important tool for greening decision-making in the private sector.

NOTES

1 In this paper, external environmental accounting is defined as environmental accounting whose main purpose is to disclose information to the public. Internal management accounting is synonymous with environmental management accounting, whose main purpose is to support internal corporate management. Environmental accounting includes both types (external and internal) of environmental accounting.
2 Before the publication of the METI workbook, a couple of books on EMA (Bennett and James, 1998; Bartolomeo et al., 1999) in English were translated into Japanese. However, governmental initiatives are much more influential especially for the industrial sector.
3 For more details about this section, see Kokubu et al., 2003 and Kokubu and Kurasaka, 2002.
4 The results of Kokubu and Nashioka (2001) was referred in Kokubu et al. (2003).
5 The percentage (18%) is not a response rate, but the percentage of companies sending environmental reports to the authors. While most companies publishing environmental reports are considered to send the reports on request, there are some possibilities that some companies publishing environmental reports ignored their requests.
6 Besides 184 companies which had been identified by Kokubu and Nashioka (2001), they found as additional 32 companies in the first section of the Tokyo Stock Exchange Market disclosing such information, as at September 2001.
7 These results were shown in Table 6.10, 6.11 and 6.12 in Kokubu et al. (2003).
8 Note that the previous survey put the question in the form "was it beneficial or not?", which is different from the four options for response provided by the current survey.
9 In this analysis, the understanding of the amount of environmental costs and their relationship with performance are distinguished from the benefits for internal management. This is because these benefits can be received from introducing environmental accounting based on the MOE guidelines oriented for external disclosure.
10 Again, note that exact comparisons between the survey results are not possible due to differences in the survey questions.
11 A book on material flow cost accounting was published in August 2002 (Nakajima and Kokubu, 2002) and not a few papers were published in either academic or professional journals. In addition, an international symposium on material flow cost accounting was organised by IGES in January 2003, about 200 participants attending.
12 The cost items (nos.1-3) are included in "Business area cost" in the MOE guidelines.

ACKNOWLEDGEMENT

The authors are very grateful for helpful comments and kind support from Prof. A. Amano, Dr. M. Stoughton, K. Saio and M. Murei at IGES Kansai Research Centre. Their thanks also go to two anonymous reviewers.

REFERENCES

Bartolomeo, M., Bennett, M., Bouma, J.J., Heydkamp, P., James, P., de Walle, F. and Wolters, T. (1999), *Eco-Management Accounting*. Dordrecht: Kluwer Academic Publishers.

Bennett, M and James, P (1998), *The Green Bottom Line*. Sheffield, Greenleaf Publishing

Kokubu, K. and Kurasaka, T. (2002), Corporate Environmental Accounting: A Japanese Perspective. In: Bennett, M, Bouma, J.J. and Wolters, T. (eds.) *Environmental Management Accounting: Informational and Institutional Developments*. Dordrecht: Kluwer Academic Publishers, pp. 161-173.

Kokubu, K. and Nakajima, M. (forthcoming), Sustainable Accounting Initiatives in Japan: Pilot Projects of Material Flow Cost Accounting. In: Seiler-Hausmann, J.-D., Liedtke, C. and von Weizsaker, E.U. (eds.) *Eco-efficiency and Beyond: Towards the Sustainable Enterprise*. Sheffield: Greenleaf Publishing Ltd.

Kokubu, K. and Nashioka, E. (2001), *Environmental Accounting Practices of Listed Companies in Japan*. IGES Kansai Research Centre Discussion Paper No.1-2001.

Kokubu, K., Nashioka, E., Saio, K. and Imai, S. (2003), Two Governmental Initiatives on Environmental Management Accounting and Corporate Practices in Japan. In: Bennett, M., Rikhardsson, P. and Schaltegger, S. (eds.) *Environmental Management Accounting: Purpose and Progress*. Dordrecht: Kluwer Academic Publishers, pp. 89-114.

METI (2002), *Environmental Management Accounting Workbook*. Tokyo: Ministry of Economy, Trade and Industry (available only in Japanese) (http://www.meti.go.jp/policy/ eco_business/index.html).

MOE (1999), *Grasping Environmental Cost: Draft Guidelines for Evaluating Environmental Cost and Publicly Disclosing Environmental Accounting Information* (Interim Report. Tokyo: The Ministry of the Environment.

MOE (2000), *Developing an Environmental Accounting System*. Tokyo: The Ministry of the Environment.

MOE (2001), *Environmental Reporting Guidelines*. Tokyo: The Ministry of the Environment.

MOE (2002), Environmental Accounting Guidelines 2002 Version. Tokyo: The Ministry of the Environment_(http://www.env.go.jp/en/ssee/eag02.pdf).

Nakajima, M. and Kokubu, K. (2002), *Material Flow Cost Accounting*. Tokyo: Nihon-Keizai Shinbunsha (available only in Japanese).

Strobel, M. and Redmann, C. (2001), *Flow Cost Accounting*. Augsburg Institute fur Management und Umwelt.

CHAPTER 17

ENVIRONMENTAL MANAGEMENT ACCOUNTING PILOT PROJECTS IN COSTA RICA

CHRISTINE JASCH* AND MYRTILLE DANSE^

**Institute for Environmental Management and Accounting, Austria,^CEGESTI, Costa Rica*

jasch.christine@ioew.at; myrdanse@racsa.co.cr

Abstract. In November 2002 a "train the trainer" program on environmental management accounting was performed in Costa Rica, following the approach developed for the United Nations Division for Sustainable Development, Working Group on Environmental Management Accounting. This programme included a public lecture and five case studies. This article describes the project organisation and applied methodology, and compares the obtained results to similar case studies in Austria.

1 INTRODUCTION

In September 2001 the Costa Rican non-governmental organisation CEGESTI initiated a project called "Increased accessibility for Small and Medium-Sized Enterprises in Central America for the implementation and maintenance of Management Systems based on the ISO 9000 and 14001 Standards". This project was financed by CEGESTI and the Dutch Development Cooperation organization ICCO. The objective of this project was to improve the access for Small and Medium Sized Enterprises (SME) to technical assistance during the implementation process of environmental and quality management systems based on the ISO standards. The target group is SMEs confronted with the impacts of globalization, such as co-operatives,

P.M. Rikhardsson et al. (eds.), Implementing Environmental Management Accounting, 343-364

small enterprises situated in rural areas or other basic structured organizations that have limited access to services that would really satisfy their needs and improve their opportunities to survive. In order to be able to maintain their competitive position, they require appropriate technical assistance to support them to increase their managerial capacity and their possibility to continuously adapt to a changing environment.

The primary aim of environmental management accounting (EMA) is to better inform and support decision-making processes that are influenced by environmental factors. Within the context of this project, the need was identified to create tools that help SME managers to define the actual environmental costs caused by their production processes, since this would help to convince them of the importance of investing in environmental management activities and cleaner technologies. Translating environmental issues into financial terms is a vital element in motivating business to take action, especially in developing countries. And even in organizations in which it would not be possible to quantify the financial benefits of environmental action, it is at least important to recognize the risks of not taking action. Environmental-related management accounting was therefore considered to be an essential tool for sustainable business development in Costa Rica.

Within this context, it is important to mention that the need to create and offer tools for EMA to Costa Rican SMEs has always existed but has grown in importance due to the increasing body of environmental legislation, efforts local government has made to reach legal compliance, and, last but not least, the economic crisis that affects the region. The economic activities in the Central American region are mostly related to agricultural and service activities. These sectors are affected by the growth in supply of agricultural products at a global level, which has caused a reduction in world market prices. A better insight ino the costs related to activities becomes more and more important in order to be able to identify opportunities to decrease them. EMA helps decision makers identify not only the basic costs of their activities but also the environmental costs and potentials for improved material efficiency.

The objectives of the project in Costa Rica were thus to

- understand and learn the methodology of EMA through real life application;
- access the applicability of the tool in the Costa Rican context in general and Small and Medium-Sized Enterprises specifically.
- define required adjustments for its implementation to be able to use the method in a Latin American context.
- determine an accounting tool that can complement and support the adequate implementation of Environmental Management Systems (e.g. those based on ISO 14001).

2 ENVIRONMENTAL MANAGEMENT ACCOUNTING BASICS

The main challenge of environmental management accounting is the lack of a standard definition of environmental costs. Depending on what one is interested in, these may include a variety of costs, e.g. disposal costs or investment costs and, sometimes, also external costs (i.e. costs incurred by parties outside the company, mostly to the general public). Of course, this is also true for profits of corporate environmental activities (environmental cost savings). In addition, most of these costs are usually not traced systematically and attributed to the responsible processes and products, but simply summed up in general overhead.

The fact that environmental costs are not fully recorded often leads to distorted calculations for improvement options. Environmental protection projects, aiming to prevent emissions and waste at the source (avoidance option) by better utilizing raw and auxiliary materials and requiring less (harmful) operating materials are not recognized and implemented. The economic and ecological advantages to be derived from such measures are not realized. The people in charge are often not aware that producing waste and emissions is usually more expensive than disposing them.

Experience shows that the environmental manager barely has access to the actual cost accounting documents of the company and only is aware of a tiny fraction of aggregate environmental costs. On the other hand, the controller does have most of the information but is unable to separate the environmental part without further guidance. In addition, he or she is limited to thinking within the framework of existing accounts. Also, the two departments tend to have a severe language problem.

In conventional cost accounting, the aggregation of environmental and non-environmental costs in overhead accounts results in their being "hidden" from management. There is substantial evidence that management tends to underestimate the extent and growth of such costs.

The UN Division for Sustainable Development has set up an EMA working group. For this group, a book on procedures and metrics for EMA (Jasch, 2000) was written, which was commissioned by the Austrian ministry of transport, innovation and technology (BM VIT), the Austrian ministry of agriculture, forestry, environmental and water management (BM LFUW) and the Austrian chamber of commerce (BWK). The objective of this book was to define principles and procedures for Environmental Management Accounting (EMA) with a focus on techniques for quantifying environmental expenditures or costs as a basis for the development of national EMA guidelines and frameworks. The intended users of these EMA metrics are national governments interested in establishing national EMA guidelines appropriate to their own countries' context and organisations seeking to install EMA systems for better controlling and benchmarking purposes.

The determination of total annual environmental expenditure for the last business year is a prerequisite for calculating improvement options. If the total annual environmental costs have not been assessed, the savings potential cannot be calculated. After the determination of the total annual environmental costs, the calculation can be done for specific cost centres or production processes.

The above-mentioned book defines the following environmental cost categories, which are hardly ever systematically assessed. The environmental cost categories follow the historic development of awareness for environmental cost categories and require clearly different improvement actions.

The first block of environmental cost categories comprises conventional waste disposal and emission treatment costs including related labour and maintenance materials. Insurance and provisions for environmental liabilities also reflect the spirit of treatment instead of prevention. The first section corresponds to the conventional definition of environmental costs comprising all treatment, disposal and clean-up costs of existing waste and emissions.

The second block is termed prevention and environmental management and adds the labour costs and external services for good housekeeping as well as the "environmental" share and extra costs of integrated technologies and green purchase, if significant. The main focus of the second block is on annual costs for prevention of waste and emissions, but without calculated cost savings. They include higher pro-rata costs for environment-friendly auxiliary and operating materials, low-emission process technologies and the development of environmentally benign products, if significant.

Conventionally, three production factors are distinguished: materials, capital (investments, related annual depreciation and financing cost) and labour. The next two blocks consider the costs of wasted material, capital and labour due to inefficient production, generating waste and emissions.

In the third block, the wasted material purchase value is added. All non-product output is assessed by a material flow balance. Wasted materials are evaluated with their material purchase value or materials consumed value in case of stock management.

Lastly, the production costs of non-product output are added with the respective production cost charges, which include labour hours, depreciation of machinery and operating materials. In activity-based costing and flow cost accounting the flows of residual materials are more precisely determined and allocated to cost centres and cost carriers.

Environmental revenues derived from sales of waste or grants of subsidies are accounted for in a separate block.

Costs that are incurred outside the company and borne by the general public (external costs) or that are relevant to suppliers and consumers (life cycle costs) are not dealt with.

Figure 1 shows the total annual environmental costs assessment scheme developed for UN DSD.

	Air and climate	Waste Water	Waste	Soil and ground water	Noise + vibrations	Biodiversity + landscape	Radiation	other	Total
1. Waste and Emission treatment□									
1.1. Depreciation for related equipment									
1.2. Maintenance and operating materials and services									
1.3. Related Personnel									
1.4. Fees, Taxes, Charges									
1.5. Fines and penalties									
1.6. Insurance for environmental liabilities									
1.7. Provisions for clean up costs, remediation									
2. Prevention and environmental management									
2.1. External services for environmental management									
2.2. Personnel for general environmental management activities									
2.3. Research and Development									
2.4. Extra expenditure for cleaner technologies									
2.5. Other environmental management costs									
3. Material Purchase Value of non-product output									
3.1. Raw materials									
3.2. Packaging									
3.3. Auxiliary materials									
3.4. Operating materials									
3.5. Energy									
3.6. Water									
4. Processing Costs of non-product output □									
∑ Environmental Expenditure									
5. Environmental Revenues □									
5.1. Subsidies, Awards									
5.2. Other earnings									
∑ Environmental Revenues									

Figure 1. *Total annual environmental costs*

During the Austrian pilot projects (Jasch and Schnitzer, 2002), the environmental cost assessment scheme (Figure 1) was adapted to an Excel file that is available for download at www.ioew.at. The Excel file consists of three sheets – Detail, Sum, and Structure. Information is only inserted into the Detail sheet. All the cost categories are already set. The environmental media can be modified if necessary. The column Account is to keep the same cost centres and accounts for the years to come without having to spend a lot of time finding them again. It is also practical to document the type of calculation used to acquire a certain figure. It is possible to add lines into the sheet. The sum of the costs of all categories in the sheet Detail is transferred to the sheet Sum for overview purposes and a better presentation layout. The sheet Structure merely calculates the costs in percentages to show the most relevant environmental costs.

3 PROJECT ORGANISATION

The assessment of environmental costs under the guidance of an Austrian expert took place at Costa Rican companies during the period November 8-22, 2002. The first part of the "train the trainers" seminars consisted of a half-day lecture on EMA and the UN DSD methodology. This lecture was aimed at the common public, and was followed up by another half day used for a preparatory workshop in which just staff from the five SMEs participated. These SMEs were selected as the pilot group to train CEGESTI consultants on applying the UN DSD methodology in a Costa Rican business context. The training was followed by a one-day site visit to each of the selected companies. Through the period, the expert and involved CEGESTI consultants got together several times to share doubts, analyse the results thoroughly, and share the lessons learned.

Though the initial plan was to organise two workshops just focused on small groups of SMEs, after which some of them would be visited afterwards, it was decided to change this method in order to invite a bigger audience to an open lecture, consequently sharing the methodology with more people. Besides, this increased the available time that could be used for the company visits and analyses, which was necessary, since the visits had to be confidential which limited the number of people that could participate in each visit. In total 61 people participated in the general lecture, of which eight were CEGESTI consultants and 53 external participants.

During the general lecture the following issues were discussed:

- What are environmental costs of production and how can they be reduced?
- Environmental costs in normal accounting practices
- Definition of environmental costs and cost categories
- How to determine and calculate environmental costs
- Assessing prevention and cost reduction potentials

- Checklists for site assessments
- Linking mass balances to financial accounts and cost calculation
- Defining environmental performance indicators

After the lecture, the participants were supposed to be able to identify in a practical way the costs and benefits of the environmental management practices used in a company. They learned the basics of linking accounting and cost calculation to material flow analysis, mass balancing, using checklists and other assessment tools, which help define environmental costs and saving potentials.

The workshop took place in English, but simultaneously translated into Spanish to avoid language being a restraint for interested parties to participate.

The four-hour workshop in the afternoon was only open for the five companies selected for the site visits and the CEGESTI consultants to be trained. The selection criteria for the companies was based on the level of awareness of environmental management issues, size and availability of an environmental management system. This means that all the companies should have a reasonable level of interest in environmental management issues and have implemented a number of related improvements. Additionally, the pilot group had to be diverse, so the tool would be applied in different business environments. For this reason two small, two medium-sized and one big company were selected. Three of these companies already employed environmental management systems based on ISO 14001, two a quality management system based on ISO 9002: 1994, and one had just started identifying its environmental management strategy.

The workshop was participatory and was meant to make the participants understand through practical application the theory explained in the morning. Furthermore the companies were instructed which data had to be available during the visit. A practical exercise was done using the Excel sheet format designed in the Austrian case studies to facilitate the data collection process. After the workshop the companies completed this sheet, which was part of their preparation for the site visit.

The agenda of the workshop with the five pilot companies covered the following issues:

- Explanation of how to proceed by practical examples
- Mass balancing methodology and implementation (the companies were requested to bring their own accounts and calculations)
- Integration into data assessment and accounting routine

After the workshop the expert and three CEGESTI consultants visited the five selected SMEs during a period of six days. The companies selected were: ETIPRES, a company producing stickers, RESINTECH, a producer of plastic pallets, Coopro-Naranjo, a coffee co-operative, PIPASA, a chicken products company and ROMA

PRINCE, a pasta producing company. The objective of the visits was two-fold. First, to analyse the cost accounting system available, and to apply the US DSD methodology to the companies' situation. Second, to give in-company training to the environmental manager, the controlling department and the involved CEGESTI consultants, by applying the tool in practice and analysing the results obtained with the participants.

In each company the environmental costs and the technical and financial information system were assessed. This was carried out by representatives of the organisation under the guidance of the expert. The results were documented by a CEGESTI consultant. The company team consisted of at least the general manager, the environmental/operational manager and the controller/accountant. Each company received a protocol of all issues raised and the Excel file with the assessment of the total annual environmental costs of the previous business year.

The workshop and the site visits created in each company the basic skills required to apply the EMA methodology, for them to repeat the exercise in future years. Moreover, it increased the awareness of top management of the environmental costs generated by inefficiencies in the production processes, waste generation and poorly functioning equipment. The direct relation between the accounting system and the material flows of the production site, improved knowledge on the information necessities, and the willingness of management to invest in environmental management, cleaner production and cost accounting tools.

4 THE PARTICIPATING COMPANIES

The following five companies were selected for the application of the tool:

4.1 Pipasa Corporation

Pipasa was founded in 1969; it is the largest poultry company in Costa Rica with about 50 per cent market share. The company is registered at the NASDAQ New York Stock Market. In Costa Rica, Pipasa is amongst the 10 largest companies in reference to its total assets, total incomes, revenue and shareholders equity. The company has 2480 employees.

Activities include production and sale of fresh and frozen poultry, processed chicken products, commercial eggs, and concentrate for livestock and domestic animals. Pipasa has an extended distribution net with 100-per cent coverage of the national area. The company is vertically integrated. The production process starts with the fertilized egg and finishes with the preparation and distribution of fresh whole chickens, fast-frozen and cooked chicken patties and sausages.

Pipasa has looked for efficient ways to prevent pollution and to protect the environment. For this purpose, the company has started emission control systems.

Also, a waste water treatment systems was built. Organic waste from the production plants is used to produce organic fertilizers. Recycling of packaging and handling materials is promoted. Additionally, the company maintains more than 500 hectares of primary and secondary forests. Lastly, the company has launched a consciousness campaign regarding the environmental and social impacts of its activities. However, the company has not yet implemented an environmental management system.

The EMA study was focused on the San Rafael slaughtering plant. This plant produces 41,300 tons of poultry per year. The process is relatively simple, consisting mainly of animal slaughtering, clean-up, cutting and separation of parts, packaging, freezing, stocking and transportation of poultry. The plant has 499 employees. The accountability, as many other controls and services, is provided and controlled by the central corporation.

The plant is registered as a cost centre, which helped define clear boundaries. The process of recycling the chicken waste to produce animal food is done in the Rendering process. Although physically this process takes place inside the plant, there is a different cost centre where this process is captured. Therefore this process was kept out of the assessment. Analysed from the EMA methodology this also implies that the process is clean in terms of waste generation, as waste that is recycled internally leaves the company as a separate product. All materials that leave the boundaries of the system as non-product are considered waste. For this reason, the recycling of waste within the process is not considered as long as it goes back into the product.

4.2 Etipres

Etiquetas Impresas, Etipres S.A., is a Costa Rican company dedicated to the design and printing of labels. It started its operations in October 1985. The company has 23 employees.

Since the beginning, the company has tried to lead the labels market with a tailor-made system of printing and production, with no limitation on style and form. The Art and Design Department has state-of-the-art software technology and highly trained staff in graphic design. The company also has a perforation system for continuous printer paper and capacity to print on film and foil.

Recently the company bought advanced equipment for label printing and production. Besides its increase of production capacity, additional selection criteria of the equipment were environmental considerations, since the equipment has a more reliable emission capturing system.

In 1998, Etipres implemented ISO-9002:1994 and ISO-14001:1996. That same year the company obtained the locally developed "Ecologic Flag" award in recognition of its environment-friendly performance. In 1999, the company received the "Eco-Label" award for its continuous efforts on improvements of the environmental impact of the production process. This label is awarded by the Costa Rican Ministry of Environment MINAE.

4.3 Resintech

Resintech started operations in 1970 as a subsidiary of the BFGoodrich Company, the world's largest producer of resins and PVC compounds. Resintech supplies PVC compounds in grains and powder for the processes of extrusion, injection, blow and lamination. The company has tried to continuously develop new formulas and to enhance its production systems to ensure prompt response and high quality in the final products. The company has 84 employees.

The company has several production lines with specialized equipment in PVC production and an advanced quality laboratory. Some of their products are shod products, isolating material, plastic fabric, thermo-shrinking film, hose, and various packaging material.

The company implemented ISO-9002:1994 in 1998 and is working on the implementation of an environmental management system based on the ISO-14001 norm.

4.4 Coopronaranjo

In May 1967 the Cooperativa de Caficultores de Naranjo R.L. (Naranjo's cooperative of coffee farmers) was created. In 1968, Coopronaranjo bought a coffee mill in order to provide a coffee processing service to its associated farmers. Currently, Coopronaranjo is the biggest coffee cooperative of Costa Rica with more than 4500 associated farmers. The cooperative has six departments: coffee mill, accounting, marketing and sales, cooperative education, supermarket, and agricultural technical assistance.

The focus of the EMA study was related to the activities of the coffee mill. The coffee mill works only in the harvest season, approximately four months per year. At the time of the visit, the plant was at the start of the harvest period and had just increased its plant personnel from 15 to 85 people (which represents 36 people on a yearly basis). The rest of the year the plant is stand-by, and equipment maintenance and enhancement is done.

Since 2002 the company has had a certified, integrated management system based on the ISO 9001: 2000 and ISO-14001:1996 norms. Several improvements have been implemented focussing on waste reduction and reuse, water treatment systems and energy efficiency programs. The company has implemented an anaerobic waste water treatment reactor through which it is able to recover the escaping methane gas and convert it into energy for its drying process. Additionally the plant has adapted its boilers to burn the dry husk (the thin outer layer of the coffee bean) and use it as a fuel for the drying process. The plant has also implemented a worm-compost plant where part of the organic waste (mainly pulp and husk) is transformed into organic fertiliser. Furthermore the plant has implemented water recycling systems which has resulted in a significant reduction in water consumption.

4.5 Roma Prince

In 1961, Pastas Alimenticias Roma, S.A. began its operations in Costa Rica, with the purpose of manufacturing pastas, using as the main ingredient 100 per cent durum wheat semolina. Pasta Roma entered the market, using Italian technology and strict quality control. Within a few years they became the company with the highest sale rate of pastas in the country. In 1973, the corporate name "Pastas Alimenticias Roma, S.A." was changed to "Roma Prince, S.A.". The company has 250 employees.

By the year 2000, Roma Prince was a mayor player in the Costa Rican, Central American and North American markets, as well as some Caribbean countries. Roma Prince S.A. exports its products to many countries such as Nicaragua, Honduras, El Salvador, Guatemala, Panama, Jamaica, Trinidad & Tobago, Barbados and the United States.

The continuing high consumer demand for Pastas Roma created the need to change and modernize the manufacturing equipment. Thus, in 1987 it was decided to acquire the best machinery available for the manufacture of pastas; at this time the company acquired very high temperature equipment with the brand name "Pavan". Environmental criteria were not really considered during the selection process.

Roma Prince has implemented a quality management system based on ISO 9002:1994 and is interested in implementing an environmental management system based on ISO 14001.

5 RESULTS FROM THE ASSESSMENT OF TOTAL ANNUAL ENVIRONMENTAL COSTS

The following section compares the results of the case studies in Costa Rica to the Austrian experience. The Austrian case studies (Jasch and Schnitzer, 2002) were performed with 12 companies, 10 of which were in the production sector, ranging from breweries, galvano shops, pulp and paper, sport equipment to hydropower and caloric energy plants. In Austria, environmental awareness and resulting legislative pressure started in the 70s. So most companies had introduced environmental management installed and published environmental reports. The main goals of the project were to arrive at a consistent information system to fulfil all the disclosure requirements by the statistical agency, the environmental protection agency and the financial disclosure requirement, which also ask for information on environmental performance. In addition, about half of the companies published an environmental report and were to report about being a pilot company in a research project. To give two examples:

The brewery *1. Obermurtaler Brauereigenossenschaft* (www.murauerbier.at) with about 120 employees and 245,000 hl beer production was the first Austrian EMAS site to register in December 1995. They have since annually published environmental statements with mass balances, performance and eco-efficiency indicators and quantified improvement targets and calculate their environmental cost savings based on the improvements shown by the performance indicators.

Due to their high environmental awareness they significantly increased their output and decreased their relative performance indicators over the last years. The monitoring of their key indicators for material input and waste figures is also used to calculate the saving of environmental costs. This is done by comparing the relative performance indicators of 2000 with actual prices and amounts of 2000 as well as with actual purchase and disposal amounts in 1995. The question easily answered by this method is: What would we have to pay today, if we hadn't acted and improved our performance? The total savings from 1995 to 2000 have been estimated at about USD 186,000.

The history of the *paper manufacturer in Laakirchen* dates back to 1874. In 1988 the company became part of the Swedish group "Svenska Cellulosa Aktiebolaget" (SCA). The Laakirchen factory specialises in the production and development of super-calendered (SC) paper (www.sca.at).

The company was one of the first EMAS sites (registration number 23) and is often the one to test pilot projects, which then get implemented throughout the corporation worldwide. The company was the pilot project on environmental management accounting for developing the UN DSD EMA approach in 2000 and since then publishes their environmental cost distribution to environmental media in their annual environmental statement.

The corporation has introduced a resource management system for the consistent tracking and reporting of material flows, which was amended in consistence with the EMA approach and now links physical and monetary data.

It is obvious that quantitative results based on ten companies in Austria and five in Costa Rica, all from the production sector, but from different industries, should not be over-interpreted. The aim of this chapter is not to compare the companies, which act in very different sectors and circumstances, but to compare the information systems, the distribution of costs in the different cost categories and show the range of costs in different cost categories. There are some very clear tendencies and general results with regard to costs distribution, information systems and cost awareness.

As all company data are always managed in a confidential way, only the percentage distributions of costs and general observations are published. It should be noted that actually the value of total annual environmental costs is an important figure for the companies, but not so much an important result on the applicability of a method. Also for the companies, the value of total annual environmental costs becomes more significant, when changes can be seen when comparing different years. The most important results for the companies mostly relate to the improved and consistent information system.

However, the Costa Rican companies showed high interest in receiving benchmark information on the industry sector and process level performance. The continuous application of the tool will help to generate such information and useful transferable experience. Statistical agencies and environmental protection agencies in some countries already require some of this information. Nevertheless, it is clear that benchmarking information is often misleading, as system boundaries are hardly ever identical. In effect, comparison is most valuable from one year to the other and within an organisation, based on a consistent information system for financial and physical data.

5.1 Distribution of cost categories from the profit and loss account

The expenditure distribution taken from the profit and loss accounts of the Austrian and Costa Rican case studies are different, even though they are all related to the production sector. An analysis of the profit and loss accounts shows the following distribution: For the Austrian production enterprises the material purchase accounts from 16 to 60 per cent, also the personnel expenses have a large margin of fluctuation from 15 to 40 per cent.

Figure 2. *Expense distribution in production enterprises*

	Austria			Costa Rica		
Production Sector	Min	Average	Max	Min	Average	Max
Materials	16%	44%	60%	42%	62%	84%
Personnel	15%	24%	39%	2%	16%	35%
Depreciation	1%	7%	16%	0%	3%	9%
Interest	0%	1%	3%	0%	5%	11%
Other Expenses	11%	24% 4	3%	4%	15%	35%

In the production sector materials in general account for 40-60 per cent of all expenditure in the profit and loss accounts and therefore all projects focusing on improving material efficiency are very important. In Austria, the average costs are 45 per cent for materials and 25 per cent for staff. The figures for Costa Rica are 62 per cent for materials and 16 per cent for staff. The reasons are that in comparison Austrian wages including social security are much higher than in Costa Rica. Due to this difference, the motivation in Costa Rica for improving material efficiency is thus much higher than on improving labour conditions. Since the pressure on compliance of environmental regulation is limited in Costa Rica because the compliance control capacity of the regulatory body is very limited, also the other costs categories are not so important in Costa Rica. Most of the sites had very old equipment that was depreciated a long time ago, so there are hardly any costs in the other cost categories, material purchase becomes extremely important and a methodology highlighting the importance of purchase costs of wasted material input actually works just as well or even better.

In Costa Rica another indicator was calculated: the percentage of environmental costs in relation to total expenditure. The average value was 4.2 per cent with a maximum value of 10.4 per cent in one company. This figure is distorted by Etipres' data, which has a high percentage due to the recent purchase of new equipment that led to high depreciation. Without considering Etipres, the average decreases to 2.7 per cent, with a fluctuation of +/- 1 per cent. Considering that material purchase value makes about 50 per cent of all environmental costs (3 per cent of total costs), this equals about 1.5 per cent of total annual expenditure, which is quite a large amount for potential costs savings.

5.2 Structure of the environmental costs

Also differences appear in the structure of the environmental costs. The environmental cost block "material purchase value of non-product output (NPO)" is most strongly weighted in the production enterprises (with 39-85 per cent in Austria and 46-92 per cent in Costa Rica). The NPO is by far the largest part of the environmental costs and this cost factor is generally not considered in the environmental costs inquiry.

The expenses for the waste and emission treatment follow with values between 13 to 52 percent in Austria and 6 to 38 per cent in Costa Rica. This includes disposal costs, depreciation and partly the operating materials for end-of-pipe technologies. In the case of Costa Rica, the expenses are lower, due to the non-existence of a waste disposal and collection tax (Environmental taxes have an average of 9 per cent in Austria and only 1 per cent in Costa Rica).

The cost block "prevention and environmental management" causes 1 to 14 per cent of the environmental costs in Austria and 1 to 17 per cent in Costa Rica. Companies with installed environmental management systems score high in this category, nevertheless the effort for prevention taken by the environmental team also helps to reduce the costs in the other cost categories (emission treatment and material purchase value of non-product output).

The fourth and last block "processing costs of the NPO" could be assessed only in some companies. It represents the production scrap evaluated by manufacturing costs of production, which is usually exposed during the stocktaking, and has a portion of approximately 3 per cent of the environmental costs, whereby sector-specific values of up to 20 per cent are possible.

The environmental revenues predominantly result from selling scrap and other material for recycling but also from selling capacity of the wastewater treatment system, energy production, and waste treatment plants to related or external companies. These revenues are about 0 to 9 per cent for Austria and 0 to 13 per cent for Costa Rica.

	Austria			Costa Rica		
	Min	Average	Max	Min	Average	Max
1. Waste and Emission treatment	13%	29%	52%	6%	18%	38%
2 Prevention + environmental m'ment	1%	6%	14%	1%	9%	17%
3. Material purchase value of NPO	39%	64%	85%	46%	72%	92%
4. Processing costs of NPO	0%	5%	17%	0%	5%	20%
5. Environmental revenue	0%	3%	-9%	0%	-4%	-13%

Figure 3. *Distribution of the cost categories by cost blocks*

	Pipasa	Resintech	Etipres	Coopro-naranjo	Roma Prince
1. Waste and Emission treatment	7%	20%	21%	38%	6%
2 Prevention and environmental management	4%	17%	13%	10%	1%
3. Material purchase value of NPO	91%	66%	46%	63%	92%
4. Processing costs of NPO	1%	0%	20%	3%	1%
5. Environmental revenue	-2%	-4%	0%	-13%	0%

Figure 4. *Distribution by cost categories in the five Costa Rican companies*

Figure 5 shows the extreme and average values of the individual cost categories of the Austrian and Costa Rican case studies.

	Austria			Costa Rica		
	Min	Average	Max	Min	Average	Max
1. Waste and emission treatment						
1.1. Depreciation for related equipment	2%	9%	25%	6%	18%	38%
1.2. Maintenance and operating materials and services	1%	5%	15%	0%	7%	20%
1.3. Related personnel	1%	5%	20%	0%	6%	15%
1.4. Taxes, Fees, Charges	4%	9%	14%	0%	1%	2%
1.5. Fines and Penalties	0%	0%	0%	0%	0%	0%
1.6. Insurance for environmental liabilities	0%	0%	0%	0%	0%	0%
1.7. Provisions for clean up costs, remediation, etc.	0%	0%	64%	0%	0%	0%
2. Prevention and environmental management						
2.1. External services for environmental managemen	0%	1%	4%	1%	3%	7%
2.2. Personnel for general environmental management	0%	4%	10%	0%	6%	16%
2.3. Research and development	0%	1%	4%	0%	0%	1%
2.4. Extra expenditure for IPPC equipment	0%	1%	3%	0%	0.2%	1%
2.5. Other environmental management costs	0%	0%	25%	0%	0%	0.1%
3. Material purchase value of the NPO						
3.1. Raw materials	3%	21%	54%	9%	19%	33%
3.2. Packaging	0%	3%	12%	0%	1%	4%
3.3. Auxiliary materials	0%	7%	31%	0%	0%	0%
3.4. Operating materials	0%	9%	37%	0%	5%	17%
3.5. Energy	16%	24%	31%	10%	45%	66%
3.6. Water	0%	1%	1%	0%	1%	3%
4. Processing costs of the NPO	0%	5%	17%	1%	6%	20%
5. Environmental revenues	0%	-3%	-9%	0%	-4%	-13%

Figure 5. *Detailed distribution of the cost categories*

Material purchase value of NPO is the most important cost category in all the companies analysed. However, in companies without EMS the amount is considerably higher (91-92%). This category includes raw materials as well as auxiliary and operating materials plus energy and water consumption cost. Nevertheless, it is important to mention that these results are very much influenced by the quality of the information system.

The low percentage of depreciation costs in Costa Rica is a result of the limited pressure experienced by the companies to renew their equipment frequently and some of the companies lack budget, so old machinery is used and little investment is made in new technology. This fact further supports the cost structure as material-intensive, increasing the importance of the materials used but also increasing the requirement of energy efficiency measures. A clear example was the case of de-pulping drums in the coffee mill. This technology is 40 years old: heavy iron-made drums were rotated to de-pulp the coffee beans. Low labour cost justifies intensive maintenance without affecting the competitive position of the company.

The cost of waste and emission treatment ranges between 6 and 38 per cent. The maximum level is mainly reached by the investment in wastewater treatment systems (Pipasa and Coopronaranjo), obligatory requirement for the Costa Rican food industry since 1995, and for which the compliance is controlled intensively by the Ministry of Health. End-of-pipe equipment, staff and related operating costs have an important position in the cost structure. In general, it could be concluded that the trend is to still use end-of-pipe technology to tackle environmental issues.

The cost category "prevention and environmental management" causes between 1 and 17 per cent of the environmental costs. The companies with an EMS score considerably higher in this category (Resintech, Etipres and Coopronaranjo).

"Material purchase value of NPO" is by far the most critical component of the environmental cost structure in the case of the Costa Rican companies. Due to relatively higher cost rates of consumption of old fashion machinery, poor maintenance and insufficient insulation of heat transportation systems; energy is the most significant element in the EMA structure.

Raw materials on NPO are the second most important element. Together with operating materials, these elements offer important opportunities for improvement.

Water does not represent a significant cost in the structure, as most of the companies extract their water from wells, and no consumption tax is paid.

In both non-EMS companies the data on environmental impact and resource consumption is scarce and based on estimates.

It is expected that increasing "Prevention and Environmental" costs will help reduce costs of "lost material value".

The cost of "waste and emissions treatment" is considerably lower in the Costa Rican companies in comparison with European companies due to the fact that the fees of waste collection are still very low or do not exist, and enforcement is weak.

As general environmental awareness grows and tighter regulation and enforcement capacity are developed, it is expected that "emission treatment" costs will increase.

5.3 Distribution by environmental media

Apart from the distribution into the individual cost blocks, the distribution of costs into the environmental media as defined by the statistical department of the United Nations has also been regarded. Costs in the categories ‘soil and groundwater’, ‘noise and vibration’, ‘biodiversity and radiation’ do not occur in most companies. However, from an environmental point of view they are very sensible issues and therefore Environmental Protection Agencies put strong emphasis on separate recording. The shares of the cost of the other media vary strongly and will allow more useful interpretations once disclosed extensively on a sector-specific level. The column “other” was used whenever the costs could not be attached clearly to a medium (e.g. general environmental management).

	Austria			Costa Rica		
	Min	Average	Max	Min	Average	Max
Air & climate	14%	28%	41%	32%	54%	86%
Waste water	0.5%	30%	56%	1%	16%	47%
Waste	3%	36%	83%	3%	21%	54%
Other	0,2%	7%	17%	0%	9%	20%

Figure 6. *Distribution of the costs by environmental media*

	Pipasa	Resintech	Etipres	Coopro naranjo	Roma Prince
Air & climate	49%	52%	32%	51%	86%
Waste water	47%	4%	1%	28%	1%
Waste	3%	23%	54%	10%	12%
Soil / Ground Water	0%	0%	0%	0%	0%
Noise / Vibration	0%	0%	0%	0%	1%
Biodiversity	-1%	0%	0%	0%	0%
Health & Safety	0%	0%	0%	1%	0%

Figure 7. *Distribution of costs by environmental mdia in five Costa Rican companies*

Waste disposal fees are non-existent or very low in Costa Rica. As other spheres present relatively low costs, energy impact in the cost structure rises to a very high level. This fact is reflected in the Air/Climate sphere.

Pipasa and Coopronaranjo have significant wastewater treatment costs. Wastewater treatment is typically an end-of-pipe technology. An important percentage of valuable material (usually raw material) is being deposited and drained in the water.

In the case of the Costa Rican companies, other environmental media are insignificant, but still have some related costs. Biodiversity even has a positive value (earnings) due to an award Pipasa received from the government for reforesting and maintaining the forest areas in its surroundings.

5.4. Awareness about the amount of the environmental costs

Apart from the distribution of the environmental costs, its absolute amount is also of great importance. This project has shown that the environment-relevant costs in most enterprises are underestimated manifold. At the beginning of the project the participating companies in Costa Rica hardly knew the costs of waste management and energy consumption. After the method used in the project was presented in the first lecture, the participants of the selected SMEs were requested to estimate the environmental costs that would be determined at the end of the workshop and site visit.

The answers given showed that the environmental managers and technical managers had insufficient information about the size of the operational costs. The accountants had a benefit here, yet the estimation on average was far from the actual result after applying the method.

Thus it becomes obvious that increased awareness of the size of the environmental and material flow costs, and above all the material purchase value contained in waste must be established and with it coherently also measures for the increase of the material and energy efficiency. It is important that environmental protection is not only regarded as a nuisance by enterprises, but that the often-significant saving potentials, which also result in an improvement of the environmental performance, do not remain concealed.

6 Concluding Remarks

The application of the UN DSD EMA method in the Costa Rican business environment was met with large interest, and interesting results that will motivate management to invest in environmental management activities. It is feasible to conduct the cost assessment in one or two days. The project resulted in suggestions regarding the improvement of the accounting information system, and the reduction of the material and energy loss. All enterprises showed their interest in the continued use of the instrument.

In all companies there is a lack of information and/or accuracy on resource flows in the accounting systems. Almost all the cost data had to be estimated based on production data. Most of the information was held by cost centres and thus, the information was diffused and segregated into different accounts. Some information did not exist, and some was captured in an account where several other costs were captured, not allowing to clearly define the specific cost.

As a general conclusion, it is considered that the methodology is very applicable for SMEs in Costa Rica. It helps decision makers identify the environmental costs generated in the production processes and to defend possible investments with data. The method is especially useful for Costa Rican companies with a certain level of environmental awareness and interest in investing in improvement processes, and very useful for ISO 14001-certified companies to connect environmental management issues at operational level with the financial system. The method helps SME to identify operational potential factors to reduce environmental costs

General management has a very limited idea of the environmental costs produced by the company. The tool is useful to create awareness amongst general management about the importance of having quantified information for decision-making processes regarding environmental and material flow management.

The results obtained in Costa Rican SMEs have some very clear differences to the ones obtained in Austria. This is partly due to the fact that European companies have already implemented many efficiency improvements in their processes, while Costa Rican companies still tend to have considerable opportunities for improving efficiency through good housekeeping. Besides this, the regulatory framework in Europe is more extensive and compliance more strict, based on fees and taxes, while the environmental legislation in Costa Rica is still very general, lacking clear parameters, and the compliance control entity lacks the budget to carry out intensive controlling activities. Therefore for Costa Rican companies it is still more attractive not to comply then to meet all the existing legal requirements. This results in very limited environmental management costs, since there are few external factors that force them to invest in pollution prevention.

However, analysing the cost structure, the companies became aware of the cost of wasting natural resources, which creates an internal impulse to invest in waste reduction practices. Finally, three of the companies had implemented ISO-14001 while two others did not. As a result it was much easier to work with companies with EMS already implemented, as their awareness and data availability is higher.

On the other hand, the deficiencies of the accounting information system are quite similar. The suggestions during the workshops raised a few general recommendations for the improvement of the data collection of the environmental and material flow costs.

- Data collection of material purchase by material groups in financial accounting

In some enterprises the entire material purchase is booked on one account only and it is only possible to evaluate by hand the extensive cost centre accounts or stocktaking lists to divide the actual material use into the material groups. As an aid, the recordings of the production manager were multiplied to the assigned quantities with average prices, in order to at least be able to indicate orders of magnitude. The fact that such a system cannot strengthen cost consciousness in handling raw, auxiliary and operating materials is obvious.

- Estimation and recalculation of material scrap percentages

The loss percentages for raw materials, packing material, auxiliary materials and the final product are often based on outdated estimated values and are only recalculated for a few material groups. The employees on-site usually have more precise estimated values than the accountants. A correct recalculation mostly lead to frightening results.

- Consistency of system boundaries for material flow accounting in technical and accounting information systems and definition, which accounts, cost centres and cost categories must be consistent by amount and value

The input-output material balance disclosed in the environmental statement is hardly ever consistent with the system boundaries of the accounts and cost centre reports. As a consequence, the data could not be audited for consistency. For the recording of the costs and amounts of waste three different values and records on one site (record of the environmental manager without the costs for weighing, transportation and rent of disposal cans, the financial account with some wrong postings and the accounts of several suppliers with additional services) were found.

- Depreciation of projects/investments before the first year of cost assessment

During the first cost assessment, the question is often posed how to deal with missing values of the previous years. If these can be estimated or assessed easily, it should be done. But, the main goal of the first assessment is to improve the data basis for the next years and not detailed and cumbersome assessment of previous values.

- Distinction to Health and Safety and Risk management

Designing a system appropriate to the company involved is the most important target. Some companies have added a column for safety and risk prevention, as this duty is also part of the job description of the environmental manager. Health is mostly the responsibility of other departments. Coopronaranjo included a new environmental medium "Health and Safety", as this is considered a significant environmental factor in the company.

REFERENCES

Jasch, C. (2000), *Environmental Management Accounting, Procedures and Principles* United Nations Division for Sustainable Development, Department of Economic and Social Affairs (United Nations Publication, Sales No. 01.II.A.3). Available for download at www.ioew.at.

Jasch, C. and Schnitzer, H. (2002), *Umweltrechnungswesen – Wir, zeigen, wie sich Umweltschutz rechnet, Beispielsammlung zur Umweltkostenrechnung und Investitionsrechnung*. Published as Schriftenreihe 29/02 des IÖW Vienna, Oktober 2002. Available for download at www.ioew.at.

Index