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A Review on Material Flow Cost Accounting (MFCA) for SMEs

Alok Shah[1], David Jacob[2], Deep Desai[3], Dhruvrajsinh Atodaria[4], Prof. Bhavesh Modi[5]

[1]*Mechanical Departmemt, Shri S'ad Vidya Mandal Institute of Technology (Bharuch);*

[2]*Mechanical Departmemt, Shri S'ad Vidya Mandal Institute of Technology (Bharuch)*

[3]*Mechanical Departmemt, Shri S'ad Vidya Mandal Institute of Technology (Bharuch)*

[4]*Mechanical Departmemt, Shri S'ad Vidya Mandal Institute of Technology (Bharuch)*

[5]*Mechanical Departmemt, Shri S'ad Vidya Mandal Institute of Technology (Bharuch);*

Abstract *– The main goal of this review paper is to explain the concept and procedure of MFCA as concerning a manufacturing company. The idea of MFCA is to contribute to the sustainable and complete development of an organization. Early findings suggest that the MFCA offer great potential for improvement in economic and environmental performance and therefore, it is recommended for manufacturing firms to proactively adopt it to achieve the sustainable development. Accordingly, examples of SMEs are taken into account. A comparison of company strategy has been given both before and after implementing MFCA. This helps in the following ways: (i) Cause of waste generation and its amount; (ii) Costs of wastes and ways to reduce them. It saves essential company assets while also reducing the organizations' negative environmental impact as material and energy saved can be used again for further purposes, thus reducing the load on the environment to sustain these organizations.*

Keywords *– Material Flow Cost Accounting, Environmental Performance, Waste Generation, Waste Reduction, Material and Energy*

I. INTRODUCTION

In the last decade, many manufacturing industries/facilities are focusing on sustainable development and higher productivity by the reduction of two things – costs (includes all material, energy and waste management costs) and wastes/emissions. A reduction in wastes/emissions is favoured as it has a negative impact on the environment. Thus new manufacturing techniques have been invented, like, lean manufacturing, cleaner production (CP) techniques, and many more.

The problem faced in the extant or the new techniques developed was that while these techniques were effective they could not extend a relationship of sorts between the costs happening and the environmental impact that any manufactured component may cause. This is when a new practice was introduced known as **M**aterial **F**low **C**ost **A**ccounting (MFCA). Developed and introduced in Germany during the 1980s, it was adopted in the Japanese industries rapidly in the 2000s and became a huge success. This methodology was then incorporated into the International Organization for Standardization (ISO) as a norm in 2011, i.e., EN ISO 14051:2011.

MFCA is one of the most basic Environmental Management Accounting (EMA) tools designed to help calculating the cost both direct and indirect of each product manufactured and then assign these costs to the element manufactured/fabricated (positive product) as positive product cost and the wastes generated (negative product) during the processes as the negative product cost.

Thus, such a differentiating method helps us to understand where exactly on the plant floor are the most wastes generated and thus the more losses occurring. Such data can be used to accurately pinpoint the source of losses and/or emissions inside any production plant and be effectively modified.

This literature outlines the procedure in which MFCA is implemented and the potential benefits behind it. MFCA works for attaining sustainable productivity while keeping both the Economy and Environment stable. Here is a graph showcasing how MFCA is implemented step by step:

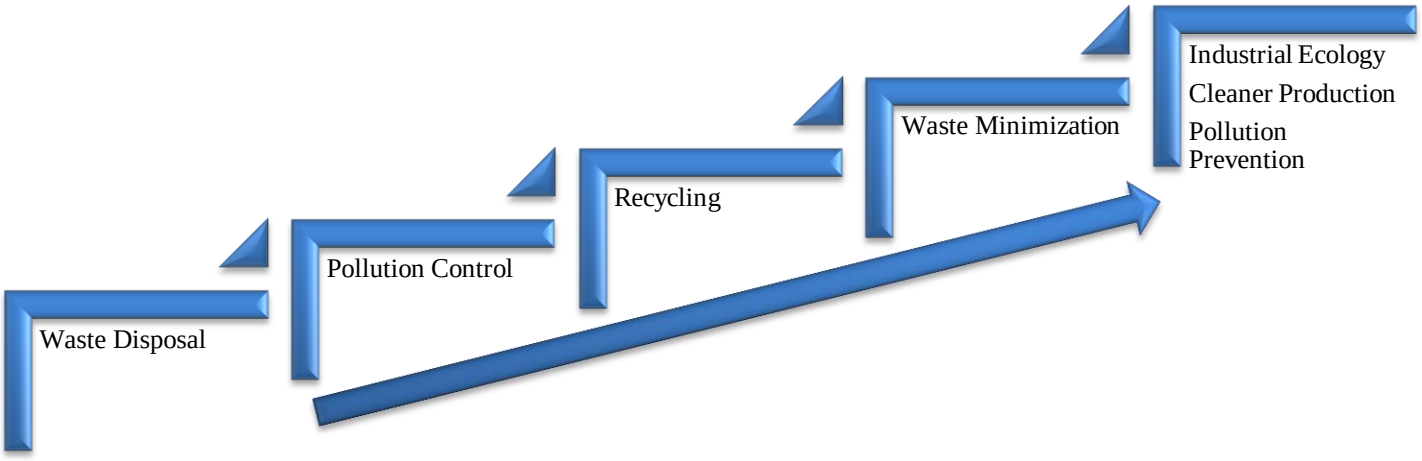

Figure1. Staircase of MFCA Implementation over [3]

II. LITERATURE REVIEW

The aim of this review is to present a framework of Material Flow Cost Accounting (MFCA) according to the various views of many authors and/or industrialists as they have understood MFCA concepts and its performance.

MFCA, as defined by ISO a "tool for quantifying the flows and stocks of materials in processes or production lines in both physical and monetary units"(ISO 2011) where 'materials' will also include energy and water. We consider these material flows and stocks as important as almost all business facilities work effectively on these flows. MFCA's aim is to provide statistical and logical data to any organization about the prospects of decreasing material use and improving the financial performance of the firms at the same time, which is quite a desirable opportunity.

Environmental strategies are being incorporated by industries and organizations, in order to improve their competitiveness. To allow the efficient use resources, while also resolving waste management and disposal issues, all the while sustaining their future and competitiveness, the management of any organization needs to consider adopting Cleaner Production methods and technologies. However, management is not keen on this strategy as they feel that CP techniques are an expensive strategy to implement and one which, while being innovative, does not provide any financial benefits to the organization. The purpose behind this project is benchmark the cost of company by comparing best-available technology and material balance indicators against technological standards. The abstracted summary is based on a MFCA implemented case study which focused on the manufacturing processes and material flow. The implementation of benchmarking enables managers to analyse and evaluate how they can improve both their economic and environmental performance in the long run and also keep up with their sustainability targets.

In many developing countries due to lack of technology up gradation wastage and emissions are higher results in profit reduction and time consumption. Strategies to reduce dependence and use of energy from fossil fuels needs to be introduced (Stringer et al, 2010). Inefficiency in production processes can affect both their profitability and competiveness. It was concluded after a global evaluation of a joint cleaner production program by UNIDO and UNEP, that CP strategy is HIGHLY motivated to implementation for companies in both developed and developing countries (Berkley, 2011). Many companies are using less efficient processes and technologies that are olden and obsolete and it consumes high resources and energy and then if they were using state-of-the art processes. This ultimately results in higher production costs which in turn affects their profitability and competitiveness. A direct consequence of these inefficiencies is rapid environmental degeneration, excessive amounts of pollution and waste generation which in turn is hazardous to human health and affects quality of life. [1] Audits into cleaner production assessments of production centres found that there are large savings potential and opportunities to be enjoyed but companies are not aware of it because of no computerized data collection and summery of any data. As the old saying goes, what you do not measure you cannot manage".

According to experts waste and emission are reasons for inefficiency and lower production rate. The cost of waste is higher due to higher material cost not because of fees of disposing material. We know that most companies have ISO 14001 regulations in follow but the companies are yet to move towards cleaner production

and eco-friendly production. Now question arise is whether it is more efficient economically and environmentally to produce goods with Cleaner Production (CP) technologies and strategies implementation. The wrong concept for companies is to have short term profitability rather than long term sustainable development. Companies are needed to be aware of unsustainable production cost and it is Environmental Sustainability Performance Benchmarking. This project will include information regarding sustainability and clean production. As a conclusion of project, Industry will have ability to analyse and evaluate how to improve both economic and environmental performance in the future and attain their sustainability targets by implementing the strategies to benchmarking that is MFCA.

Table.1 given below lists out some of the few SMEs (Small and Medium-sized Industries) that have benefitted immensely after implementing MFCA. A comparison is provided before and after MFCA implementation that gives precise knowledge about the changes in company losses and profits.

Table1. Examples of SMEs

Name of Industry	Industry Type	Product Type	Before Implementing MFCA	After Implementing MFCA
Micro Brewery[2]	Food Industry	Beer	Difficult to gather information on waste cost and make waste reduction decisions. Also difficult to quantify material as well as energy losses.	Framework was made to measure the losses and the environmental issues according to organizational needs.
Paper Manufacturing Company[3]	Manufacturing Company	Paper	Material losses were not evaluated and added to negative products costs.	The company saved approximately Rs 1.1 crore and also achieved higher technological standards.
Japanese Camera Maker[4]	Manufacturing	Camera Lens	Total process efficiency by other methodologies came as 99%. Extra wastage of lens material during grounding.	The total process efficiency came as 64% due to no accounting of negative products. Thickness of the lens was reduced from the supplier side leading to lower cost.
A SME of Taiwan[5]	Manufacturing	Metal Processing	Major wastes were produced from water resources which increased remaking cost of defective products by 100%.	Remaking cost was reduced by implementing checkpoints throughout the whole process to register waste produced while also eliminating old and obsolete equipment.
Textile factory in Thailand[6]	Textile	Clothes	Factors contributing to product cost were not pin pointed. Also Positive and Negative product cost were not ascertained.	It was discovered that during production 84.26% and 15.74% were the positive and negative product respectively. Material Cost was the highest contributor in negative cost, which was 14.73% out of 15.74%

III. TECHNIQUES OF EXECUTING MFCA

From the above examples, we can see how MFCA has a relationship with every field, from food industry to manufacturing industry. MFCA concept can be applied successfully with clear results everywhere. We can also say that MFCA concept can be applied in all such organizations and institutions which use some type of inputs like manpower, energy, resources, etc., to obtain an output that can be marketed or supplied in the public sector for profit and customer satisfaction to obtain continued patronage.

As understood from the above information, in all the industries MFCA plays a similar role irrespective of type of industry or product. Thus, a relationship can be established across all businesses from engineering organizations to teaching institutions, hospitals, etc.

Mostly Industries who have successfully implemented MFCA and got better results after implementation followed PLAN-DO-CHECK-ACT Cycle. Industries can also increase profitability by creating flow structure modelling of processes, quantification of flows and cost appraisals of quantified flows.

3.1. Prolific results derived from executing MFCA

From Examples of different MFCA implemented industries it is conspicuous that all industries have increased their profitability either by reducing material consumption or by reducing material losses. Here, Different ways of implementing MFCA are discussed as below:

SMES like Micro Brewery lack in identification of generation of waste throughout different processes. At Micro Brewery, They needed to collect adequate information on financial and non-financial costs and impact due to waste generation. They implemented MFCA by adopting it at different management systems. After successful implementation they got attention on different costs generated during processes that they were not aware of before or conventionally structured management approaches couldn't reveal it. Having knowledge of waste generation, increased the attention of management to reduce it and helped management to take effective decision making to increase efficiency and profitability of Industry. Previously, Contribution of Energy cost to the Negative Product cost of Brewery was not identified, which was identified 43% after implementing MFCA. For beer production of every litre, 91% of water volume was estimated, but after replacing leaking pipelines, water usage was reduced to 71% per litre.

Table 2. MFCA matrix for Brewery[2]

	Material cost (R)	% of Total cost	Energy cost (R)	% of Total cost	System cost (R)	% of Total cost	Waste disposal	Total Cost (R)
Positive Product	110,124	70	31,350	20	15,732	10	0	157,206
Negative Product	83,076	70	23,650	20	11,868	10	0	118,594
Total	193,200		55,000		27,600		0	275,800

R1= $0.1183

At The Paper manufacturing company, Prior Material losses were not evaluated and cost relevant to losses were not identified. Implication of MFCA helped industry to understand negative costs merged with material losses. MFCA implementation helped industry to count negative costs. It increased ability of industry to take decision towards waste reduction. To achieve high standards of quality and Profitability, They improved technological standards.

Canon is a renowned Industry for Camera Lenses. They implemented MFCA to understand losses and to reduce manufacturing timings. After Implementing MFCA, it was identified that 68% was positive product cost and 32% was negative product cost. The Implications revealed extra wastages were occurring during grinding processes. They looked into supply chain management to reduce wastage. They asked their suppliers to reduce the thickness of lens which resulted in reduction in wastage generation and helped industry to lower product cost.

A Taiwan based Metal Processing Company implemented MFCA to reduce the wastage generated during the processes. MFCA helped Industry to minimal the wastage and also increase social responsibility to make cleaner production. MFCA helped industry understanding environmental cost affiliated with all processes written in the Table 3. It enabled industry to reduce negative costs generated during processes and reduced product cost and environmental impacts.

Table 3. Positive Products in Taiwanese Company[5]

	Drawing	Spheroidizing	Phosphating	Continuous Drawing
Material costs	$25.1133	$25.1133	$25.1133	$25.1133
System costs	$0.3098	$0.4425	$0.6863	$0.8792
Energy costs	$0.1684	$0.7095	$0.7897	$0.8374
Total costs	$25.5915	$26.2654	$26.5893	$26.8299

Small Textile Industry implemented MFCA and it revealed the negative product cost 15.74%. Further, it was found that material cost was 14.73%. After Implications of MFCA Industry got insightful ideas which can save product cost and Industry successfully reduced negative cost to 11.27%. In depth, cost analysis revealed that 80% of the negative cost was generated due to cutting and sewing processes. Industry achieved high efficiency by taking necessary measures at different managerial levels and by revising the design of clothes. An outline of the positive and negative products is as shown in Table 4.

Table 4. Process chart for Thai Textile Industry (Cost in Baht)[6]

Process	Total input material cost (1)	Negative product cost (2)	Positive product cost (3)	(2)/(1)	% In total negative product cost
Cutting	7924.12	1296.54	6627.57	16.36%	61.69%
Sewing	6627.57	427.91	6199.66	6.46%	24.36%
Others	511.37	18.90	492.47	3.70%	13.95%
Total				26.52%	100%

To sum up, Industries, which have successfully implemented MFCA concepts, have gained cleaner production systems and increased their profitability by minimizing negative costs identified by MFCA. Different Industries have adopted MFCA concept for different processes but, it increased capability of management towards social responsibility and Industries emerged as an eco-efficient Industries.

IV. CONCLUSION

MFCA is a contemporary tool which helps industries to minimize their environmental cost and increases production quality. Implementing MFCA leads manufacturers towards cleaner production as well as green manufacturing. It helps Industries to establish benchmarked standards for lean manufacturing. MFCA enhances processes of industries to be eco-efficient and increases decision making of management. It also helps to achieve sustainable development of the firm as well leads to overall growth of the company.

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