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The effectiveness of using material flow cost accounting to eliminate losses

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Abstract

This investigation aimed to explain the mechanism of MFCA by applying this method on air-cooled engine factory which was suffering from high production cost. The results of this study revealed that MFCA is a useful tool to identify losses and inefficiencies of the production process. It is found that the factory is suffering from high losses due to material energy and system losses. In conclusion, it is calculated that system losses are the highest among all the losses due to inefficient use of available production capacity.

Keywords: Material Flow, Cost Accounting, Management.

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La efectividad del uso de la contabilidad de costos de flujo de materiales para eliminar pérdidas

Resumen

Esta investigación tuvo como objetivo explicar el mecanismo de MFCA mediante la aplicación de este método en una fábrica de motores enfriados por aire que sufría de un alto costo de producción. Los resultados de este estudio revelaron que MFCA es una herramienta útil para identificar pérdidas e ineficiencias del proceso de producción. Se encontró que la fábrica está sufriendo grandes pérdidas debido a la energía del material y las pérdidas del sistema. En conclusión, se calcula que las pérdidas del sistema son las más altas entre todas las pérdidas debido al uso ineficiente de la capacidad de producción disponible.

Palabras clave: Flujo de materiales, Contabilidad de costos, Gestión.

1. INTRODUCTION

The environmental management system for businesses was introduced in 1990. This gave birth to the issues of input optimization (reduction of material and energy) as a common goal of economic and environmental interests (Schaltegger and Zvezdov, 2015). The concept of environmental management accounting (EMA) has emerged which provides information on the environmental aspect. Environmental management accounting (hereafter referred as EMA) includes life cycle costing; including assessment of benefits and strategic planning for environmental management and improves business operations by minimizing waste (Hyrslova et al., 2008). In the last two decades, the

EMA literature has developed to incorporate a number of different tools, whereas Material Flow Cost Accounting (MFCA) is the most fundamental and well-developed techniques (Christ and Burritt, 2015). The Ministry of Economic Trade and Industry (METI) in Japan started EMA project in 1999 and published a workbook in 2002. The METI project developed the six EMA tools ranging from environmental capital investment appraisal, environmental target costing, environmental cost matrix, life cycle costing and material flow cost accounting. Moreover, METI project implemented some pilot studies by introducing MFCA into four Japanese companies (Nitto Denko, Tanabe Seiyaku, Takiron and canon). The idea of MFCA was first introduced by Wagner and Strobel (Schmidt et al., 2013). Japan took the initiative to incorporate MFCA with the ISO 14000, the objective was to set out and standardize the general principles and frameworks for MFCA in order to disseminate the method. Consequently, MFCA was adopted in 2011 and published as ISO 14015 (Schmidt and Nakajima, 2013). Material Flow Cost Accounting helps to analyze the overall operating process such as, reducing waste and maximizing resource utilization. Therefore, effective use of resources leads to cost minimization and improvement in the manufacturing process (Ichimura, 2012).

Most of the industrial companies in Iraq suffer from high production costs due to several factors including the different type of waste in the production processes and processing raw material. The traditional methods for the calculation of production costs consider all the costs incurred during the manufacturing of the products. Although some costs are non-productive and result from waste and loss of resources during the production process which results in higher production costs. The traditional production systems in Iraqi companies lead to high-cost products which do not fulfill the demands of customers. The purpose of this paper is twofold: first is to identify the concept of MFCA and determine the requirements for the application of this method in the case study of General Company for Electrical Industries in Iraq. Second is to calculate the effectiveness of MFCA method in determining losses in production processes and reducing costs in General Company for Electrical Industries. This will helps the management to improve the manufacturing process as well as benefits of environmental protected operations to promote long term sustainability.

2. LITERATURE REVIEW

The research dealt with the concept of material flow cost accounting. The historical review of literature to explain the structure and objective of MFCA has been undergone. Furthermore, the process of MFCA costs calculation to reduce production costs and losses has also been discussed in detail.

3. THEORETICAL FRAMEWORK

Material Flow Cost Accounting (MFCA) is described as the Environment Management Accounting (EMA) tool aimed at simultaneously reducing both cost and environmental impact (Doorasamy and Garbharran, 2015). MFCA is a material and energy flow-oriented accounting approach, which can be used within an environmental management accounting framework. The focus of MFCA is to control and optimize material and energy flows as cost objects. The MFCA aimed at higher visibility for inefficiencies in a production system. Therefore, losses and other inefficiencies are quantified and visualized regarding their physical units and their costs.

In MFCA inputs and outputs can be determined through a quantity center. The inputs can be materials, energy, water and other inputs whereas the output can be primary products, wastes, wastewater and emissions (Hyrslova et al., 2011). Material loss refers to a material, energy and other economic resources that were not transformed into products and left unused as waste resulted from the production process (Sipi, 2013). The usage of material can be monitored in physical units or monetary units (material cost). The data can be ascertained to determine which part of the material flows to products and which part leaves as material losses after analyzing the material flows within a quantity center (Ichimura, 2012). In the production processes, waste and loss of resources occur at different stages. Waste material generated from processing includes the material loss during processing, material remaining in equipment, auxiliary material and work in process material of discarded products. MFCA measures the stock of raw material in a production process and their flow in terms of physical and monetary units. Bierer et.al. (2015) classified the costs of products as positive product cost and negative product cost. Positive product cost is further defined by Ichimura (2012) as the cost of all activities in the production process until the final output. In addition to this, Sipi (2013) asserted that positive product cost is subdivided into material cost, energy cost and system cost. Material cost includes the cost of all input material whereas energy cost consists of electricity, fuel and related energy sources. System cost can be defined as the all other costs instead of material and energy (labor, transportation, depreciation etc.). Consequently, negative product cost consists of all wasted or recycled items during the production process (Schmidt et al., 2013). Waste cost includes material losses, defective product, defective processing, and deterioration of work process inventory, deterioration of finished goods and loss of auxiliary materials (Schmidt et al., 2013). Loss cost is due to defective products, wastes and other emissions, by calculating their quantities and resources used in each step or stage of the manufacturing process and converting them into monetary value. In addition to the raw material cost, labor cost, depreciation cost and other processing costs are also quantified under loss cost (Let et.al, 2010). Figure 1 explains the basic concept of cost classification under MFCA.

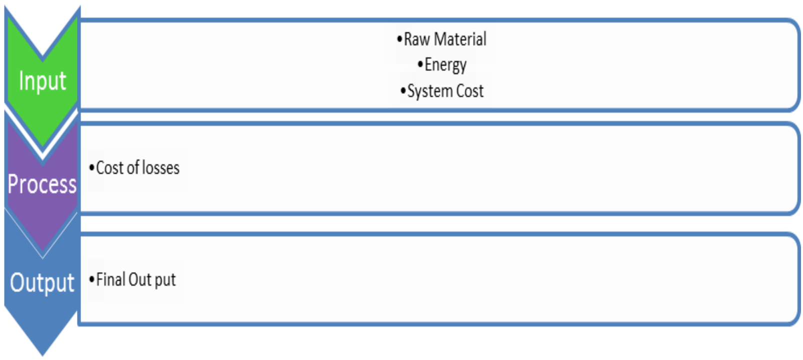

Figure 1: Distribution Cost in Value Chain According to MFCA (Schmidt and Nakajima, 2013)

Figure 1 illustrates material that cannot be converted into finished goods and classified as losses. It explained that, the loss during whole value chain production process from input to output. Therefore, the purpose of MFCA assessment it to examine the waste produced in the system in terms of quality control failure at each production process. Under the traditional cost accounting system, all costs are allocated to the products as the cost of unit produced. Material losses such as waste or unproductive outputs are not recognized, and waste is viewed as irrelevant to the value chain process (Change et al, 2015). The process of applying MFCA needs to provide advanced production systems to help eliminate the waste and loss that occurs during the production processes. In this regard, the system that is required in the industries is the lean production system. The term lean production is a concept that implies a series of activities or solutions for identifying and eliminating waste and non-value operations (Malihe et al., 2014). Lean is referred to as a powerful set of tools and techniques sustained as a way of increasing the customer value while at the same time eliminating waste.

3.1. MFCA process and lean production system

The model of lean production was born in the 1950s at the Toyota factories. Toyota was getting ready to enter the low-price markets with a variety of cars, which required flexibility in the production system of the factories. Ichimura (2012) were the first to use the term lean production in their seminal publication the machine that changed the world. In this book, they translated the model of Toyota's production system to the Western world. The lean production assumes the continuous change in a production environment by taking an optimal decision. Therefore, the implementation of lean production system needs to change the accounting system. However, the appropriate management accounting system for lean production is a vital task (Aherns, 2006). A well-designed accounting system is necessary to avoid the negative consequences of the lean production system.

MFCA is the logical continuation of the efficiency approach of lean production with a focus on both the reduction of cost and environmental burdens. At the same time, the method also offers major opportunities for learning from the long-standing and practice-driven experience of lean production. There is a correlation between MFCA and lean production through the fact that MFCA focuses on the smooth flow of materials during production processes by eliminating the waste during production processes. Therefore, companies that implement lean production can easily apply material flow cost accounting.

3.2. Benefit of MFCA

Doorasamy and Garbharran (2015) explained that MFCA provides internal benefits for the company by strengthening the company competitiveness. Since MFCA delivers twofold benefits in terms of increased profits and material productivity whereas identifying problems and the insight of the existing economic loss hidden under conventional cost accounting. It highlights conventionally uncontrolled material losses which only on-site operators are normally aware of and assists in identifying material loss reduction options. Furthermore, MFCA is a tool to enhance the efficiency of operations and produce products with less input. Therefore, a reduction in wasteful activities leads to better profitability and long-term sustainability of the business.

4. METHODOLOGY

The research aimed to achieve understanding with the concept of MFCA while identifying the method of classification and calculation of costs. This research applied material flow cost accounting to the Iraqi industrial companies to elaborate the relationship between the lean production system and MFCA. Therefore, a case study method is applied in this regard. This material flow cost accounting was applied in an industrial company, which suffers from problems of waste and loss. The processing of material from input to output was analyzed and divided into the different process to identify the efficiency of each process (Doorasamy and Garbharran, 2015; Gould and Colwill, 2015; Ichimura, 2012).

4.1 Overview and description of the manufacturing process of general company for electric industries-air cooled engine factory

The General Company for Electrical Industries - Air Cooled Engine Factory is selected as a sample for research. Hence, this study follows the case study approach. The costs of production for each stage of production in the factory are calculated according to MFCA for the year 2017.

4.1.1 Organizational profile

The General Company for Electrical Industries is one of the most distinguished industrial companies in Iraq in terms of product line. The air-cooled engine is a key part of the air cooler used for home cooling in Middle East countries. However, in the last 10 years the company suffered from a significant drop in demand for its products due to the high price as compared to competitors. The air-cooled engine factory is selected as a case study. The factory is one of few factories in the company that still manufacturing products despite the low demand for its products. The high cost of manufacturing the air-cooled engine raised the need to apply new accounting methods in order to reduce production costs.

4.1.2 Material flow of target process

The Data on the production stages and costs of each stage in the air-cooled engine factory were obtained through the following ways:

1. The financial records prepared by the accounting department of the company were obtained and reviewed to identify the costs.

2. The author repeatedly visits the site to monitor and understand the production process of the factory.

3. Thorough interviews were conducted with the manager and field staff including engineers and supervisors of the production department.

The manufacturing process of air-cooled engine production was divided into eight processes. Each process contains a number of specialized machines and also includes manual processes. These processes are explained by the following figure 2.

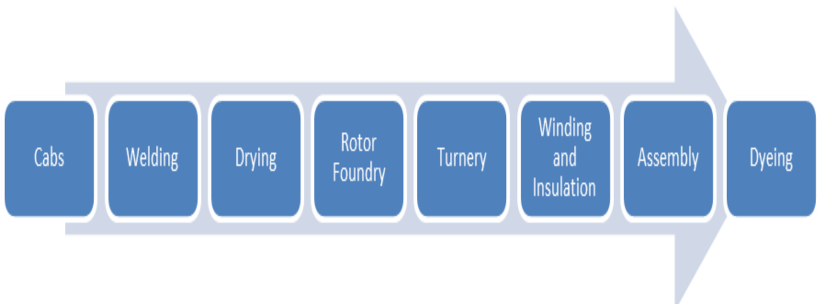

Figure 3: Distribution of manufacturing process

The working hours for the batch production line were seven hours per day. The major raw material of the factory was iron and aluminum. The factory of the air-cooled engine suffered from high manufacturing costs.

4.2. Costing method and calculations

There are several steps involved to identify and measure the cost of production in each step of the production process of the air-cooled engine. In the first step process of production was divided into nine processes whereas each process is considered as quantity center.

In a second step, the input is divided into two main categories as physical material and energy. In the third step, the quantity flow of material is identified for each quantity center to model the flow quantity model. The quantity flow model was determined under the following conditions:

a- Material inputs are determined by the number of units entering each quantity center, whereas material outputs are determined by the number of units manufactured in each quantity center.

b- Energy inputs are determined by the number of amperes consumed by each quantity center, whereas energy outputs are determined by the number of amperes that were actually used to manufacture the product during the month.

The quantity flow model then translated into financial terms by mathematical equations. The equations were followed to measure the cost of material, cost of energy and system cost.

Equation 1: Cost of Material

Cost of material input/output/losses = number of unit input/output/lose ×cost per unit input/output/losses

Equation 2: Cost of Energy Input

Cost of energy input = total energy cost of production department × (the number of amperes used in each quantity center ÷ the total number of amperes used in production department)

Equation 3: Cost of Energy output

Cost of energy output = cost of energy input × the rate of energy produced

Equation 4: Cost of Energy Losses

Cost of energy losses = cost of energy input – the cost of energy output

Whereas, the energy cost includes electricity, fuel and kerosene costs.

Equation 5: System Input Cost

System input costs = the total system cost for each quantity center

Equation 6: System output Cost

System output costs = cost of system input per unit ×number of output material

Equation 7: System Losses Cost

System losses cost = system input cost – system output costs

4.3. Drawing a model for each quality center

After determining the production process and identifying nine quantity centers, the next step is to draw a model for each quantity center that shows inputs, outputs and losses of material, energy and system costs. The factory calculates the cost of the air-cooled engine by dividing the total costs of the factory during the month by the number of engines produced during the month. To identify cost under MFCA, the costs were recalculated by allocating costs to each quantity center. These costs are divided into material costs, energy costs and system costs. The cost of losses was calculated through the difference between input costs and output costs for material, energy and system. The equations above have been adopted for the purpose of calculating the material, energy and system costs of each quantity center. Figure.3 depicts the complete model for each quantity center.

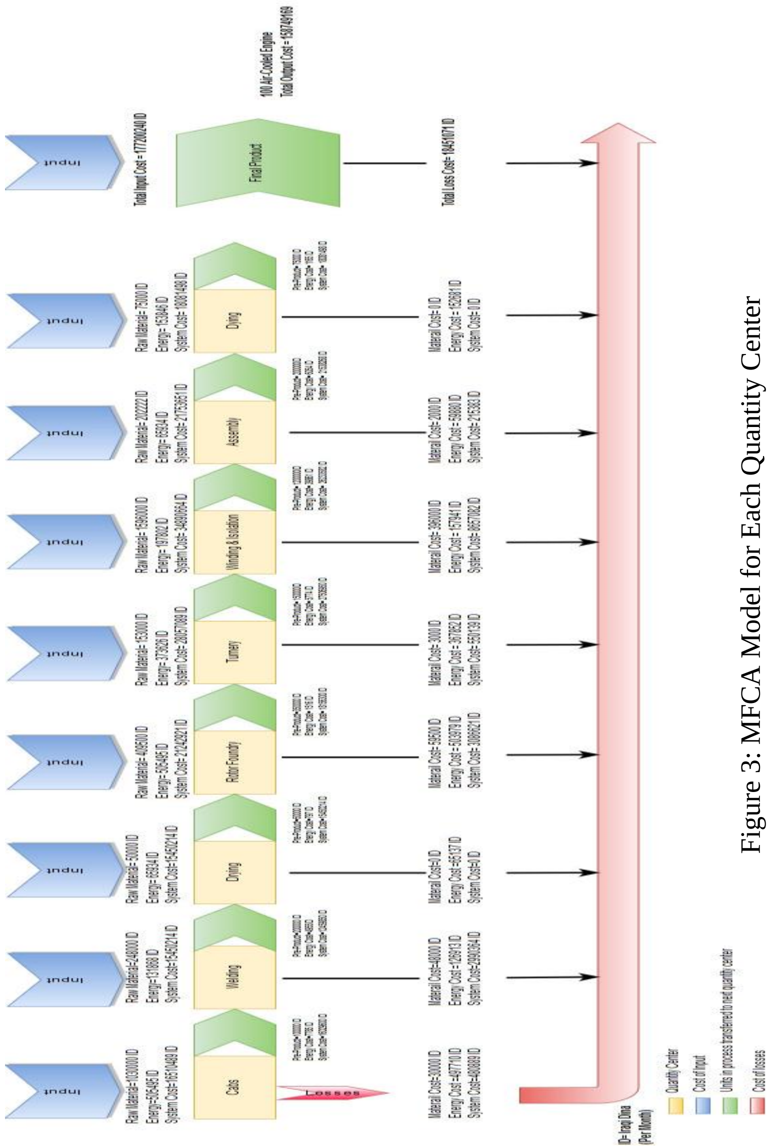

Figure 3: MFCA Model for Each Quantity Center

In addition, the costs of each quantity center has been classified as positive and negative costs, as show in table 1.

Table 1: Material Flow Costs Matrix for Quantity Center of the Air Cooled Engine Factory

Details	cabs	Welding structure and pressing stater	Drying	Rotor foundry	Turnery	Winding and insulation	Assembly	Dyeing	Total
Material cost Energy cost System cost	1030000 505495 16510489	248000 131868 15450214	50000 65934 15450214	409500 505495 21242921	153000 373626 28057089	1596000 197802 34890664	202000 65934 21753651	75000 153846 18081498	
otal input costs	18045984	15830082	15566148	22157916	28583715	36684466	22021585	18310344	177200240
Material cost Energy cost System cost	1000000 7785 16029600	200000 4955 12459850	50000 797 15450214	350000 1516 18156300	150000 5774 27506950	1200000 39861 26233582	200000 6054 21538268	75000 1165 18081498	
al positive costs	17037385	12664805	15501011	18507816	27662724	27473443	21744322	18157663	158749169
ate of positive osts to the total input costs	94.4	80%	99.6%	83.5%	96.8%	74.9%	98.7%	99.2%	89.6%
Material cost Energy cost System cost	30000 497710 480889	48000 126913 2990364	0 65137 0	59500 503979 3086621	3000 367852 550139	396000 157941 8657082	2000 59880 215383	0 152681 0	
Total negative costs	1008599	3165277	65137	3650100	920991	9211023	277263	152681	18451071
ate of negative osts to the total input costs	5.6%	20%	0.4%	16.5%	3.2%	25.1%	1.3%	0.8%	10.4%

In the above table.1, it is calculated that the total input cost of the air-cooled engine factory in June is 177200240 ID. This amount under Material Flow Cost Accounting is divided into two main groups.

1- Positive product costs**:** The total cost of produced goods in quantity centers are 158749169 ID which represented 89.6% of total input costs and these costs are charged to production during the month.

2- Negative product costs: The total cost of non-produced good in quantity centers are 18451071 ID which represented 10.4% of total input cost and these costs are charged to the profit and loss account during the month. The negative costs in the factory of the air-cooled engine are caused by the following reasons:

a- Losses of material cost resulting from defective units during production processes in quantity centers. The main reason for these defective units is the use of old technology. Obsolete technology leads to an increase in the rate of defects in quantity centers. Another problem identified during this analysis is the lack of quality control over the manufactured parts of the product in each production center. The lack of quality control leads to increase the rate of defective units.

b- It is found that a major cause of energy losses is that the machines are working very below to its production capacity. Therefore, a fixed system cost resulting in a major loss for the factory. For example, in the quantity center of winding and insulation, the available production capacity during the month of June was 660 units while the number of units produced during the month was only 100 units.

c- Losses of system cost generated from a high proportion of defective units in some quantity centers. Negative costs are excluded from the total costs of production which will reduce production costs by 10.4%.

5. CONCLUSION AND RECOMMENDATIONS

The MFCA method represents one of the accounting methods that are designed to support the decision-making process. This leads to improve production processes within the companies. It is also used to evaluate the performance of material flow during the production process. This study aimed to describe the basic steps to apply the MFCA method in Iraqi companies to assess the quality of the production process. The analysis of production process leads to determine the losses during each stage of production turns to improve performance. This investigation concludes that MFCA improves the traditional cost method by improving material costs. In manufacturing companies, material costs represent an important component of costs compared to other costs. Within MFCA, the data in physical units are interconnected with the monetary units. It explains the flow of material through the quantity center. This information can be used to support the decision-making that determines the types of losses occurred during the flow of materials in the quantity centers. By eliminating these losses that occur during the production processes the performance and profitability of the company can be improved. Another aspect of this study is that the cost of production can be reduced by improving the process. The identification of losses in each quantity center under MFCA in an air-cooled engine factory, the total costs were reduced by 10.4%. These costs are not charged to production during the period but are charged to the profit and loss account of the company. This study suggests guidelines for company management to improve performance and production process of air-cooled engine factory are as under;

1- Apply the target cost method because the competing products in the market are less expensive than products manufactured by the company.

2- There is an increase in the wages paid in the air-cooled engine factory due to the rise in the number of workers combined with the decrease in the number of units sold; therefore, the number of workers should be reduced. The benefit of reduced labor would be reflected in the reduction of production costs.

3- There is a problem in allocating factory overhead costs. The company depends on the traditional allocation and distribution method which leads to an inaccurate distribution and allocation of factory overhead costs. Therefore, the company should use Activity Based Costing System for the distribution and allocation of factory overhead cost.

4- Replacing the old machines for the air-cooled engine factory will reduce defective units.

5- Increase the sales to reduce system cost occurred due to inefficient use of production capacity of machines.

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