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Theoretical developments in environmental management accounting and the role and importance of material flow cost accounting

Abstract

Environmental Management Accounting (EMA) is a broader concept of accounting which uses accounting tools and practices to support company-internal management decision making on environmental issues and its impact on company performance. Research on EMA can be divided into two broad categories: theoretical and empirical studies. The theoretical studies are based on framework that aims to explain the nature of the relationship between economic and environmental performance and the adoption of Environmental Management Accounting in a business environment. The empirical studies follow two lines of research: instrumental studies aim to empirically test the relationships hypothesized in theoretical studies; descriptive studies are intended to examine the factors that encourage the adoption of EMA. This review paper examined the role of MFCA in identifying non-product output (waste) and its impact on an organizations profitability. Various case studies are examined in this article that demonstrates MFCA to be an important environmental management tool to ensure future sustainability of an organization.

Keywords: environmental management, material flow cost accounting, economic and environmental performance, sustainability, profitability.
JEL Classification: O31.

Introduction

Although environmental accounting forms an important part of industrial decision making in first world countries, there is, however, a lack of commitment to the environment in South Africa (De Beer and Friend, 2006). Environmental assessment (EA) is an integral component of environmental regulatory systems in developing countries like South Africa. It is one of the most important emerging trends in national environmental legislation. The EA process can contribute to effectiveness of the environmental regulatory system by integrating environmental considerations into the planning and appraisal of development activities. It can contribute to an improvement in environmental performance and cost effectiveness of the environmental regulatory systems.

The concept of EMA is not clear to many individuals in an organization and is conceived as a system that merely monitors and reports environmental costs. Jasch (2008, p. 4) argues that "Doing environmental management accounting is simply doing better, more comprehensive management accounting, while wearing an 'environmental' hat that opens the eyes for hidden costs." It should be noted that management of environmental-related costs is important even before reporting them. Hence, environmental and financial performance is managed and improved by adopting an EMA system (Schaltegger et al., 2010, p. 47).

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However, EMA adoption is still slow and lagging. Managers are reluctant to invest large amounts of money unless they are made aware of the amount of money they could save by adopting cleaner production techniques and technologies. This article discusses the underlying concepts of EMA, CP and MFCA, and provides empirical evidence and case studies on the benefits of using MFCA as an environmental tool to identify the 'true' value non-product outputs that managers need to consider during decision making.

Theoretical review of EMA

Environmental cost identification

Environmental changes and future threats can generate higher costs to the company. Strategic operational issue is that companies are not aware of the magnitude of these costs as they are generally hidden in overhead accounts. Greater transparency of these costs was being managed in a way that resulted in environmental and economic benefit (Olson and Jonall, 2008).

Initially, the reaction to environmental challenges was to disperse pollutants better to reduce its harmful impact on communities, thereafter, environmental management paradigm was to implement measures to control pollution and treat wastes after they have been created. Examples include effluent treatment plants, catalytic converters and waste incineration, also referred to as end-of-pipe technologies (Environmental strategies, 2013). Jonall's research was a review of academic journal articles that focused on environmental management accounting methodology that could be used to support decision

making in companies. Corporate environmental costs as revealed by research, were twice as high as the environmental costs that were disclosed by companies in their annual reports.

Jasch and Schnitzer (2002, p. 6) suggested that environmental protection projects aimed at prevention of emissions and waste at its source by more efficient use of raw materials are not recognized and implemented due to the fact that environmental costs are not being accurately recorded resulting in distorted calculations for improvement options. It had been discovered, subsequently, that many of the businesses' costs are environment-related and that simple actions could be taken to improve environmental and business performance. This has led to an increase in the number of publications to create awareness among practitioners. To overcome these challenges, the American healthcare multinational Baxter Inc.'s published Environmental Financial Statement (EFS) as a subset of the company's overall income statement to calculate the aggregate costs and benefits arising from their environmental program. Abdel-Kader (2011, pp. 64-65) confirmed that the EFS generally showed positive financial contributions whilst adhering to legal compliance.

Jonall (2008, p. 29) mentioned in his review of corporate results that when EMA methodology was applied at a Canadian Mackenzie Paper Division paper mill, environmental costs were found to be more than twice as high as those reported in the company's year-end report. Many important environmental costs are hidden in other accounts and support the view that environmental costs are higher than generally perceived by management. The results of the case were concluded reporting that established accounting practices needed to be evaluated because it is suspected that it may be unintentionally supporting polluting technologies (Jonall, 2008, p. 32).

Environmental Accounting can be used to demonstrate the potential for environmental investment to yield financial. A pilot testing project of Environmental Management Accounting on 10 case studies conducted by Jasch and Schnitzer (2002, 6) showed that there is clearly lack of communication between the environmental manager and cost accountant in companies. The environmental manager has limited access to actual cost accounting documents and, although the cost controller has most of the information, they lack the ability to separate the environmental part without proper guidance. Environmental Management Accounting is a combined approach to bridge this communication gap and provide for the transition of data from cost accounting and financial accounting to reduce environmental impact by increasing material efficiency.

Similar findings were reported by Albelda (2011, pp. 76-100) who explored the role of management accounting practices as facilitators of the environmental management. The results showed that by reinforcing the four significant EMA's elements: commitment to continual improvement of environmental performance; compliance with environmental legislation; communication with stakeholders; and employee involvement, management accounting practices operate as a facilitator mechanism for environmental management. Poor communication links between the accounting and technical departments result in inaccurate cost allocation, which eventually leads to managers making incorrect operational and investment decisions. This, ultimately, has inverse impacts on a company's environmental and financial performance. It had been discovered, subsequently, that many of the businesses' costs are environment-related and that simple actions could be taken to improve environmental and business performance (Jasch and Schnitzer, 2002, p. 6).

Framework of EMA

Cost allocation by EMA could result in the following benefits: (Introducing Environmental Management Accounting at Enterprise Level: 9). Jasch (2003, pp. 667-676) claims that this comprehensive framework for EMA ensures that all relevant and significant costs are considered during decision making.

- Pricing of products could change due to recalculation of costs.
- Profit margins of products could be re-evaluated.
- Decision to phase out products because of high environmental cost.
- Processes and procedures may be re-designed to reduce environmental cost.
- Continuous monitoring of environmental performance and good housekeeping measures implemented.
- Unnecessary costs are eliminated.

Framework for EMA proposed by Burritt et al. (2002) on categories of different EMA methods is based on the attributes of the information and the uses to which the information is to be applied. The 16 categories in which different EMA methods can be positioned and understood in terms of their purpose and data source are demonstrated in the table below (Bennett, Schaltegger, Zvezdov, 2013).

Table 1. Categories of EMA

Time	Type of report	Physical short-term	Physical long-term	Monetary short-term	Monetary long-term
Past-oriented	Routinely generated	X	X	X	X
	AD HOC	X	X	X	X
Future-oriented	Routinely generated	X	X	X	X
	AD HOC	X	X	X	X

Source: Burritt, R.L., Haun, T. and Schaltegger, S. (2002, p. 43).

The Table above explains the categories of EMA information generated as follows:

- Information is monetary and non-monetary (physical).
- Measure past performance or to make decisions for the future.
- Distinguished between decision involving strategic information over several years and more operational information covering shorter time periods.
- How routinely the information is provided regularly for a recurring purpose or on an ad hoc basis for a specific non-recurring need.

During a study conducted by Ambe (2007, p. 7), external factors influencing EMA adoption were discussed as follows:

- Increased stakeholder pressure concerning environmental issues;
- Greater need for integration of physical and financial aspects of environmental management;
- Combined financial, environmental and social consideration incorporated into concepts of sustainable development and corporate social responsibility; and
- Greater environment-related costs.

Monetary EMA methods rely on corresponding physical information about materials and energy flows and are past-oriented. This type of information can provide managers with an overview of inefficiencies in material and energy usage which is useful in identifying and analyzing potential improvement opportunities. Bennette, Shaltegger and Zvezdov (2013) reported that, however, once managers become aware of opportunities for efficiency improvements and other benefits, then future-oriented information will also be needed. Firms will thus be able to achieve first mover advantage by being proactive in strategic planning.

Hyrslova (2011, p. 47) states that within the EMA framework, it is necessary to analyze the individual activities and processes to prepare material and energy balances in order to understand waste flows and express them in monetary units. According to EMA any waste generated is a sign of inefficiency. Therefore it can be concluded that an EMA system provided much more valuable information to support decision making within an organization than a traditional management accounting system. The concept of EMA is not clear to many individuals in an organisation and is conceived as a system that merely monitors and reports environmental costs. It should be noted that management of environmental related costs is important even before reporting them.

Tools of environmental management accounting

Material flow cost accounting (MFCA)

Development of MFCA

MFCA is a powerful method of environmental management and is being disseminated to industries because of its potential to help organizations realize that by increasing the transparency of material losses, companies can reduce environmental impacts and improve business efficiency. Japan then took the leading role wishing to make a contribution to the world by making both environment and economies compatible through dissemination of an advanced environmental management accounting approach. As a result, ISO/TC207/WG8 (MFCA) was established in 2008.

The effectiveness of Japanese MFCA best practices and successful case examples was communicated after ISO 14051 (international standardization of MFCA) was issued in 2011.

MFCA was first developed in Germany but has since been adopted in Japan. It involves the detailed mapping of the material and energy flows through an organization, however, the costs of wasted materials (non-product output) are not absorbed into product costs but are identified and reported separately at all stages (Abdel-Kader, 2011, pp. 67-68). MFCA was developed as a tool to enhance material productivity in manufacturing operations. This process gained widespread significance as it was used in Japan and became evident as a useful tool to evaluate the loss of material in both physical and monetary units. Due to great pressure being placed on organizations to improve their economic and environmental performance and also considering the large cost of raw material inputs, MFCA was established as an official international standard for organizations, ISO14051. This method was applied by

manufacturing companies to assess the loss of materials through inefficient use of resources and to identify possible savings that could bring about economic and environmental benefits (Schmidt and Nakajima, 2013).

MFCA is a key management tool with an objective to manage manufacturing processes with regard to the flows of materials, energy, and data to ensure that the manufacturing process proceeds efficiently. Hyrslova et al. (2011, pp. 5-18) define material losses that occur during the course of corporate processes as an inseparable part of material flows (examples: defective products of poor quality, scrap, waste and damaged products).

Definition and theoretical framework of MFCA

Schaltegger et al. (2010, p. 397) describe MFCA as one of the EMA tools aimed to reduce both the environmental impact and cost simultaneously. In addition, MFCA is also a tool used in organizations' decision making which is aimed at improving their business productivity by reducing costs through waste reduction. MFCA measures the flow of raw materials in both physical and monetary units. Cost categories are material cost, energy cost, system cost and waste management cost (Schmidt and Nakajima, 2013, pp. 358-369).

According to Schmidt and Nakajima (2013, pp. 358-369), a large number of companies are introducing MFCA in Japan which is aimed at reducing material losses rather than recycling wastes. Reduced material input and material cost directly results in reduced waste generation. This, eventually, leads to improved efficiency in processing and waste treatment costs.

Hence, two key activities of environmental management are reduction of waste generation and resource consumption in order to lower the environmental impact of the manufacturing process. MFCA identifies the source of waste generation as well the quantities and costs of waste generated from a process.

Furthermore, MFCA can be seen as an effective management tool used to help management to better understand the environmental aspects and profitability by improved material productivity and cost reduction. It traces and calculates both the physical and monetary values of material flows for products and wastes (material flow cost accounting (MFCA) case examples, 2010).

MFCA was developed as a tool to enhance material productivity in manufacturing operations. This method was applied by manufacturing companies to assess the loss of materials through the inefficient use of resources and to identify possible savings that could bring about economic and environmental benefits (Schmidt and Nakajima, 2013). Scavone (2006, pp. 1276-1285) had similar findings and adds that the aim of adopting this methodology is to successfully reduce material inputs and to achieve new measures for increasing overall efficiency which will eventually lead to positive economic and environmental improvements.

Lagioia, Tresca, and Gallucci (2014) studied the adoption of MFCA to integrate physical and monetary data in small enterprises for waste reduction decisions. They found that environmental impacts are not correctly recorded using traditional accounting systems and this leads to inaccurate decision making. Strategic, informed decision making is a key to an organization's success and is highly influenced by the availability of an integrated data management system. This pilot test was conducted on a small Italian enterprise producing rubbish bags and operating in the plastic sector. MFCA was used to verify and assess the efficiency of the production process. However, there were some problems experienced by the research team in applying the MFCA methodology.

The company, being an SME, had a traditional accounting thinking, which focused mainly on monetary information with a lack of clear flow chart of the production process in physical units. Both organizational and accounting difficulties were experienced in applying the MFCA methodology.

Economic loss caused by material losses includes all input costs of the process, such as energy, labour, depreciation, and material cost. MFCA assists the organization in identifying, analysing and evaluating their economic loss by material loss.

Material flow cost accounting (MFCA) case examples (Ministry of Economy, Trade and Industry of Japan, 2010) provide information on limitations and benefits of MFCA implementation.

There were certain limitations related to MFCA application:

- Operational control of collecting MFCA information for quantification and incorporating it as part of daily activities.
- Need for an interface for linking a cost management system with a daily report, and
- Coordination with ISO 14001 activities.

Challenges of MFCA:

- Daily report improvement.
- Data collection method.
- Communication barriers between management and on-site workers.

Benefits of MFCA

The Figure below represents the most important benefit of MFCA.

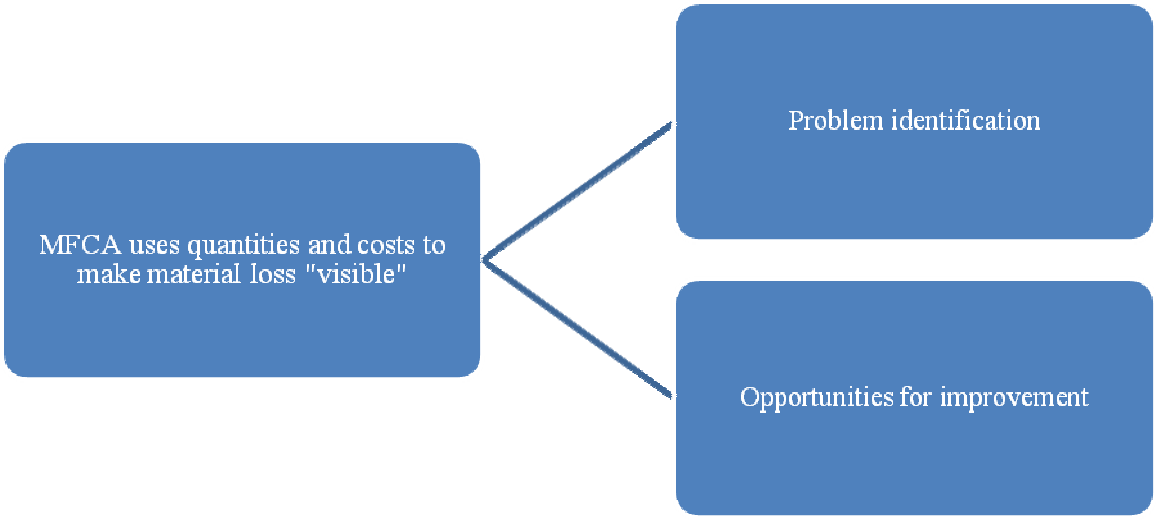

Fig. 1. Benefits of MFCA

Source: Self-generated.

The Figure above shows that MFCA helps companies to identify and quantify their non-product output (material losses) by increasing the transparency of material losses throughout the process. This enables management to identify problem areas and implement measures to improve process efficiency.

This information was identified during analysis of the case examples provided.

Case studies on MFCA application

MFCA has been adopted in many case studies and resulted in environmental and economic benefits for the organization. Some of these cases have been cited below.

MFCA was carried out as a test project at a Japanese firm, Canon, on their lens production process. Conventional accounting revealed 1% loss on defective products, however, after the application of MFCA, it became evident that a large part of the costs was due to material losses of defective products. Approximately 32% of the process costs could be allocated to material loss.

Following the successful implementation of MFCA, the approach was adopted at 17 Canon plant sites in Japan and abroad resulting in a total saving of 5.1 billion yen, between 2004 and 2012. This saving was mainly due to more efficient use of resources resulting in improved economic and environmental performance. It was also found that between 20% - 30% of costs are actually non-product output costs. MFCA enabled the companies to identify material losses that were previously hidden in their production processes. It was evident that cooperation with suppliers, data exchange and high measure of trust between companies is important and a pre-requisite for the successful implementation of MFCA approach (Schmidt and Nakajima, 2013, pp. 358-369).

In a case study of Shinryo Co. Ltd, MFCA was applied to the processes from producing to packaging of brown sugar products. The results were reported in the booklet that was produced by the “FY 2009 International Standardization of Low-Carbon Environmental Management Accounting” committee, commissioned by the Ministry of Economy, Trade and Industry, Japan (2010). MFCA data were defined as follows:

- Material costs: all input materials.
- Waste management cost: waste management cost for raw-sugar paper bags added to the calculation.
- Energy cost: electric power and heavy oils cost.
- System costs: personnel, depreciation, and maintenance/repair cost.

MFCA analysis found that:

- Off-specification products accounted for 5% of overall products. However, they did not incur any material losses, just losses, such as system costs and energy consumption.
- Losses from dropped products and others comprised of % of overall products.
- Losses from packaging materials were a significant cost. Improvement based on MFCA analysis was operational improvement and loss reductions by reducing relevant cost down to a reasonable level. Packaging waste reduction op-

tion was changing to less costly materials, rather than prioritizing the quality. This will reduce costs and result in better customer satisfaction due to less waste for customers.

MFCA analysis identified minor improvement measures that could generate benefits, such as improved productivity, more efficient use of resources, better customer satisfaction, reduced material loss and lower costs.

In the case study of Kodai Sangyo Co., Ltd, MFCA was targeted towards the project processing wooden materials for home-use "drain boards". MFCA application showed that there had been 33% of material loss in mill-ends. It had been found that information from three sources, that is, 'sales management system', 'accounting system', and 'production management system', required for the establishment of the MFCA management system, increased the transparency of the flow of material losses in the process, and also improved the company's business performance.

During the last decade the importance of effective material flows have increased significantly. Companies, however, require access to a measurement system to measure and compare material flows and costs in order to identify potential savings.

In another article published by Schmidt and Nakajima (2013), it had been found that the volume of production waste is as much as a quarter of total quantity used. Production waste of German companies in 2011 was higher than product waste in 2010 by 1.54 million tons.

Hyrslova et al. (2011, pp. 9-16) applied MFCA, a tool for the optimization of corporate production processes in a ceramic tile manufacturing company. He discovered that costs associated with material losses was approximately 86 million CZK. A recommendation, based on MFCA calculation, was made for the company to mainly concentrate on the 'preparation of material' process as this was where majority of material losses occurred.

Conclusions drawn from this case was that MFCA method contributed significantly to the development of new technologies which eliminated deficiencies of traditional technological processes by reducing the quantity of material losses wherever possible.

MFCA application increased the transparency of material losses and highlighted saving opportunities in the case studies cited. Hence, it provided useful information to assist management decision making regarding the introduction of new technologies.

South African companies are not familiar with this approach, therefore, there is a need to increase awareness of the benefits of this new tool to organizations that generate lots of waste during their production processes. There is, therefore, a need for more publications on cases in South Africa that have become aware of their non-product output costs by adopting MFCA models.

Companies that applied MFCA identified material losses to be significantly higher than they had previously realized. It has also been established that MFCA presents the opportunity for engineers/companies to aim towards CP and achieving their targets of lower material losses and cost reduction (material flow cost accounting case examples, 2010). Furthermore, the Japanese Industrial Standards Committee (2007, p. 6), in its proposal for international standardization of MFCA, argued that, since MFCA forms the ultimate platform of an organizational unit, it should be considered for standardization. ISO14051 was developed in Japan in 2011 within the ISO14000 family, to set out standards and general principles for MFCA to provide support and guidance to companies and contribute to worldwide resource efficiency.

South Africa together with a number of other countries like Brazil, United Kingdom, Finland, Malaysia and Mexico were involved in developing the norms for ISO14051. At this stage, more than 300 manufacturing companies had successfully adopted the MFCA approach and have benefited economically and also reduced the environmental impact of their production processes.

Waste costing

It considers not only the purely end-of-pipe costs and disposal costs, but also the materials costs involved in material losses, and the share of system costs involved in material losses, and the share of system costs connected with material losses. Waste costing places materials efficiency much more clearly in the foreground than traditional environmental costing.

Flow cost accounting

Aims to identify and analyze the entire system of material flows as an essential cost driver. Not only the material costs but also all the system costs are assigned to material flows. A kind of total cost accounting, encouraging the following actions:

- develop products that require less materials;
- develop product packaging that requires less materials;
- reduce materials losses (rejects, scrap, cut-offs), and, as a result of this, reduce waste (solid waste, effluent and exhaust).

The instrument of flow cost accounting shifts a company's in-house materials flows to the centre of

the cost analysis. In order to achieve this vital transparency, the values and costs of the material flows are divided up into the following categories: i) materials, ii) systems, iii) delivery and disposal.

Conventional Accounting Practices vs Environmental Management Accounting

Schmidt and Nakajima (2013, pp. 358-369) found some weaknesses in conventional cost accounting in that it cannot give all the required data. Monetary value flows are traced and interpreted as product cost in a conventional cost accounting (CCA) system. CCA focuses on cost figures for each product in each process, whereas MFCA checks mass balances in each process. Generally, companies focus on the input materials and the quantity of products produced from these inputs, not on the material losses generated from the specific process. In MFCA input materials, output and non-product output (material losses) are measured and then evaluated in monetary terms. MFCA is seen as the new 'Kaizen' for many Japanese companies.

Schmidt and Nakajima (2013) concurred that lessons for companies is that inconsistencies in management information will result in material losses being incorrectly calculated. Therefore, accuracy and relevance of internal data, as well as data collection and cost evaluation, are extremely important for an organization. Hyrslova (2011, p. 47) states that within the EMA framework, it is necessary to analyze the individual activities and processes to prepare material and energy balances in order to understand the waste flows and express them in monetary units. Therefore, it can be concluded that an EMA system provided much more valuable information to support decision making within an organization.

Khalid and Dixon (2012) investigated the level of EMA implementation in companies within industries in Malaysia to gain insight into pressures of implementing environmental management. It had been found that elements of environmental-related management accounting were implemented aimed to primarily at cost reduction. Companies with which they do business, as well as pressures from custo-mers for environmentally sensitive workplaces, play an important role in how a company reacts to environmental issues.

Khalid et al. (2012, p. 3) claims that, by using EMA, companies could implement proactive techniques that could prevent or reduce the environmental impact on their operational activities.

Jasch (2009, p. 832) noted that the obvious defects of conventional accounting practices is that it does not provide comprehensive and adequate information for environmental management purposes. EMA, on the contrary, includes and integrates both monetary and physical information about the "use, flows and destinies" of resources enabling good management decisions taking into consideration environmental impact and profit margins. Conventional accounting methods do not track and trace excess material and energy used to their sources or incorrectly allocate these costs to an overhead account. Hence, wasted material and energy remain unabated. Domil, Peres, and Peres (2010, p. 720) identified EMA as a combined approach that assists in transition of financial and cost accounting data to improve material efficiency and reduce environmental impact and risk of organizational activities.

Sygulla et al. (2011, p. 2) suggested that traditional cost accounting is not well suited for monetary evaluations of processes, as they have a strong departmental orientation and material cost are considered to be a direct cost.

Hence, traditional cost accounting provides insufficient knowledge about internal use of material in manufacturing, as well as material losses. Environmental cost accounting analyzes environmental costs and costs of material flows, but not in detail. MFCA has been developed to overcome this shortcoming and is more suitable for the economic appraisal of alternative material and energy saving process configurations and technologies. Sygulla et al. (2011, p. 2) states that MFCA supports managerial decision making by making it possible to visualize and quantify material losses. MFCA has been mainly implemented in practice in Germany and Japan, where the approach had first been developed. It has been reported that MFCA has been extensively promoted by the Japanese Ministry of Economy, Trade and Industry, whilst German examples still remain low.

A guidance document on corporate Environmental Management Accounting (EMA) was developed in 2005 for IFAC, the International Federation of Accountants which was based on a publication on principles and procedures of EMA initially written for the United Nations Division for Sustainable Development (UN DSD) (Jasch, 2005).

According to the UN DSD, two types of information are considered under EMA:

1. Physical information – including data on the use, flows and final destination of energy, water, materials and wastes.
2. Material purchase costs as a major cost driver in many organizations.

According to the guidance document for EMA (Savage and Jasch, 2005), material can be distinguished as follows:

- Raw and Auxiliary materials – EMA loss percentages are estimated, as not all raw material inputs are converted into products.
- Packaging materials purchased – leave the company with the product but have a loss percentage during production.
- Operating materials – are not part of the product but necessary for the production process. They are part of waste and emissions and constitute the most significant share of total EMA costs and also have major saving potential in production companies.

The System of Environmental-Economic Accounting (SEEA, 2003) handbook provides common framework for economic and environmental information. There is a need for consistencies in data collection and reporting to aid assessment and benchmarking process.

Jasch (2009, p. 833) noted his findings of a case study of a Danish food company that implemented an EMA system using guidelines provided by the International Federation of Accountants (IFAC). It was found that operational management was not aware of several environmental costs and these costs were not easily accessible for external reporting and when considering investment options. EMA system revealed that its non-product output (NPO) costs accounted for 88% of total environmental related costs and end-of-the-process costs which focused on dealing with the consequences of NPO were only 11% of total costs. The company now uses NPO to benchmark their performance which highlights potential savings in resources for the company.

Material costs are determined by summing up the results of the physical amount of the particular material multiplied by their specific input prices. Sygulla et al. (2011, p. 6) pointed out that the MFCA approach allows for greater transparency of material usage and losses as well as to identify opportunities for increased performance of manufacturing processes by the detailed information of current costs that is provided.

It was suggested by Sygulla et al. (2011, p. 6) that a stronger integration of the MFCA and the traditional cost accounting is needed to ensure continuous use and in order to lower barriers of adoption.

Model of material flow cost accounting (MFCA)

Figure 2 illustrates a tool of EMA to measure the physical and monetary unit flows of material in the manufacturing process to identify accurate cost of waste and emissions for substantial cost reduction.

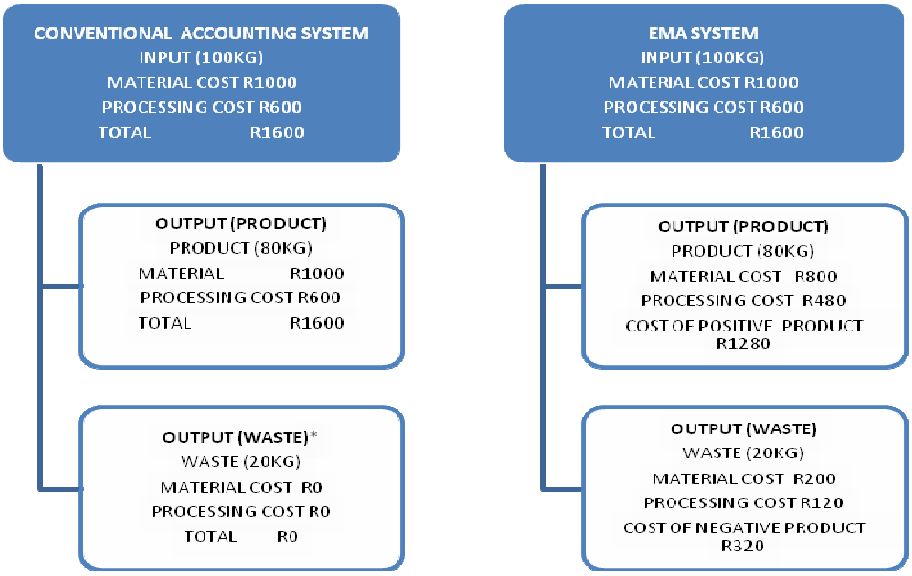

Fig. 2. Model of material flow cost accounting

Source: Model first was developed in Germany in 1999, thereafter, it was modified by Ministry of Economic, Trade and Industry of Japan 2007.

Empirical evidence that cleaner production can improve both environmental and economic performance of an organization

Recent developments in MFCA

Schmidt and Nakajima (2013, pp. 358-369) stated in their article that it is possible to undertake economic and environmental assessments of the material loss when the cross-country approach is used. The key question is 'what costs can be saved in the overall system by using resources more efficiently and reducing material losses?' CO_2 emissions are connected to material loss, if material loss is avoided then CO_2 emissions will be also reduced (see Schmidt and Nakajima, 2013, p. 367).

Non-product output

The most significant share of total environmental costs is usually non-product output costs. An EMA system can provide information needed that could be used for directing decisions towards the adoption of cleaner production measures implementing new technologies to reduce these costs (Domil, Peres, and Peres, 2010, p. 720).

Hyrslova (2011) believes that an EMA system provides users with valuable information regarding the material purchase value of non-product output and makes it possible to track and trace where non-product outputs are created. Management can use this information to propose measures to increase the efficiency of material use that will reduce environmental impacts and concurrently improve economic performance of the organization.

The purpose of material flow balance as explained by Jasch (2009, p. 832) is to completely understand how much of what is put into the system becomes a product, and how much becomes non-product output (NPO). The generation of waste or NPO is a sign of inefficient production. Therefore, material flows, are not only important for assessment of environmental cost, but also for production oriented cost assessment. It had been concluded that Material Flow Cost Accounting (MFCA), although in its imperfect form, is a powerful tool to ensure the future sustainability of a business. Schmidt and Nakajima (2013) concluded that a key concept of MFCA is to distinguish between product cost and non-product output, to evaluate which streams of material end up as part of the final product and which streams of material are non-product output. Once material losses are quantified, improvement measures and opportunities to reduce costs by avoiding material losses are identified. Knowing the complete costs allows for scope for technical measures to be implemented in order to reduce material loss.

One of the major cost drivers reported during company workshop studies was the material purchase value of non-product output (Jonall, 2008, p. 32). Thus evidence has been found that has identified material purchase value of non-product output as the category of EMA that has the potential of largest cost savings as stated by Jonall (2008, p. 40). Polluting companies actually pay three times for non-product output. First, the cost of purchasing the raw material which ends up as wasted material. Secondly, the company incurs costs for operational use of raw material, example labour and investment cost. Finally, the company then pays for the disposal of this wasted material (Jonall, 2008, p. 42). This is the actual cost of the wasted material which most companies fail to realize. Making them aware of this can create the need to improve material efficiency by investing in newer, cleaner production technologies. Not all wastes and emissions can be eliminated even if state of the art technology (BAT) is used, Domil, Peres, and Peres (2010, p. 720) believe that a more suitable approach to help managers plan cleaner production measures and investments in cleaner technologies would be to create three different benchmarks against which companies can compare their non-product output costs. These benchmarks will be an indication as to how a company can manage and control their non-product output costs in the short-, medium, and long-term. The first standards indicate technological norms.

These represent the most efficient use of material at optimal functioning of the company's existing technology. Best available technology (BAT) levels are more stringent. These technologies are considered to be the most efficient and environmentally protective available on the international market currently.

Domil, Peres, and Peres (2010, pp. 721-722) discussed the different levels of non-product output costs and how these costs can be controlled within different time frames. The difference between actual non-product output costs and cost for the technological norms is what most companies will be interested in for operational reasons. This information shows deviation from technological standard costs due to inefficient use of existing technology.

The non-product output costs at this level can be reduced by better housekeeping, example better monitoring of raw material consumption, avoiding scraps and wastes and reducing energy and water consumption. This information needs to be generated on a monthly basis for companies to react faster. Level 2 non-product output costs (BAT) norms need to be generated on less frequent basis. This can be used to work out the economic feasibility of performing technological improvement.

This information will be used when considering changing technologies, between 3-7 years depending on the technological life cycle of the equipment. Total environmental costs reported must include non-product output costs related to BAT. It is suggested that these costs be calculated annually for internal reporting purposes and to assist managers in making important investment decisions.

Domil, Peres, and Peres (2010, pp. 721-722) discuss the different levels of NPO costs and how these costs can be controlled within different time frames.

Benchmarking and controllability of non-product output costs

Benchmarks are used in environmental management to compare environmental performance. Benchmarking allows companies to assess their performance and identify opportunities for improvements.

Table 2. Benchmarks of companies

Material purchase value of non-product output	Ability to control cost	Method of controlling cost	Potential cost savings
Non-product output less technological standards	Short-term	Good housekeeping measures	Small to medium
Technological standards cost less state-of-the-art standards	Medium-term	Switch to state-of-the-art technology	Medium to large
State-of-the-art standards less theoretical costs	Long-term	Technological invention	Medium to large

Source: Csutora and Palma, 2009, p. 6.

Furthermore, benchmarking assists managers in identifying areas that incur large environmental costs that could be easily reduced by good housekeeping measures. It can, therefore, be concluded that since benchmarking is a process of continuous searching for best practices in completing tasks, it is also most likely that this could increase an organizations' success in adopting CP techniques and technologies.

Conclusion

Recent paradigm shift of environmental management from pollution control to pollution prevention had led to the introduction of Cleaner Production techniques and technologies. The emphasis of CP is on reducing waste at its source. Many case studies have been cited in the literature review highlighting the benefits of adopting CP measures. However, in South Africa, CP is still very much in its infancy stage. Research shows that this is the only solution for companies that generate significant waste and consume large amount of resources. Waste is a sign of inefficient production processes which impact negatively on a company's profitability and environmental performance. In order to identify which processes are inefficient, there is a need to trace material and energy flows.

Material Flow Cost Accounting (MFCA), an EMA tool, traces the flow of material throughout the entire production process, highlighting inefficiencies. The most significant portion of environmental costs was non-product output costs. Previous research has shown that MFCA accurately traces the monetary and physical amounts of non-product output costs. It increases the transparency of environmental costs allowing managers to identify saving opportunities by adopting CP techniques or technologies. This enables them to make informed investment decisions and to assess the benefits of adopting Cleaner Production techniques or technologies.

It is evident from various case studies that many organizations are not fully aware and knowledgeable on how to actually implement EMA and, therefore, are unable to experience the benefits of EMA implementation. Since this concept is new to many industries, there is clearly a need for more structured guidelines on how to adapt current management accounting practices to include environment-related information.

Governments, environmental support groups and other regulatory organizations need to promote and encourage EMA adoption in various industries. EMA implementation remains a 'niche' in South Africa as organizations are reluctant to adopt new systems unless they are compelled to do so as a regulatory or legislative requirement.

References

1. Abdel-Kader, G.M. (2011). *Review of Management Accounting Research*. United Kingdom. Palgrave Macmillan, pp. 63-65.
2. Albelda, E. (2011). The role of management accounting practices as facilitators of the environmental management: Evidence from EMAS organizations. *Sustainability Accounting, Management and Policy Journal* (online), 2(1), pp. 76-100. Available at: http://www.emeraldinsight.com/journal.htm (Accessed 9 June 2014).
3. Ambe, M.C. (2007). *Environmental Management Accounting in South Africa. Status, challenges and implementation framework.* D.Tech. Tshwane University of Technology.
4. Bennett, M., Schaltegger, S., and Zvezdov, D. (2013). *Exploring Corporate Practices in Management Accounting for Sustainability* (online), pp. 1-56. Available at: http://www.icaew.com/academic (Accessed 15 March 2014).
5. De Beer, P. and Friend, F. (2006). Environmental accounting: a management tool for enhancing corporate environmental and economic performance, *Ecological Economics*, 58 (3), pp. 548-560.
6. Domil, A. E., Peres, C., and Peres, I. 2010. Capturing environmental costs by using activity based costing method. *Economic Science Series* (online), pp. 719-721. Available at: http://www.ceeol.com (Accessed 10 October 2013).
7. *Environmental Strategies* (online) (2013). Available at: http://www.unido.org/en/what-we-do/environment (Accessed 18 March 2014).

8. Hyrslova, J., Vagner, M., and Palasek, J. (2011). Material Flow Cost Accounting (MFCA) – Tool For The Optimization of Corporate Production Processes, *Business, Management and Education*, 9 (1), pp. 5-18.
9. Japanese Industrial Standards committee (2007). *International standardization committee for Environmental Management Accounting*. Preliminary proposal for the International Standardization of Material Flow – Based Envonmental Management Accounting for ISO TC 207, pp. 1-3, pp. 10-11.
10. Jasch, C. and Schnitzer, H. (2002). Environmental Management Accounting. How to profit from environmental protection. EMA – environmental management accounting pilot testing.
11. Jasch, C.M. (2008). Environmental and Material Flow Cost Accounting – Principles and Procedures, *Eco-Efficiency in Industry and Science*, 25. Heidelberg: Springer-Verlag.
12. Jonall, P. (2008). *Environmental Management Accounting (EMA), Management Accounting including Environmental Management*, 2.
13. Khalid, F.M., and Lord, B., and Dixon, R. (2012). *Environmental management accounting implementation in environmentally sensitive industries in Malaysia.* 6th NZ Management Accounting Conference. University of Canterbury, New Zealand.
14. Ministry of Economy, Trade and Industry of Japan (METI) (2010). *Environmental Management Accounting: MFCA Case Examples;* METI: Tokyo, Japan.
15. Olson, O. and Jonall, P. (2008). Environmental Management Accounting (EMA), *Management Accounting including Environmental Management – a literature review*.
16. Scavone, G.M. (2006). Challenges in internal environmental management reporting in Argentina, *Journal of Cleaner Production* (online), 14, pp. 1276-1285. Available at: http://www.sciencedirect.com (Accessed 23 October 2013).
17. Schaltegger, S., Bennett, M., Burritt, R.L., and Jasch, C. (2010). *Eco-efficiency in industry and science. Environmental Management Accounting for Cleaner Production.* 5th edition. Springer Science and Business Media. UK.
18. Schmidt, M. and Nakajima, M. (2013). Material Flow Cost Accounting as an approach to improve resource efficiency in manufacturing companies. *Resources* (online), 2, pp. 358-369. Available at: http://www.mdpi.com/journal/resources (Accessed 13 March 2014).
19. Sygulla, R., Bierer, A., and Gotze, U. (2011). *Material Flow Cost Accounting – Proposals for Improving the Evaluation of Monetary Effects of Resource Savings Process Designs*. 44th Conference on Manufacturing Systems (online). Wisconsin, USA. Available at: https://tu-chemnitz.de/wirtschaft/bwl3/DownloadAllgemeinOffen/44thCIRP_MFCA.pdf (Accessed 3 September 2013).