TOWARDS A COMPREHENSIVE FRAMEWORK FOR ENVIRONMENTAL MANAGEMENT ACCOUNTING – LINKS BETWEEN BUSINESS ACTORS AND EMA TOOLS.

by

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Abstract

Environmental accounting and, more specifically, environmental management accounting (EMA), have developed significantly during the last two decades. Review of available literature and corporate practice reveals that a range of different perceptions and conceptions of environmental management accounting has been developed. However, recently, there has been a movement towards a common understanding of the term environmental management accounting. This paper moves in the direction of a comprehensive framework for EMA by discussing EMA’s position within the larger context of environmental accounting and, then, proposing a comprehensive framework for EMA which links business actors and EMA tools. The framework integrates the two major components of environmental management accounting – monetary environmental management accounting (MEMA) and physical environmental management accounting (PEMA) – in a systematic way. The term MEMA is used to cover all internal corporate environmental accounting tools and procedures that measure environmentally related financial impacts in monetary units, whereas PEMA covers all internal corporate environmental accounting tools and procedures that address environmental impacts using physical units. By uniting the main recent perceptions of EMA, the proposed framework provides structure for managers to assess the variety of environmental management accounting tools that have been developed to date. The framework highlights the time horizon associated with different environmental management accounting tools by introducing the distinction between the past and future and between the short and long term emphases of the different tools. A final dimension is that the EMA framework considers the importance of the regularity of information generation required for the different environmental management accounting tools available to management. The paper concludes with a brief discussion about the choice of the most important EMA tools.
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1 Environmental Accounting and Environmental Management Accounting

With the emergence of environmental accounting in the last two decades, various perceptions of the concept of environmental accounting have been developed (Gray et al. 1993; Schaltegger and Stinson 1994; EPA 1995; Gray et al. 1996; Schaltegger et al. 1996; Parker 1999; Schaltegger and Burritt 2000). Given the variety of stakeholders who require company related environmental information, numerous approaches and tools have been proposed within the field of environmental accounting in order to meet these information needs. Up until the present, no commonly accepted framework for environmental accounting has been established that integrates the different approaches and tools. This is in particular true for Environmental Management Accounting (EMA). This lack of a comprehensive framework to map the existing EMA-tools hinders a more widespread use of EMA-tools in business as no clear guidance is provided on which tools are pertinent for which business decision contexts. Therefore, the aim of this paper is to develop a comprehensive framework to map all the different EMA-tools. Such a framework will facilitate the appropriate application of EMA and show which EMA tools meet the requirements of, and could be useful for, different business actors in different decision contexts.

Such a common framework of EMA has to be anchored in the broader concept of environmental accounting. With regard to the concept of environmental accounting there is a wide consensus that there are two main groups of environmental impacts related to company activities (Schaltegger and Burritt 2000, 58):

- Environmentally related impacts on the economic situation of companies,
- Company related impacts on environmental systems.

Each of these impacts can be reflected by its own category of company related environmental information.

1.1 Monetary and Physical Information, Internal and External Addresses

Environmentally related impacts on economic systems are reflected through monetary environmental information. Monetary environmental information addresses all the impacts that company related environmental impacts have on its past, present or future financial stocks and flows. Monetary environmental information is expressed in monetary units (e.g. measures expressed in US$ for expenditure on cleaner production; cost of fines for breaching environmental laws; dollar values of environmental assets).
Related impacts of corporate activities on environmental systems are reflected in physical environmental information. Thus, at the corporate level, physical environmental information includes all past, present and future material and energy amounts that have an impact on ecological systems. Physical environmental information is always expressed in physical units - such as kilograms, cubic meters, or joules (e.g. kilograms of material per customer served; joules of energy used per unit of product).

In a similar way to the distinction introduced above for environmental information, conventional accounting also provides separate information about monetary and physical aspects of the company’s activities. Conventional accounting systems expressed in monetary units include:

- conventional management accounting – designed to satisfy internal needs of corporate decision makers for short term cost and revenue, long term investment information and internal accountability;
- conventional financial accounting – which serves to provide external corporate stakeholders with information about the company’s dated financial position and changes in the financial position on a regular basis over specified periods of time;
- other accounting systems such as tax or bank regulatory accounting – intended to provide specific information, mostly for regulatory purposes.

Conventional accounting systems with information expressed in physical units include approaches such as production planning systems, inventory and material accounting systems and quality systems.

Conventional corporate accounting does not normally give explicit, separate recognition to company related environmental impacts. Instead, it is mainly designed to satisfy the needs of different stakeholders seeking information about the economic performance of the company. Yet, from a pragmatic perspective, the critical test for any accounting system is whether it produces information that is useful to particular stakeholders for evaluating their own ends (Chambers 1966, 54; Schaltegger and Burritt 2000, 45). Hence, different accounting systems should be designed to satisfy the fact that various addressees require different information. Different conventional accounting systems can be distinguished according to the main target audiences.

Some stakeholders have a major concern with physical environmental impacts of corporate activities, whereas other stakeholders are mainly interested in monetary effects induced by the environmental impacts of the company. For instance, shareholders are interested in the monetary bottom line and may only be partially interested in a separate report containing pollution information expressed in physical units, even if it is put into a clear context with its monetary consequences, insofar as they affect the financial bottom line. Shareholders are interested in pecuniary information that shows material effects on shareholder value, including environmentally related impacts on the economic situation of companies. Environmental protection agencies and corporate environment managers (see Parker 1999), on the other hand, are interested in various waste and pollution figures expressed in physical units and generally have no direct interest in, for example, whether the costs of pollution abatement or waste reduction measures are capitalized or considered as expenses in the monetary account.
Unfortunately, the conventional approach to accounting tends to neglect the fact that information interests vary very much between different stakeholders.

It is common to distinguish between at least two major target stakeholder groups in conventional accounting systems for companies: internal company addressees (e.g. management) and a fairly narrow range of external groups (e.g. shareholders, rating agencies and financial analysts). Internal and external accounting systems can be distinguished, depending on whether the main purpose of the accounting system is to satisfy the information needs of either internal or external stakeholders. Financial accounting and reporting is the branch of accounting concerned with classifying, measuring and recording of transactions, transformations and events external to the company for the purpose of external reporting. Financial accounting is mainly concerned with the provision of information to external company stakeholders, especially investors and shareholders. Other accounting systems such as regulatory accounting and reporting systems are dedicated to a more specific audience external to the company, such as tax agencies or other regulatory bodies. Apart from the distinction between monetary and physical information, this leads to a first fundamental criterion for structuring environmental accounting – internal vs external stakeholders. EMA is, hence, internal environmental accounting, for managers. On the other hand, the main focus of this paper is on the information needs of different types of company managers. Management accounting has the provision of such information as its main aim. Management accounting is, in general, “... the identification, measurement, accumulation, analysis, preparation, and interpretation of information that assists executives in fulfilling organizational objectives” (Horngren and Foster 1987, 2) and thus focuses on internal accounting and reporting.

The main difference between conventional accounting and environmental accounting is that environmental accounting systems separately identify, measure, analyze and interpret information about environmental aspects of company activities. Within the conventional approach this distinction between conventional and environmental accounting is somewhat unclear. Yet, differences in the units of measurement, in the data quality and its sources cannot simply be neglected if purpose-orientated information is to be provided.

1.2 Accounting in Monetary and Physical Units for Different Target Audiences

As with conventional accounting systems, both of the different classification criteria introduced above - accounting in monetary units vs physical units, and internal vs external accounting - also hold true for environmental accounting systems.

Monetary environmental accounting systems measure the environmentally related economic impacts of the company in monetary terms. Monetary environmental accounting systems can be considered as a broadening of the scope, or a further development or refinement of, conventional accounting in monetary units as they are based on the methods of conventional accounting systems. Physical environmental accounting systems reflect the impacts of company related activities on the environment. They are designed to satisfy the growing demands of various internal and exter-
nal stakeholders for information about the company’s environmental performance. Taken together, monetary and physical environmental accounting form environmental accounting (see the debate in e.g. Bennett & James 1998, ECOMAC 1996, IFAC 1998 and Schaltegger, Hahn and Burritt 2001a). Figure 1 illustrates the scope of environmental accounting (see the grey shaded part).

On the basis of this fundamental understanding of environmental accounting the set of different environmental accounting systems can be positioned within the framework of environmental accounting.

Monetary environmental accounting covers:
- monetary environmental management accounting (MEMA) as internal environmental accounting expressed in monetary units;
- external monetary environmental accounting (EMEA) as external environmental accounting and reporting expressed in monetary units; and
- other monetary environmental accounting, such as environmental tax accounting.

Physical environmental accounting includes:
- physical environmental management accounting (PEMA) as internal environmental accounting expressed in physical units;
- external physical environmental accounting (EPEA) as external environmental accounting in physical units; and
- other physical environmental accounting, such as regulatory environmental accounting in physical units.

All the three major corporate environmental accounting systems: environmental management accounting, external environmental accounting, and other environmental accounting, can be further divided according to their emphasis on monetary or physical aspects. This is also illustrated in Figure 2 by the area shaded in grey, which shows the scope of environmental management accounting (EMA).

A range of factors, outlined briefly below, supports the development of this conceptual framework of environmental accounting, including the associated framework of environmental management accounting.
Firstly, given the assumption that the philosophy and tools associated with environmental accounting, including EMA, can assist the drive towards a sustainable society (Schaltegger and Burritt 2000, 46), it is important to create a common understanding in order to facilitate its communication and promotion among managers and other stakeholders.

Secondly, a conceptual separation between internal and external accounting is based on the fact that the level of detail and aggregation of information and the extent of confidentiality differ between management and other stakeholder needs. It has also been argued that a separate focus on the accounting needs of management (rather than on the needs of external stakeholders) is to be encouraged because a focus on external reporting can lead to distortions in the collection and use of information for decision-making (Kaplan 1984; see also Bennett and James 1999, 32).

Thirdly, different types of managers rely on and have their performance assessed using either physical, or monetary, or both types of information. For example, managers in the corporate environmental department have various goals including:

- Identifying environmental improvement opportunities;
- Prioritizing environmental actions and measures;
- Environmental differentiation in product pricing, mix and development decisions;
- Transparency about environmentally relevant corporate activities;
- Meeting the claims and information demands of critical environmental stakeholders, to ensure resource provision and access;
- Justifying environmental management division and environmental protection measures.

Different forms of information are required to help environmental managers meet their goals, including:

- Physical measures of material and energy flows and stocks and related processes and products, and their impacts upon the environment;
- Monetary measures about the economic impact of environmental initiatives (such as pay-back periods, return on capital/investment, etc.);
- Qualitative measures of stakeholder claims.

This contrasts with the needs of, for example, a production manager concerned with task control over operations, optimizing energy and material consumption, and reduction of environmentally-induced risks and in need of physical measures of material and energy flows and process records.¹

The need for integrating environmental with economic issues by combining them in one category – environmental accounting - provides a fourth driver. A major focus of environmental accounting is to raise management awareness about the potential importance, positive and negative, of environmental impacts on corporate economic performance. Environmentally induced monetary impacts of a company are strongly interrelated with corporate environmental performance measured in physical units. Integration can be typified through, for example, measures of eco-efficiency that combine measures of economic performance with measures of environmental impact in a ratio format (see e.g. Schaltegger and Strum 1992 and 1998).

¹ See the typical goals of different types of managers outlined in Schaltegger, Hahn and Burritt (2001b): EMA-Links – The Promotion of Environmental Management Accounting and the Role of Government, Management and Stakeholders.
Finally, conventional accounting in physical units, as noted above, exists independently of, and prior to, the development of environmental accounting systems (Horngren and Foster 1987). Managers have always been concerned to improve materials and energy efficiency in order to improve economic results of their corporations. For example, productivity measures of efficiency, expressed in physical units, have long been derived in most conventional management accounting systems (e.g. material input per unit of product). The derivation of physical material and energy flows is necessary information prior to their later expression in monetary units. Consequently, much physical information derived in conventional management accounting systems is of great use in environmental management accounting.

Taking all these factors into account, it is possible to provide greater insight into the development of a general framework for EMA. It is to this main purpose of the paper that attention is now directed.

2 General Framework for Environmental Management Accounting.

2.1 Monetary Environmental Management Accounting and Physical Environmental Management Accounting

The simple bifurcation between monetary and physical information types is not apparent in conventional management accounting where both coexist. Standard costing provides a case in point, where variance analysis includes price and quantity variances to be examined in tandem, not just price (monetary) variances for management control purposes. Internal tax planning provides another case where physical emissions of pollution are calculated first by management and then estimates of the cost of a specific environmental tax are made (e.g. a tax on carbon emissions).

Hence, it is proposed that EMA be defined as a generic term that includes both Monetary Environmental Management Accounting (MEMA) and Physical Environmental Management Accounting (PEMA). This situation is illustrated in Figure 3. The scope of EMA illustrated also complements the views of authors who have canvassed the idea that companies should provide greater emphasis on the management and measurement of non-monetary aspects of corporate performance (Johnson and Kaplan 1987; Kaplan and Norton 1996) in order to encourage a mind set that takes the long term into account.

Monetary Environmental Management Accounting (MEMA) deals with environmental aspects of corporate activities expressed in monetary units and generates information for internal management use. In terms of its methods MEMA is based on conventional management accounting that is extended and adapted for environmental aspects of company activities. It deals with the environmentally related impacts of a company expressed in monetary terms (e.g. costs of fines for breaking environmental laws; investment in capital projects that improve the environment). It is the central, pervasive tool providing, as it does, the basis for most internal management decisions, as well as addressing the issue of how to track, trace, and treat costs and revenues that are incurred because of the company’s impact on the environment (Schaltegger & Burritt 2000,
MEMA is an accounting system with a focus on the economic impacts of environmentally related corporate activities. It contributes to strategic and operational planning, provides the main basis for decisions about how to achieve desired goals or targets, and acts as a control and accountability device (Schaltegger & Burritt 2000, section 6.1).

**Physical Environmental Management Accounting (PEMA)** also serves as an information tool for internal management decisions. However, in contrast with MEMA it focuses on a company’s impact on the natural environment, expressed in terms of physical units such as kilograms. PEMA tools are designed to collect environmental impact information in physical units for internal use by management (Schaltegger & Burritt 2000, 61-63). According to Schaltegger & Burritt (2000, 261) PEMA as an internal environmental accounting approach serves as:

- an analytical tool designed to detect ecological strengths and weaknesses;
- a decision-support technique concerned with highlighting relative environmental quality;
- a measurement tool that is an integral part of other environmental measures such as eco-efficiency;
- a tool for direct and indirect control of environmental consequences;
- an accountability tool providing a neutral and transparent base for internal and, indirectly, external communication; and
- a tool with a close and complementary fit to the set of tools being developed to help promote ecologically sustainable development.

### 2.2 Time: Frame, Length and Routineness

Building on these arguments, which support the notions of MEMA and PEMA as core constructs in EMA, additional dimensions can also be seen as being a necessary, important part of environmental management accounting. In particular, three dimensions of environmental management accounting tools are emphasized below:

- **time frame** - the time frame being addressed by different tools (e.g. past vs current vs future time frames);
- **length of time frame** – how long is the time frame being addressed by the tool (e.g. tools addressing the short term vs those with a focus on the long term); and
- **routineness of information** – how routinely is information gathered (e.g. ad hoc vs routine gathering of information).

Figure 3 includes all of the five dimensions - internal vs external; physical vs monetary classifications, past and future time frames, short and long terms, and ad hoc vs routine information gathering - in the proposed framework for EMA. Any specific EMA accounting tool can be assigned on the basis of the classification scheme drawn up by these five dimensions (see the detail in Figure 3 and Schaltegger and Burritt 2000, Chapter 6 for a detailed description of different EMA tools).

**Time frame.**
Accounting systems and associated tools of analysis, used to attach meaning to the signals produced by accounting tools, can be classified into those with a focus on the past, and those looking to the future. Rows headed ‘past orientated’ and ‘future orientated’, in Figure 3, distinguish between the MEMA and PEMA tools that are available to management for addressing environmental issues with a focus either on measurement of past transactions, transformations or events or the prediction of the impact of possible future transactions, transformations or events. For example, environmental cost accounting (in the top box in the third column) provides routinely generated short term information about the past environmental monetary impacts of activities, products, divisions, departments and the total economic entity, whereas monetary environmental operating budgeting (the third box down in the third column) projects this information into the short term future for planning and control purposes.

**Length of time frame.**
Environmental issues are generally considered to be long term; while management is frequently criticized for adopting a short term perspective, to appease the financial markets and one group of stakeholders in particular - shareholders. Columns headed ‘short term focus’ and ‘long term focus’, in Figure 3, distinguish between the MEMA and PEMA tools that are available to management for addressing environmental issues with either a short or long term focus. The length of time frame associated with the discretion available to different levels of management has been highlighted by the need to emphasize length of planning periods, e.g. short run operational budgeting expressed in monetary terms (the third box down in the third column) vs long run financial planning (the third box down in the fourth column), and the span of control over physical actions, e.g. short span over tactical operational decisions in physical environmental budgeting (the third box down in the fifth column) vs a long span over strategic situations involving long term physical environmental planning (the third box down in the sixth column).

**Routineness of information gathering.**
From the viewpoint of internal management decision making and internal accountability, both, past and future orientated approaches can be further distinguished into routinely generated information - general accounting systems that routinely produce information for management - and ad hoc information - specific accounting tools that produce information on a “needs” basis for particular decisions. Rows headed ‘ad hoc information’ and ‘routinely generated information’, in Figure 3, distinguish between the MEMA and PEMA tools that are available to management for addressing environmental issues on a regular or irregular basis. For example, the PEMA tool ‘environmental capital impact accounting’ (the first box down in the final column) provides regular information about corporate impacts on natural capital (e.g. whether critical and non-critical environmental capital has been maintained, improved, or depleted), whereas PEMA information about ‘life cycle inventories’ (the second box down in the final column) is only required on an ad hoc basis for the purpose of conducting life cycle assessment of new products.

By combining all of these analytical factors this paper suggests a comprehensive conceptual framework for EMA within which the different tools of internal environmental accounting, MEMA as well as PEMA tools, can be placed and assigned according to the decision or internal accountability setting. Figure 3 shows that EMA encompas-
ses a large range of different accounting approaches that serve different needs which depend on the decision context, purpose and management level. While detailed information about the EMA tools mentioned in the cells in Figure 3 are further discussed in the standard environmental accounting literature (see Schaltegger and Burritt 2000), the question of choice of the most important EMA tools does need further consideration and is examined in the next section.

3 Choice of the most important EMA tools.

To illustrate the benefits stemming from the general framework for EMA outlined above it is useful to outline the specific decision making and accountability contexts of some of the tools illustrated in Figure 3 as the primary general aim of EMA is to inform and support decision making by, and accountability of, those managers who influence, or who are influenced by, environmental factors. A general theoretical basis for analysis of the scope of management will be used here based on the well established value chain approach of Porter (see Figure 4), and extending the main focus of Bennett & James (1998, 34) on accounting and finance, environment and production departments.

Figure 5 illustrates a generic set of users of EMA information, the basic goals of these managers and the type of information they need.

For example, as shown in Figure 5, top management tends to be concerned with strategic, long term accounting information used to plan and control activities at the corporate level. Columns four and six in Figure 3 display EMA tools that have a long term focus and which may be of particular use to top management (e.g. when there is imposition of a carbon tax on an organization, or the introduction of a carbon trading scheme). Because top management need aggregate information, they look for measures that can be used to compare a range of diverse corporate activities. Hence they have a preference for monetary information that uses a common unit of account and facilitates comparison between different course of action. Hence, their emphasis is likely to be on MEMA tools that affect strategic decisions relating to monetary capital on a regular basis for the organization, as well as on an ad hoc basis for appraising the performance of individual projects with environmental impacts involving large amounts of monetary capital (column four boxes one and two). Top management are also responsible for steering their organization into the future and would find routine long term MEMA planning tools of use, e.g. related to environmentally driven research and development plans for the company, and ad hoc monetary environmental investment appraisal tools such as NPV using growth options for large single investments where environmental considerations play a key role (e.g. the decision by

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2 Contrast, for example, this specific analysis of the link between managers and EMA tools with Parker (1999) who makes a general recommendation that selected environmental costs be ‘rafted on’ to the conventional full cost accounting system and onto the corporation short term operational budgeting system in order to promote environmental costing within organizations.
producers of halons to cease production and introduce substitutes because of the deleterious effects of halons on the ozone layer).

In contrast, divisional management has been added as an additional column as they are accountable to top management for their monetary performance and the performance of their divisions and this implies the feedback of cost and revenue MEMA results about key divisional performance measures. The emphasis is likely to be on the type of short term routine EMA information represented in box one column three of Figure 3, even though long term information is ideally considered by divisional managers.

Production managers need production specific accounting information. Such information, related to production activities in the value chain (Porter 1980) has a tendency to be expressed in physical terms because production managers plan and control physical rather than monetary processes. Production management will tend towards the use of PEMA tools, especially short term PEMA tools because of their concern to keep production flowing, and to improve the technical efficiency with which production is carried out. Hence, use of material and energy flow accounting information will be a routine requirement, relating to the past for control purposes (box one in column five) and projected through physical environmental budgeting (box three in column five) for production scheduling plans.

To give another example, product management is mostly concerned with product specific information. Such information has to be expressed both in monetary and in physical units because decisions related to both pricing and environmental quality have to be made. Thus the ad hoc MEMA tool environmental life cycle (and target) costing represented in the second box down in column four of Figure 3 is of particular interest to product managers. However, they may also be interested in routinely generated environmental cost information, especially about material and energy flows. The most important PEMA tool for product managers is the past orientated ad hoc life cycle inventory information which covers all the physical environmental impacts of a product over all the stages of product life (see second box down in column six of Figure 3). In addition, product management might seek physical information on material and energy flows.

Relevant EMA tools for other groups of management identified in Figure 5 are illustrated in Figure 6 but are not examined in detail in this short paper. In summary, Figure 6 illustrates the main relationships between management groups and EMA tools, based on information contained in Figures 3 and 5. The different information needs of the various management groups reflects both the underlying diversity and commonalities and the reason why separate accounting for physical and monetary EMA systems within an integrated whole is necessary.
Further exploration of the full range of tools used for management decision making and accountability by different groups of management, and in different organizations (e.g. manufacturing, service, knowledge, non-profit and government, small companies and companies in developing countries), can be used to demonstrate the applicability of the general EMA framework that has been developed above.

4 Outlook

At present there is still no precision in the terminology associated with EMA. Drawing upon the existing literature it has been argued above that there is scope for deriving an agreed, pragmatic general framework for EMA. Such an opportunity depends on the recognition of:

- monetary and physical accounting systems that, both separately and in combination, are of use to different types of managers in seeking to reduce environmental impacts from the activities of their organizations;
- a mapping of the tools available for EMA related to the time frame of impacts (impacts in the past, contemporary impacts, impacts in the future);
- a mapping of the tools available for EMA with the length of time frames used by different managers for analysis (the length of the time frame – short or long term; and
- a mapping of EMA information needs with the routineness of decisions and accountability processes faced by different managers.

Among the main advantages of the proposed new framework for EMA are:

- the movement towards agreement about what EMA is, or what it might be, is necessary for effective communication and research between academics as well as for the promotion and establishment of modern EMA approaches in practice;
- the recognition that EMA needs to include monetary and physical measures, albeit in systems that can be considered independently of each other, or in combination;
- the mapping of tools with EMA sub-systems that facilitate particular types of decisions and internal accountability processes; and
- the incorporation of time as a key element in the classification, in order to bring stronger focus on the links between short term and long term monetary considerations and short and long term ecological considerations in management decision making.

Furthermore, increased emphasis upon EMA systems that are largely required by management in need of information to help them achieve the goals of their various organizational segments (e.g. divisions or departments), may help reduce the emphasis on manipulation of public environmental disclosures for political purposes evident in environmental financial accounting (see e.g. Gray et al. 1993) while, at the same time, stressing the need for improved environmental performance expressed in both physical and, where appropriate, monetary terms.

Finally, this development of a general framework of EMA is offered as a way forward for management seeking to adopt environmental management accounting systems. A major benefit corporate managers will experience from the proposed general frame-
work is that the framework considerably clarifies the concept and applicability of EMA and related tools. Once managers have a clear picture of the classification of MEMA and PEMA tools promotion and adoption will be easier for them and therefore it will be more likely that they will adopt the appropriate tools in a particular decision making or internal accountability setting in which environmental aspects play a part, such as:

the extent of subsidies from government that are environmentally damaging and which may be removed in the future;
potential corporate impacts of environmental taxes and tightening regulations designed to bring corporations closer to tracking the full cost of their activities;
divisional impacts on environmental capital such as biodiversity, land, water and air quality;
corporate impacts on the goal of sustainable society; and
product and production managers taking green opportunities when these are available.
Bibliography.


Figure 1. Scope and delineation of environmental accounting.
Figure 2. Environmental accounting systems (modified from Bartolomeo et al. 2000, 33)

Environmental accounting

- Monetary environmental management accounting (MEMA)
- Physical environmental management accounting (PEMA)

Environmental management accounting (EMA)

- External monetary environmental accounting and reporting (EMEA)
- Monetary environmental regulatory accounting and reporting
- External physical environmental accounting and reporting (EPEA)
- Physical environmental regulatory accounting and reporting

Internal

Monetary units

Physical units

External
Figure 3. Proposed Framework of Environmental Management Accounting (EMA) (according to Schaltegger, Hahn and Burritt 2000)
Figure 4. Value chain and internal corporate EMA users (based on Porter 1985, p. 37)

<table>
<thead>
<tr>
<th>Type of Information</th>
<th>Aggregate</th>
<th>Specific</th>
</tr>
</thead>
<tbody>
<tr>
<td>Support Activities</td>
<td>Top Management</td>
<td>Finance and Accounting</td>
</tr>
<tr>
<td></td>
<td>Environmental, Health and Safety Management</td>
<td>Quality and Human Resource Management</td>
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<td></td>
<td>Legal Affairs</td>
<td>Research &amp; Development and Product Design</td>
</tr>
<tr>
<td></td>
<td>Corporate Marketing and PR</td>
<td></td>
</tr>
<tr>
<td>Operational Activities</td>
<td>Purchase</td>
<td>Production</td>
</tr>
</tbody>
</table>
Figure 5. Generic aims and objectives of different types of managers (Schaltegger, S.; Hahn, T. and Burritt, R.L., 2001b)

<table>
<thead>
<tr>
<th>Relevant EMA users</th>
<th>Basic Goals</th>
<th>Type of Information desired</th>
</tr>
</thead>
</table>
| **Top Management** | - Long term profitability and survival of company  
- Securing legal compliance with minimal cost to the corporation  
- Realization of all economically beneficial environmental protection measures  
- Securing the provision of resources from the critical stakeholders (Schaltegger 1999)  
- ... | Highly aggregated financial and strategic (qualitative and quantitative) information on the business environment and the company’s performance. |
| **Accounting and Finance Department** | - Identifying and realizing cost saving potential  
- Transparency about cost-relevant (environment-related) corporate activities  
- Transparency about the impact of (environment-related) activities on the income statement and/or balance sheet  
- Reduction of environmentally-induced risks (Bennett & James 1998, 34ff.)  
- Compliance with accounting regulations  
- Maximization of shareholder value  
- ... | Financial measures about corporate activities, e.g. cost-, income- and balance sheet related issues, risk assessments, investment decisions, mergers and acquisitions etc. Financial information on the value and economic performance of the enterprise. |
| **Environmental Department** | - Identifying environmental improvement opportunities  
- Prioritizing environmental actions and measures  
- Environmental differentiation in product pricing, mix and development decisions  
- Transparency about environmentally relevant corporate activities  
- Meeting the claims and information demands of critical environmental stakeholders, to ensure resource provision and access  
- Justifying environmental management division and environmental protection measures  
- ... (Bennett & James 1998, 34ff.; UNDSD 2000, 46) | Physical measures on material and energy flows and stocks and related processes and products, and their impacts upon the environment. |
| **Health and Safety Department** | - Safeguarding the safety, health and welfare of employees at work from environmental accidents and disasters | Physical measures of health and safety. |
| **Quality Department** | - Meeting the (environmental) product requirements of customers at the minimum cost for a given level of product quality | Information on cost of quality. Physical measures of technical product requirements. |
| **Human Resources Department** | - Job related (including environmental) concerns of employees  
- Remuneration, including rewards for good environmental performance  
- Physical jobs allocated and job conditions monitored | Information on financial rewards. Physical information on turnover, satisfaction, morale. |
<p>| <strong>Legal Department</strong> | - Ensuring (environmental) legal compliance by the company’s operations | Physical measures. Qualitative compliance information. |</p>
<table>
<thead>
<tr>
<th>Department</th>
<th>Tasks</th>
<th>Information Provided</th>
</tr>
</thead>
<tbody>
<tr>
<td>R&amp;D and Design Department</td>
<td>- Development and design of marketable products and services</td>
<td>Strategic information about market demands. Financial information about costs of new products and services. Information on technical feasibility and environmental impacts of newly designed products and services.</td>
</tr>
<tr>
<td></td>
<td>- Reducing (environmental) risks of investments</td>
<td></td>
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<tr>
<td></td>
<td>- Development of improved production processes</td>
<td></td>
</tr>
<tr>
<td>Corporate Marketing and PR</td>
<td>- Meeting external information demands of critical stakeholders</td>
<td>Information about stakeholder claims. Physical and financial information on the company’s environmental impacts and efforts for pollution reduction and prevention.</td>
</tr>
<tr>
<td>Department</td>
<td>- Meeting claims and information demands of shareholders, other economic stakeholders (including those interested in environmental reports)</td>
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<tr>
<td></td>
<td>- Developing a green image of the company and its products</td>
<td></td>
</tr>
<tr>
<td>Production Management</td>
<td>- Task control over operations</td>
<td>Information on material and energy flows and process records.</td>
</tr>
<tr>
<td></td>
<td>- Optimizing energy and material consumption</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Reduction of environmentally-induced risks</td>
<td></td>
</tr>
<tr>
<td>Purchasing Department</td>
<td>- Efficient procurement of the inputs for corporate operations</td>
<td>Information on quality and environmental properties of the goods purchased. Financial information on prices.</td>
</tr>
<tr>
<td></td>
<td>- Establishing and securing favorable relationships with suppliers</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- ...</td>
<td></td>
</tr>
<tr>
<td>Logistics</td>
<td>- Efficient organization of, collection, storage, and physical distribution of goods and products</td>
<td>Physical measures e.g. on distribution means and storage facilities and related environmental impacts.</td>
</tr>
<tr>
<td></td>
<td>- ...</td>
<td></td>
</tr>
<tr>
<td>Marketing and Sales Department</td>
<td>- Increasing sales and attracting and satisfying buyers.</td>
<td>Information on operational market conditions (e.g. pricing, competitor activities, etc.) Information on customer demands.</td>
</tr>
<tr>
<td></td>
<td>- Provision of means by which buyers can purchase the product</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Inducing customers to buy the enterprise’s products through the tools of the marketing-mix (especially pricing, distribution, and communication)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- ...</td>
<td></td>
</tr>
<tr>
<td>Disposal and Recycling</td>
<td>- Efficient disposal and recycling of wasted or used material</td>
<td>Physical measures of the properties of disposable and recyclable goods. Technical information on treatment and recycling options.</td>
</tr>
<tr>
<td></td>
<td>- Minimization of wastes to be treated, especially hazardous wastes</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- ...</td>
<td></td>
</tr>
</tbody>
</table>
### Figure 6: Management groups and relevant EMA tools compared.

<table>
<thead>
<tr>
<th>Corporate EMA System</th>
<th>Relevant EMA Tools</th>
<th>Conventional rationale for link with tools</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Top Management</strong></td>
<td>MEMA (regular and ad hoc, long term, past and future)</td>
<td>Main concern is with aggregate financial and strategic information about the company’s overall investment and financial performance.</td>
</tr>
<tr>
<td></td>
<td>see boxes 2, 4, 6, and 8 in Figure 3.</td>
<td></td>
</tr>
<tr>
<td>Divisional Management</td>
<td>MEMA &amp; PEMA (regular and ad hoc, long and short term, past and future)</td>
<td>Emphasis is on divisional financial and strategic information with a focus on short term profitability measures such as return on capital employed, economic value added, and residual income.</td>
</tr>
<tr>
<td></td>
<td>see boxes 1, 3, 5 and 7 in Figure 3.</td>
<td></td>
</tr>
<tr>
<td>Accounting and Finance</td>
<td>MEMA (regular and ad hoc, long and short term, past and future)</td>
<td>Focus is on short and long term investment and financial performance measures of activities at the corporate, segmental and product levels, e.g. cost-, income- and balance sheet related issues, risk assessments, investment decisions, mergers and acquisitions etc. Includes measures and estimates of costs of quality, health and safety and human resources management.</td>
</tr>
<tr>
<td>Department</td>
<td>see boxes 1, 2, 3, 4, 5, 6, 7, and 8 in Figure 3.</td>
<td></td>
</tr>
<tr>
<td>Environmental Department</td>
<td>PEMA (regular and ad hoc, long and short term, future and past)</td>
<td>Emphasis on physical measures of material and energy flows and stocks and related processes and products, and their impacts upon the environment.</td>
</tr>
<tr>
<td></td>
<td>see boxes 9, 10, 11, 12, 13, 14, 15, and 16 in Figure 3.</td>
<td></td>
</tr>
<tr>
<td>Health and Safety Department</td>
<td>PEMA (regular and ad hoc, long and short term)</td>
<td>Physical information about health and safety (and concern about the impact of the environment on the health and safety of employees).</td>
</tr>
<tr>
<td></td>
<td>see boxes 9, 10, 11, 12, 13, 14, 15, 16 in Figure 3 (re environmental health and safety issues for employees)</td>
<td></td>
</tr>
<tr>
<td>Quality Department</td>
<td>PEMA (regular and ad hoc, long and short term, past and future oriented)</td>
<td>Main focus is on physical information about technical product attributes, and aspects of personnel and technology that provide the customer service or product.</td>
</tr>
<tr>
<td></td>
<td>see boxes 9, 10, 11, 12, 13, 14, 15, and 16 in Figure 3 (re environmental quality management)</td>
<td></td>
</tr>
<tr>
<td>Human Resources Department</td>
<td>MEMA &amp; PEMA (regular and ad hoc, short term, past and future oriented)</td>
<td>Main emphasis is on short term physical information about employee numbers and types, allocation to segments of the business, turnover, satisfaction, morale and financial information about employee rewards.</td>
</tr>
<tr>
<td></td>
<td>see boxes 1, 3, 5, 7, 9, 11, 13 and 15 in Figure 3.</td>
<td></td>
</tr>
<tr>
<td>Legal Department</td>
<td>PEMA (regular and ad hoc, short term, past and future)</td>
<td>Main concern is with physical information about compliance with legislation and regulation and financial penalties for non-compliance.</td>
</tr>
<tr>
<td></td>
<td>see boxes 9, 11, 13, and 15 in Figure 3 (and some concern for 1, 3, 5 and 7).</td>
<td></td>
</tr>
<tr>
<td></td>
<td>...</td>
<td></td>
</tr>
<tr>
<td>Department</td>
<td>MEMA &amp; PEMA (regular and ad hoc, long term, past and future)</td>
<td>PEMA (regular and ad hoc, long term, past and future)</td>
</tr>
<tr>
<td>------------------------------------------------</td>
<td>------------------------------------------------------------</td>
<td>------------------------------------------------------</td>
</tr>
<tr>
<td>R&amp;D and Design Department</td>
<td>- see box 16 in Figure 3.</td>
<td>- see box 16 in Figure 3.</td>
</tr>
<tr>
<td>Corporate Marketing and PR Department</td>
<td>- see box 2, 4, 6, 8, 10, 12, 14, 16 in Figure 3.</td>
<td>- see boxes 2, 4, 6, 8, 10, 12, 14, 16 in Figure 3.</td>
</tr>
<tr>
<td>Production Management</td>
<td>- see boxes 9, 11, 13 and 15 in Figure 3.</td>
<td>- see boxes 9, 11, 13 and 15 in Figure 3.</td>
</tr>
<tr>
<td>Purchasing Department</td>
<td>- see boxes 1, 3, 5, 7, 9, 11, 13, 15 in Figure 3.</td>
<td>- see boxes 1, 3, 5, 7, 9, 11, 13, 15 in Figure 3.</td>
</tr>
<tr>
<td>Logistics Department</td>
<td>- see boxes 9, 10, 11, 12, 13, 14, 15, 16 in Figure 3.</td>
<td>- see boxes 9, 10, 11, 12, 13, 14, 15, 16 in Figure 3.</td>
</tr>
<tr>
<td>Marketing and Sales Department (and product managers)</td>
<td>- see boxes 1, 3, 5, 7, 9, 11, 13, 15 in Figure 3.</td>
<td>- see boxes 1, 3, 5, 7, 9, 11, 13, 15 in Figure 3.</td>
</tr>
<tr>
<td>Disposal and Recycling Department</td>
<td>- see boxes 7, 9, 11, 13 in Figure 3.</td>
<td>- see boxes 7, 9, 11, 13 in Figure 3.</td>
</tr>
</tbody>
</table>
