

# Indonesian Management and Accounting Research

<http://www.trijurnal.lemlit.trisakti.ac.id/index.php/imar>

---



## Environmental Management Accounting with Material Flow Cost Accounting: Strategy of Environmental Management in Small and Medium-sized Enterprises Production Activities

**Ahmad Maulana Syarif\***

Fakultas Ekonomi, Bisnis dan Humaniora, Universitas Trilogi, Jakarta  
Email: [ahmadms1003@gmail.com](mailto:ahmadms1003@gmail.com)

**Novita**

Fakultas Ekonomi, Bisnis dan Humaniora, Universitas Trilogi, Jakarta  
Email: [novita\\_1210@trilogi.ac.id](mailto:novita_1210@trilogi.ac.id)

\*Correspondence Author

### ABSTRACT

The purpose of this research is to analyze activities of related environmental costs that occur and how to manage the use of raw materials and energy in the production process. Research methods used are observation, interview, and documentation. While methods of analysis research data using qualitative descriptive analysis i.e., describing object examined through data collected to produce a generally accepted conclusion. Based on data retrieved explains that activities related to environmental management in the tofu production process has not been made optimally. This impact on the cost of environmental management has not been presented in environmental quality cost report which is divided into four types, namely prevention cost, detection cost, internal failure cost, and external failure cost. The results of the analysis in this research obtained information that raw material costs into positive output (product) of 88,74% and negative output (material losses) of 11,26%. This environmental quality cost report that is used as consideration in management decisions related to waste management as well as increased production practices related use of raw materials and energy in the production process as an effort to reduce material loss and minimize negative impact to the environment.

**Keywords:** waste production, Environmental Management Accounting, Material Flow Cost Accounting, raw materials and energy, environmental management

**JEL Classification:** D24, Q53, O13, Q56

Received:  
05 Jun 2018  
Revised:  
05 Nov 2018  
Accepted:  
18 Aug 2019

---

Indonesian  
Management and  
Accounting  
Research  
ISSN:  
(e) 2441-9724  
(p) 1411-8858

Volume 17  
Number 02  
July 2018

---

## INTRODUCTION

Small and Medium-sized Enterprises (SMEs) is a business sector contributed significantly to economic activity in Indonesia. Based on data from the Ministry of Cooperatives & SMEs by 2013 that entrepreneurs in Indonesia are still dominated by SMEs amounting to 99.99% from all business units or 57,895,721 business units consisting of 57,189,393 units of micro-enterprises, 654,222 units of small business and 52,106 units of medium business. In business activities, whether a large-sized entrepreneur or SMEs unwittingly generates waste production impacting potential negative for the environment. Waste production does not only occur at the end of the production process but can also be started from the use of raw materials and energy during the production process. The efforts made by various parties including government through the Ministry, Office related, nor the environmentalists and both institutions as well as individuals presumably yet to produce something very significant to mitigate these environmental problems.

In conducting its activities, entrepreneurs seldom realize the stages of the production process that can cause deficiency and material loss, which are considered the cost. They are not aware that these costs can affect production cost.

Many SMEs in Indonesia produce tofu, a soybean processed food liked by Indonesians. Tofu is one of the authentic and distinctive products owned by Indonesia. Various people from young to old are really like of this one soybean processed food. Currently, the tofu industry not only shaped home industry committed by individuals but has been developed into a large company in Indonesia. The existence of these industries is economically beneficial for the entrepreneur or government. Although the tofu industry has become bigger and economically beneficial, waste disposal has not been placed as a priority for this business. The utilization and further processing of these wastes can involve three elements that are known by the 3R i.e., reuse, reduce, and recycle, as well as potentially increasing profitability of the company.

According to Haryanto (2010), the company requires environmental accounting systems as control over corporate responsibility, for the management of waste is done by the company requires measurement, assessment, disclosure and reporting the cost of waste management from the results of operations of the company. The

system of Environmental Management Accounting (EMA) with Material Flow Cost Accounting (MFCA) is a system that the company/industry needed to resolve these problems. In EMA with MFCA system, companies must consider the issue that focuses on deficiency production process and describes input and output of use of raw materials and energy in physical and monetary units so give companies overview about a material loss that occurs inflow of raw materials and energy use in production process as well as present the related activities environmental management in production activities as management considerations in decision-making process.

The purpose of this research is to analyze related activities of environmental management costs that occur and how to manage the use of raw materials and energy in the tofu production process through design and implementation of Environmental Management Accounting with Material Flow Cost Accounting. Hopefully, this research can deliver benefits for tofu manufacturers in “Primer Koperasi Produsen Tempe Tahu Indonesia” or commonly abbreviated PRIMKOPTI tofu production center, South Jakarta which consists of 3 (three) tofu manufacturers as objects of research. The tofu manufacturers can then use energy and raw materials optimally to reduce material losses and provide related information activities of environmental management in production activities to minimize the negative impact on the environment.

## **LITERATURE REVIEW**

### **Definition of Environmental Management Accounting**

Environmental Management Accounting (EMA) is identification, collection, analysis and use of two types of information for internal decision making: (1) physical information on the use, flows and destinies of energy, water and materials (including wastes) and (2) monetary information on environment-related costs, earning and saving (UN-DSD, 2001). While Ikhsan (2009) suggests that the concept of EMA is used to perform managing and evaluating measurable information from financial or management accounting (in monetary units) as well as current data on raw materials and energy are interconnected in reciprocity to enhance the efficiency of the utilization of raw materials or energy, reducing the environmental impact of the company's operations, products and services, reducing risks to the environment and improve the results of the management of the company.

### ***Benefits and Advantages of Environmental Management Accounting***

According to the Guide to Corporate Environmental Cost Management (2003) in IFAC (2005), the benefits and advantages of EMA consist of:

a. Compliance

EMA is beneficial to support the protection of the environment through compliance with environmental regulation internally.

b. Eco-Efficiency

The benefit provided is in the form of simultaneous support towards cost reduction and environmental impact through the use of energy, water, and materials that are more efficient in the process and the products of the company.

c. Strategic Position

The benefit provided is in the form of support in the evaluation and implementation of programs that are environmentally friendly and effective in terms of cost to ensure the strategic positioning of the company in the long term.

### ***Definition of Material Flow Cost Accounting***

Material Flow Cost Accounting (MFCA) is a management tool that is designed to support better environmental management, enhance the competitiveness of the company, and developed more sophisticated manufacturing techniques. MFCA measure waste or emissions from each process and evaluate them in terms of cost reduction. MFCA will become a tool that can solve problems related to the cost of industrial waste in the cutting of production cost (Furukawa, 2008). MFCA create material losses seen by identifying waste and material loss, both in the monetary and physical unit as well as the results of their conversion into product cost of positive and negative product costs (emissions). Apply the MFCA to production line gives transparency information of the problems at the factory. Companies can reduce waste and increase productivity. Thus, the MFCA is a management tool that supports the relationships between environment and economy.

### ***Functions and Advantages of Material Flow Cost Accounting***

The function of MFCA as a tool that helps companies clearly illustrates the flow of materials in conjunction with the presentation of cost allocation. The result of the MFCA is expected to help organizations create a more comprehensive decision to optimize the production process.

### ***Difference between MFCA with Conventional Cost Accounting***

In conventional cost accounting, the cost to produce a "material loss" included as part of production costs. On the other hand, on the previous explanation, MFCA focuses on identifying and distinguishing between costs associated with "product" and "material losses." In this way, the material losses were evaluated as economic losses that prompted management to find ways to reduce material losses and increase efficiency operations (APO, 2014). Consequently, in the MFCA, production costs will be separated between the cost of the product and the cost of material losses. Whereas in conventional cost accounting, incorporating product cost with the cost of material losses become one unit, so there is no information regarding the allocation of production costs. Table 1 in the appendix will explain the difference in the presentation of information about the allocation of production costs in conventional cost accounting and MFCA (unit: USD).

### ***Step-by-Step Implementations Material Flow Cost Accounting***

The Asian Productivity Organization (APO) in Manual on the Material Flow Cost Accounting: ISO 14051 (2014), has a five-step implementation MFCA to the factory that is as follows.

#### **Step 1: Engaging Management and Determining Roles and Responsibilities**

A successful project usually starts from company management support, is no exception in the MFCA. If the management of the company understand the benefits of the MFCA and its usefulness in achieving environmental targets and financial organizations, will facilitate the commitment of the whole organization. In general, management must be involved in all stages of implementation MFCA and recommended that the project MFCA starts from aggressive management support and followed a bottom-up approach on-site. Also, successful implementation MFCA requires collaboration between different departments within the company. Collaboration is needed because different sources of information needed to complete the MFCA analysis.

#### **Step 2: Scope and Boundary of the Process and Establishing a Material Flow Model**

In the next step is to determine the boundary of MFCA to understand clearly the scale of activity of MFCA. Usually, it is recommended to focus on a specific product or process in the

beginning, then extending the implementation to other products. The boundary can be limited to a single process, multiple processes, entire facility, or supply chain. It is recommended that the process chosen for the initial implementation into a process that has economic and environmental impacts are potentially significant.

After the boundary process is determined, then classified in quantity center from information processes and procurement records, in MFCA, quantity center is part of the process when the input and output measured and quantity center represents part of the process when the raw materials are changed. After determining the limitation and quantity center, the period for data collection, MFCA need is determined. MFCA did not indicate how long the period of data must be collected for analysis. Analysis period should allow accurate data are collected as well as minimizing the impact of any variation of the significant processes that can affect the reliability and usefulness of the data, such as seasonal fluctuations.

In MFCA, production, recycling, and other system represented a model of visual or a material flow model that illustrates the limits of MFCA and some quantity center, place of raw materials used or modified, as well as the movement of raw materials between quantity centers. A material flow model is useful to provide an overview of the entire process and identify the points of material losses occurred.

Step 3: Cost Allocation MFCA divide costs into the following categories.

- a) Raw material costs are the cost of input raw material to the quantity center.
- b) Energy costs are the costs of fuel, electricity, steam, heat, and compressed air.
- c) System costs are labor costs, depreciation, and maintenance costs, as well as transportation costs.
- d) Waste management/disposal costs, i.e., the cost of handling waste generated in quantity center.

Raw material costs, energy costs, and system costs are allocated to products or material losses at each quantity center based on the proportion of input quantities of raw materials. Raw material costs for each input and output flow are measured and calculated by multiplying the amount of physical material flow with a material unit cost during the period selected for analysis. In

contrast with the allocation of positive output and negative outputs of raw material costs, the allocation of energy costs, and system costs for positive output and negative outputs follow determined proportionately percentage output of positive and negative outputs on the use of raw materials because it is difficult to determine with certainty the costs allocated on the output of positive and negative output in energy usage and system. For waste management costs, 100% of the costs associated with material losses. The formula calculation of percentage output of positive and negative output of raw materials is following.

Percentage of the positive output of raw materials:

$$\frac{\text{the positive output of raw materials}}{\text{positive output of raw materials} + \text{negative output of raw materials}} \times 100\%$$

Percentage of the negative output of raw materials:

$$\frac{\text{the negative output of raw materials}}{\text{positive output of raw materials} + \text{negative output of raw materials}} \times 100\%$$

#### Step 4: Interpreting and Communicating MFCA Results

Implementation of MFCA provides information, such as material losses during the process, use of raw materials that do not become products, energy costs, and system costs associated with material losses. This information brought some impact by increasing awareness of the company's operations. Managers are aware of the costs associated with material losses can identify opportunities to increase the efficiency in the use of materials and improve business performance.

Through the identification of MFCA problems that cause material losses, companies have the opportunity to identify economic losses, which are usually ignored when only relying on conventional cost accounting. Physical and monetary quantification of the material flow can be summarized in a format that is suitable for further interpretation, for example, in a matrix of cost flow. Table 2 in appendix describes the format of the matrix of material cost flow.

In General, review, and interpretation of data summarized will allow companies to identify quantity centers with the material losses that have an environmental impact or significant financial. Quantity center can be analyzed in more detail.

After analysis of MFCA is completed, the results should be communicated to all relevant parties. Also, management can use the

information to support various types of MFCA decisions aimed at improving environmental and financial performance. Communicate results to employees of the company can be useful in describing the process or a change of raw materials companies and get the full commitment of all the organs of the company.

#### Step 5: Improving Production Practices and Reducing Material Loss through MFCA Results

After analysis of MFCA helps companies understand the costs associated with material losses, the organization can review the MFCA data and look for opportunities to improve environmental performance and finance. The measures taken to achieve these improvements can include a substitution of materials; modification of the production line, process, or product; as well as research and development activities related to the efficiency of materials and energy.

#### ***Definition of Environmental Cost Accounting***

Minister of the environment of Japan in Meilanawati (2005) stated that environmental accounting includes about identifying the costs and benefits of environmental conservation activities, the provision of the means or the best way through quantitative measurement, as well as to support communication process that aims to achieve development that is sustainable, profitable relationship with community and achieve effectiveness and efficiency of environmental conservation activities. In other words, environmental cost accounting is the process of identifying, assessing, and measuring important aspects of socio-economic activities of the company in order to maintain the quality of the environment in accordance with the intended purpose. So companies cannot go around to cultivate resources without regard for its impact on the environment and society.

#### ***Classification of Environmental Quality Cost***

According to Hansen Mowen & (2007), environmental costs can be classified into four categories, namely:

- a. Environmental prevention costs are the costs for activities undertaken to prevent produced waste and/or waste damaging the environment.



- b. Environmental detection costs are the costs for activities conducted to determine that a product, process, and other activities in the companies have met the environmental standards which are valid or not.
- c. Environmental internal failure costs are the costs for activities undertaken since the produced waste and garbage, but not thrown to the outside environment. So, the cost of internal failure occurred to eliminate and to process waste and garbage when it is produced. The activity of internal failure has one of the two following purposes:
  - To ensure the waste produced is not dumped into the outside environment.
  - To reduce the level of waste that is created so that the amount not passed environmental standards.
- d. Environmental external failure costs are the costs for activities conducted after removing waste or waste into the environment. External failure costs are divided into two, namely realized external failure costs and unrealized external failure costs.

## **METHODOLOGY**

The objects used in this research consists of 3 (three) tofu manufacturers at PRIMKOPTI tofu production center, South Jakarta. This research was conducted on November 2016. The sample research used in the tofu production process in every manufacturer at PRIMKOPTI tofu production center, South Jakarta. As for the method of data collection in the study done in three ways:

1. Interview were conducted with each tofu manufacturers consisting of the owner and 2 (two) employees on November 5, 2016.
2. Observation were made in each production process to determine the flow of input and output material in raw material and energy used at every tofu manufacturers on November 19, 2016.
3. Documentation, the documentation process is carried out by taking a picture and collecting all data related to the production process at every tofu manufacturers on November 19, 2016.

As for the method of data analysis used in this research is descriptive qualitative. Here are the stages of data analysis related problems in this study, as follows.

- 1) First Stage: Design and Implementation of Material Flow Cost Accounting (MFCA)
  - a. Step 1: Engaging Management and Determining Roles and Responsibilities
  - b. Step 2: Scope and Boundary of the Process and Establishing a Material Flow Model
  - c. Step 3: Cost Allocation
  - d. Step 4: Interpreting and Communicating MFCA Results
  - e. Step 5: Improving Production Practices and Reducing Material Loss through MFCA Results
- 2) Second Stage: Design and Implementation of Environmental Cost Accounting (ECA)
  - a. Step 1: Identify Environmental Activities and Environmental Costs
  - b. Step 2: Classifying and Quantifying Environmental Costs
  - c. Step 3: Presenting and Disclosing Environmental Costs

## **RESULT & DISCUSSION**

The descriptive analysis of this research reveals that PRIMKOPTI tofu production center conducts two stages of Environmental Management Accounting with Material Flow Cost Accounting, which is:

### **First Stage: Material Flow Cost Accounting**

#### ***Step 1: Engaging Management and Determining Roles and Responsibilities***

First steps in implementing MFCA is doing coordination and communication to all manufacturers and employees of factory involved in the production process to build an understanding of the benefits and usefulness of implementation MFCA to the optimization of the production process to minimize the negative impacts of production against environmental pollution around the factory. It also aims to build commitment and responsibility between all manufacturers and employees of the factory involved.

Then, a team was formed in order to implement MFCA. In the formation of this team, the owner of tofu manufacturers will act as a team leader in the implementation of MFCA. The owner's election as leader of the team aims to let employees feel motivated because not only are the employees of factory involved but the owner too participate in this

implementation MFCA so carrying out its role of employees would be more optimally. The task and responsibility of the team leader are to provide basic information and training to factory employees and guidance in implementing MFCA. The next step is to determine the role of each factory employee who wants to become a coordinator with the required expertise. However, due to the lack of human resources required to support the success of MFCA, the MFCA was not implemented as it was planned. Table 3 describes the roles and responsibilities of the coordinator needed by producers to know for the successful implementation of MFCA.

**Table 3. Roles and Responsibilities of Coordinator in MFCA Implementation**

No.	Position	Number of Required	Roles and Responsibilities
1.	Team Leader	1	<ul style="list-style-type: none"> <li>Give Information and Basic Training to Employees as well as guide in implementation of MFCA</li> </ul>
2.	Coordinator of Operational Production	1	<ul style="list-style-type: none"> <li>Monitoring the flow of use of raw materials and energy during production process</li> </ul>
3.	Coordinator of Quality Control and Environmental Management	1	<ul style="list-style-type: none"> <li>Monitor and maintain the use of machinery and equipment for production process</li> <li>Monitoring the frequency of product defects and guarantee the quality of product</li> <li>Monitoring waste generated during production process, along with how to manage them</li> </ul>
4.	Coordinator of Cost Accounting	1	<ul style="list-style-type: none"> <li>Create and calculate production costs incurred at each stage of production</li> </ul>

Source: Asian Productivity Organization (APO), 2014 and Researcher (processed)

### ***Step 2: Scope and Boundary of the Process and Establishing a Material Flow Model***

The second step of implementation MFCA is determining the scope and boundary of the production process and build a model of material flow. For this step, tofu manufacturers in PRIMKOPTI tofu production center, South Jakarta is determined the scope of discussion on the fried tofu products are produced as well as the boundary of the process only on the fried tofu production process itself.

After determining the scope and boundary of the production process, the next stage is to build or create a model of material flow. In making a model of material flow, quantity center must be specified first. Quantity center is part of the process when the inputs and outputs are measured physically. Quantity center represents the part of the process

when the raw materials are changed. Thus eight quantity centers occur in the tofu production process, namely tofu soaking, washing, grinding, boiling, filtering, coagulation, printing, and cutting, as well as frying. The following is an explanation of the overall stage in the tofu production process in PRIMKOPTI tofu production center, South Jakarta.

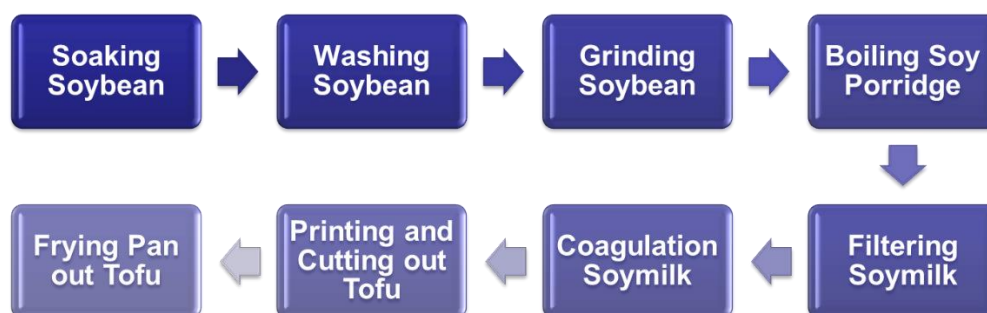
- a) Soaking Soybean Process. In this process, soybean is purchased from the supplier, namely PRIMKOPTI, South Jakarta soaked with water in special containers/place made from steel and plastic. This water soaking aims to make soybean becomes soft and in easy to be in the process of grinding soybeans to produce soy porridge. Also, this process can help reduce the number of Antitrypsin substances that exist in soybean where can reduce the power of protein, so it needs to be lowered applied.
- b) Washing Soybean Process. In this process, the soaked soybean will be transferred to a large plastic container and then washed with water. It is aimed at cleaning up seeds of soybeans from shit-dirt so as not to interfere with the process of grinding and mixed into the batter out. After completion of washed, filter the soybean by using a large-sized bamboo strainer.
- c) Grinding Soybean Process. In this process, soybean began using soybean grinder machine with propulsion machinery from electricity. This stage aims to obtain soy porridge will then be processed on the next step while the grinding process should preferably be attached the water to get the desired texture of soy porridge.
- d) Boiling Soy Porridge Process. In this process, soy porridge is boiling in large containers made of steel with a steam heater pipelines contained in the upper part of the container. The heater comes from the boiler machine on the other side of the tofu production process. A fuel that is used as the heat source boilers is gas fuel. The endpoint of boiling soy porridge process is characterized by the onset of a bubble-bubble heat inside the container.
- e) Filtering Soymilk Process. The next stage after soy porridge is boiled, then filtering process by using a filter sieve. Filtering is carried out continuously with water added to the edge of the sieve so that no solids are left on the sieve. The addition of water is terminated when soymilk (filtrate) produced already suffice then

sieve containing the tofu dregs were squeezed until completely dry. This process aims at separating the tofu dregs with soymilk.

- f) Coagulation Soymilk Process. In this process, soy milk (filtrate) as resulting from the filtering process will be added auxiliary materials i.e., acidic water and cioko (reinforcement material) in a certain amount. The function of this addition to sedimenting and agglomerate protein of tofu as well as to separate between whey (top layer) and tofu sediment (underlayer). Tofu sediment is the main ingredient to be printed into tofu.
- g) Printing and Cutting out Tofu Process. After the tofu sediment obtained by the process of coagulation soymilk, then the tofu started printing and cutting out using a special tool prints out which made of wood with a container made from wood too.
- h) Frying Pan out Tofu Process. In this process, tofu that already printed and cut will be fried in a large pan with cooking oil to produce brown colored skin tofu.

At each quantity center in the tofu production process has turned out to be a positive output of products or parts of products and the negative output in the form of waste or material losses resulting from the use of raw materials, energy, and systems. However, because the calculation of the positive and negative output physical output of some energy uses and the system has several difficulties in determining clearly. Therefore, predestination will vary proportionally in accordance with the percentage of positive and negative output raw material products that are described in the determination of cost allocation. Figure A below shows the process of making tofu step by step.

**Figure A. Step by Step Tofu Production Process**



Source: Interview with Tofu Manufacturers in PRIMKOPTI South Jakarta, November 2016

### Step 3: Cost Allocation

The third step in implementation MFCA is to determine the allocation of costs to obtain a monetary basis calculation regarding the material flow into products and material losses. In the concept of the cost allocation process, the MFCA is classified into four elements, namely, raw material costs, energy costs, system costs, and waste treatment/disposal costs.

#### 1. The Process of Raw Material Costs Allocation

The main raw material is used in the manufacture of the fried tofu is soybeans. While the additional raw materials of products this fried tofu is water, acidic water, the material of the speaker know (cioko) as well as a cooking oil. In the calculation of raw material costs allocation, tofu factory measured cost allocation by multiplying the measured amount of input from the physical materials used with materials cost per unit during the selected period is the month of November 2016.

Raw materials are processed in the stages of production will produce a positive output of products or parts of products. Of the processed raw materials, there is also production waste generated at each stage of production is considered a negative output or material losses. Calculation of cost allocation for positive and negative output is generated by calculating allocations based on proportional use of raw materials for the overall input of raw materials used. Table 4 presents a summary of the calculation of the cost allocation of inputs, positive output, and negative output from the use of raw materials in every stage of production.

Table 4. Calculation Cost Allocation of Material Inputs, Positive Outputs, and Negative Outputs from Raw Materials

Input	Cost Allocation (Rp)	Positive Output	Percentage	Cost (Rp)	Negative Output	Percentage	Cost (Rp)
<b>A. Soaking Soybean Process</b>							
1. Soybean	4,500,000	Soybean	85.75%	3,858,750	Soybean Sour	14.25%	641,250
<b>Total</b>	<b>4,500,000</b>			<b>3,858,750</b>			<b>641,250</b>
<b>B. Washing Soybean Process</b>							
1. Soybean	3,858,750	Soybean	80.95%	3,123,750	Soy Damage (Pora Quality)	6.80%	735,000
<b>Total</b>	<b>3,858,750</b>			<b>3,123,750</b>			<b>735,000</b>
<b>C. Grinding Soybean Process</b>							
1. Soybean	3,123,750	Soy Porridge	98.17%	3,066,750	Soy Porridge Remaining in	1.92%	57,000
2. Water	27,500			26,875		625	
<b>Total</b>	<b>3,151,250</b>			<b>3,093,625</b>			<b>57,625</b>
<b>D. Boiling Soy Porridge Process</b>							
1. Soy Porridge	3,093,625	Soy Porridge	98.36%	3,042,925	Soy Porridge Remaining in	1.65%	50,700
<b>Total</b>	<b>3,093,625</b>			<b>3,042,925</b>			<b>50,700</b>
<b>E. Filtering Soymilk Process</b>							
1. Soy Porridge	3,042,925	Soymilk	69.22%	2,106,300	Tofu Dregs	30.77%	936,625
<b>Total</b>	<b>3,042,925</b>			<b>2,106,300</b>			<b>936,625</b>
<b>F. Coagulation Soymilk Process</b>							
1. Soymilk	2,106,300	Soymilk	98.26%	2,074,625	Soymilk Wasted	1.54%	31,675
2. Acidic Water	1,500,000			1,471,250			28,750
3. Ciko (Reinforcement Material)	30,000			27,000			3,000
<b>Total</b>	<b>3,636,300</b>			<b>3,572,875</b>			<b>63,425</b>
<b>G. Printing and Cutting out Tofu Process</b>							
1. Soymilk	3,572,875	Tofu	95.30%	3,405,100	Soymilk Wasted	4.57%	167,775
<b>Total</b>	<b>3,572,875</b>			<b>3,405,100</b>			<b>167,775</b>
<b>H. Frying Pan out Tofu Process</b>							
1. Tofu	3,405,100	Fried Tofu	85.84%	3,360,325	Failed Tofu and Residual of Cooking Oil	10.60%	44,775
2. Cooking Oil	1,656,000			984,000	672,000		
<b>Total</b>	<b>5,061,100</b>			<b>4,344,325</b>			<b>716,775</b>
<b>Total</b>	<b>29,916,825</b>		<b>88.74%</b>	<b>26,547,650</b>		<b>11.26%</b>	<b>3,369,175</b>

Source: Interview with Tofu Manufacturers in PRIMKOPTI South Jakarta, November 2016 (processed)

## 2. The Process of Energy Costs Allocation

In the tofu production process, there is also energy consumption in every stage of production, such as the need to use the machine's energy production, so that the allocation of energy costs must also be done to find out the usage and the resulting energy loss. The calculation of allocation to energy input is done by calculating the energy needs and time needs used at each stage of production multiplied the cost of each energy. Table 5 explains the summary of calculation cost allocation of inputs, positive output, and negative output from energy use in each stage of production.

**Table 5. Calculation Cost Allocation of Inputs, Positive Outputs, and Negative Outputs from Energy**

Production Process	Energy Used	Energy Needs	Time Needs (minutes)	Cost/hours (Rp)	Cost Allocation (Rp)	Percentage of Positive Output from Raw Material	Cost (Rp)	Percentage of Negative Output from Raw Material	Cost (Rp)
Soaking Soybean Process	Water	360 litre	120	250	180,000	87.92%	158,250	12.08%	21,750
Washing Soybean Process	Water	825 litre	35	250	120,313	0%	-	100%	120,313
Grinding Soybean Process	Electricity	3,5 kWh	75	2,000	8,750	98.08%	8,582	1.92%	168
Boiling Soy Porridge Process	Gas	150 Kg	60	6,500	975,000	98.35%	958,951	1.65%	16,049
	Water	225 litre		250	56,250	33.33%	18,750	66.67%	37,500
Filtering Soymilk Process	-	-	-	-	-	-	-	-	-
Coagulation Soymilk Process	-	-	-	-	-	-	-	-	-
Printing and Cutting out Tofu Process	-	-	-	-	-	-	-	-	-
Frying Pan out Tofu Process	Gas	75 Kg	55	6,500	446,875	89.40%	399,523	10.60%	47,352
<b>Total</b>					<b>1,787,188</b>	<b>86.40%</b>	<b>1,544,056</b>	<b>13.60%</b>	<b>243,131</b>

*Source: Interview with Tofu Manufacturers in PRIMKOPTI South Jakarta, November 2016 (processed)*

Different from the positive and negative output of raw materials cost allocation, energy costs allocation process for output of positive and negative outputs follow determined proportionally based on percentage output of positive and negative outputs on the use of raw materials. This determination happens because it is difficult to determine with certainty the costs allocated on the output of positive and negative output in energy use. The calculation of the allocation of costs to the output of positive and negative outputs of energy generated is by calculating the allocation based on the percentage of use of the raw material to the overall input of the raw materials used and then multiplied by the allocation of energy input costs.

## 3. The Process of System Costs Allocation

Every stage of production will not work if no system is running and driving the production process, such as operator or labor. Therefore, the allocation of system costs in the production process also needs to be done in order to know the use and losses resulting from system

costs. The calculation of the allocation to the input system is done by calculating the time requirements, and the amount of labor needed at each stage of production multiplied labor wages in accordance with the time clock works, i.e., in one day reached eight hours of work. Table 6 explains the summary of calculation cost allocation of inputs, positive output, and negative output from the use of the system in each stage of production.

**Table 6. Calculation Cost Allocation of Inputs, Positive Outputs, and Negative Outputs from System**

Production Process	Total Labor	Time Needs (minutes)	Wages/day (Rp)	Cost Allocation (Rp)	Percentage of Positive Output from Raw Material	Cost (Rp)	Percentage of Negative Output from Raw Material	Cost (Rp)
Soaking Soybean Process	3	120	40,000	30,000	85.75%	25,725	14.25%	4,275
Washing Soybean Process	6	35	40,000	17,500	80.95%	14,167	19.05%	3,333
Grinding Soybean Process	3	75	40,000	18,750	98.08%	18,390	1.92%	360
Boiling Soy Porridge Process	3	60	40,000	15,000	98.35%	14,753	1.65%	247
Filtering Soymilk Process	6	45	40,000	22,500	69.23%	15,576	30.77%	6,924
Coagulation Soymilk Process	3	90	40,000	22,500	98.46%	22,154	1.54%	346
Printing and Cutting out Tofu Process	6	180	40,000	90,000	95.43%	85,890	4.57%	4,110
Frying Pan out Tofu Process	3	55	40,000	13,750	89.40%	12,293	10.60%	1,457
<b>Total</b>				<b>230,000</b>	<b>90.85%</b>	<b>208,948</b>	<b>9.15%</b>	<b>21,052</b>

Source: Interview with Tofu Manufacturers in PRIMKOPTI South Jakarta, November 2016 (processed)

The calculation of the allocation of the cost of positive output and negative output on specified proportionally system follows the percentage of positive and negative output on the use of raw materials to the overall input of the raw materials used and then multiplied by the input system cost allocation, which is the same as the calculation of the allocation of the cost of the output of positive and negative energy.

#### 4. The Process of Waste Treatment/Disposal Costs Allocation

Based on the results of interviews with all tofu manufacturers in PRIMKOPTI tofu production center, South Jakarta, unknown disposal costs issued Rp 500,000 per day for a whole production out. Disposal is like a place of disposal and storage of solid waste know i.e., damaged soybeans and tofu dregs. The cost of waste treatment is entirely allocated 100% as negative output.

#### **Step 4: Interpreting and Communicating MFCA Results**

After determining cost allocation associated with the tofu production process, the fourth step is to construe and interpret the results of MFCA



with preparing a matrix of material cost flow. All costs are classified as part of a product or material losses. The main purpose of this matrix gives the MFCA analysis results in a table format that is easy to grasp and understand third parties and organizations. Table 7 presents a matrix of material cost flow that occurs in the production process at PRIMKOPTI tofu production center, South Jakarta.

**Table 7. Matrix of Material Cost Flow**

Component of Costs		Product (Positive)	Percentage	Material Losses (Negative)	Percentage
Raw Material Costs	Rp 29,916,825	Rp 26,547,650	88.74%	Rp 3,369,175	11.26%
Energy Costs	Rp 1,787,188	Rp 1,544,056	86.40%	Rp 243,131	13.60%
System Costs	Rp 230,000	Rp 208,948	90.85%	Rp 21,052	9.15%
Disposal Costs	Rp 1,500,000	Rp -	0%	Rp 1,500,000	100%
<b>Total Costs</b>	<b>Rp33,434,013</b>	<b>Rp 28,300,655</b>	<b>84.65%</b>	<b>Rp5,133,358</b>	<b>15.35%</b>

*Source: Interview with Tofu Manufacturers in PRIMKOPTI South Jakarta, November 2016 (processed)*

Based on the analysis that has been made, the percentage of positive output and negative output that occurs in the use of raw materials during the tofu production process is 88,74% and 11,26%, while the percentage of positive output and negative output happens in energy use during the production process was 86,40% and 13,60%. Then the percentage of positive output and negative output that occurs in the use of the system during the process of production is 90,85% and 9,15%, while in the processing of waste/disposal allocated entirely or 100% into negative output so that there are no positive output resulting from the processing of waste/disposal.

On the matrix of material cost flow, visible material losses that still generated all tofu manufacturers in PRIMKOPTI tofu production center, South Jakarta are related to the tofu production process of 15,35% or Rp5.133.358,-. Worth of material losses that shows that in every stage of the production process is still less efficient and still need sustainable improvements to be held to optimize the production process. The steps that can be taken to achieve sustainable improvements include a substitution of raw materials and energy usage, modification or value engineering process, as well as research and development activities related to raw material and energy efficiency.

***Step 5: Improving Production Practices and Reducing Material Loss through MFCA Results***

The fifth step, researchers conduct communication and coordination with the tofu manufacturers to give some alternatives to optimize tofu production process in terms of the cost of raw materials and energy as well as the cost of production. Based on interviews with tofu manufacturers, some tofu manufacturers already did processing solid waste discharge like selling tofu dregs to third parties which are used as animal feed and provides wastewater treatment Installations (IPAL) for processing tofu liquid waste so that the water was dumped by a factory uncontaminated so was able to reduce the cost of the negative output of the factory. However, the processing has not been made to the maximum because it still has other negative output that is untapped and is optimized, so that factory production costs reduced. Through this research, the researchers tried to provide several recommendations and solutions that could be applied by tofu manufacturers in PRIMKOPTI tofu production center, South Jakarta so that negative output costs could be minimized, among others:

- a. Simple Waste Water Treatment, which aims to optimize liquid tofu waste that comes from the process of soaking and washing of soybean related production costs to reduce the energy of the water used.
- b. Utilization of tofu waste into crackers, which aims to make tofu waste compost, namely tofu waste through the drying process and the type of processed waste becomes a new product to increase company revenue compared to direct sales to third parties.

## **Second Stage: Environmental Cost Accounting**

### ***Step 1: Identify Environmental Activities and Environmental Costs***

The first step in determining the Environmental Cost Accounting (ECA) are identified environmental management activities that appeared in the tofu production process and identified the costs arising from such activities. Here are environmental management activities that arise during the tofu production process in PRIMKOPTI tofu production center, South Jakarta.

#### **1. Management of Tofu Liquid Waste**

Liquid waste produced by tofu manufacturers in PRIMKOPTI tofu production center, South Jakarta is liquid remaining results soaking soybeans, washing soybeans, boiling soy porridge, coagulation soymilk and liquid of tofu that unsold. From liquid waste generated, there is liquid waste that is already well managed by the existing system of filter factory owned IPAL so that water out and flows into the river even to the

outside of the factory become sterile and clean and do not cause negative impacts to environment and society. Also, the tofu liquid that unsold earlier in the day able to generate acidic water and reuse by the factory into the additional raw materials for the product idea generated, so the factories do not have to buy water for acid production and increased production costs. Fixed assets used in support of this activity is pipe water sanitation as well as fiber bucket and plastic drum/barrel for the needs of simple wastewater treatment tools.

## 2. Management of Tofu Solid Waste

While the solid waste generated by tofu manufacturers in PRIMKOPTI tofu production center, South Jakarta is the results of the rest of soy porridge in the filtering process, usually called tofu dregs. Tofu dregs have quickly stale and smell unpleasant, if not immediately dealt with quickly. From solid waste generated, the factory has done the management by selling it to a third party to serve as livestock feed. But there are other management that can be performed by the factory to improve the income of factory, among others, to cultivate tofu dregs to make a variety of products processed foods such as tofu crackers, “tempe gembus”, “tempe bongkrek”, tofu dregs flour, tofu nuggets, tofu dregs soy sauce, and much more. Fixed assets used in support of these activities is a warehouse for tofu solid waste storage.

## 3. Management of Waste Gas Factory

Also, there is a waste gas produced by tofu manufacturers in PRIMKOPTI tofu production center, and South Jakarta are smoke and steam from the boiling process and tofu production machines. Tofu manufacturers reduce waste gas by doing the gas filter before it is released to the outside of the factory. The gas filter is done so that the air outside the factory become sterile and not polluted. Fixed assets used in support of this activity is air filter equipment.

## 4. Certification & Maintenance of Waste Water Treatment Installation Equipment (IPAL)

Subsequent activities undertaken by tofu manufacturers are doing certification and maintenance of the IPAL equipment, and this activity performed by a manager of the production center PRIMKOPTI South Jakarta. However, maintenance activities such as checking the garbage that piled up in the wastewater drain pipes are not done routinely by the factory manager. The manager only acts when there is damage to the pipeline and the IPAL machine used in the management of the environment. Fixed assets used in support of this activity is IPAL equipment.

After identifying environmental activities that appear in the tofu production process and determine fixed assets required in support of any such activity, the next step is to identify the environmental costs arising from those activities. In Table 8 will show the costs arising from activities of the environment during the production process in tofu manufacturers.

**Table 8. Details Costs of Environmental Activities**

Item	Environmental Costs
1. Management of Tofu Liquid Waste	- Chemical cost
	- Depreciation cost of pipe water sanitation
	- Maintenance cost of pipe water sanitation
	- Depreciation cost of fiber bucket
	- Depreciation cost of plastic drum
	- Maintenance cost of waste water treatment equipment
	- Labor cost for management of tofu liquid waste
2. Management of Tofu Solid Waste	- Storage cost for tofu solid waste
	- Depreciation cost of warehouse
	- Labor cost for management of tofu solid waste
3. Management of Waste Gas Factory	- Depreciation cost of air filter equipment
	- Maintenance cost of air filter equipment
	- Labor cost for management of waste gas factory
	- Electricity cost of air filter equipment
4. Certification and Maintenance of Waste Water Treatment Installation Equipment (IPAL)	- Depreciation cost of IPAL equipment
	- Maintenance cost of IPAL equipment
	- Labor cost for maintenance of IPAL equipment
	- Environmental certification cost

Source: Interview with Tofu Manufacturers in PRIMKOPTI South Jakarta, November 2016 (processed)

### Step 2: Classifying and Quantifying Environmental Costs

The next step is classification and measurement of environmental costs into the four cost categories of environmental quality, namely prevention costs, detection costs, internal failure costs, and external failure costs. In Table 9 will present the calculation of fixed assets in support of the management of the environment in tofu production activities. Whereas in Table 10 will present the classification and measurement of environmental cost in tofu manufacturers in PRIMKOPTI tofu production center, South Jakarta into four categories of environmental cost quality.

**Table 9. The Calculation Of Fixed Assets Supporting Environmental Management**

No.	Fixed Assets	Acquisition Year	Acquisition Cost (Rp)	Economic Usage	Residual Value (Rp)	Depreciation Method	Depreciation 2016 (Rp)	Depreciation per Month (Rp)
1.	Pipe Water Sanitation	2012	15.000.000	10 year	2.000.000	Declining Balance	1.228.800	102.400
2.	IPAL Equipment	2014	6.000.000	5 year	950.000	Declining Balance	864.000	72.000
3.	Warehouse	2012	20.000.000	20 year	5.000.000	Straight Line	750.000	62.500
4.	Fiber Bucket	2016	750.000	3 year	80.000	Declining Balance	500.000	41.667
5.	Plastic Drum	2016	330.000	3 year	25.000	Declining Balance	220.000	18.333
6.	Air Filter Equipment	2016	12.000.000	10 year	1.700.000	Declining Balance	2.400.000	200.000

Source: Interview with Tofu Manufacturers in PRIMKOPTI South Jakarta, November 2016 (processed)

Table 10. Classification and Measurement of Environmental Costs (November 2016)

Component	Costs		
	Tofu Manufacturer "X"	Tofu Manufacturer "Y"	Tofu Manufacturer "Z"
<b>Environmental Prevention Cost</b>			
- Environmental certification cost	Rp 3.500.000	Rp 3.500.000	Rp 3.500.000
- Electricity cost of air filter equipment	Rp 150.000	Rp 150.000	Rp 225.000
- Depreciation cost of pipe water sanitation	Rp 102.400	Rp 102.400	Rp 102.400
- Depreciation cost of air filter equipment	Rp 200.000	Rp 200.000	Rp 200.000
- Depreciation cost of warehouse	Rp 20.833	Rp 20.833	Rp 20.834
- Depreciation cost of fiber bucket	Rp 83.335	Rp 83.335	Rp 125.000
- Depreciation cost of plastic drum	Rp 36.666	Rp 36.666	Rp 54.998
- Depreciation cost of IPAL equipment	Rp 72.000	Rp 72.000	Rp 72.000
- Labor cost for management of tofu liquid waste	Rp 250.000	Rp 250.000	Rp 250.000
- Labor cost for management of waste gas factory	Rp 250.000	Rp 250.000	Rp 250.000
- Labor cost for management of tofu solid waste	Rp 250.000	Rp 250.000	Rp 250.000
- Labor cost for maintenance of IPAL equipment	Rp 300.000	Rp 300.000	Rp 300.000
<b>Total Environmental Prevention Cost</b>	<b>Rp 5.215.234</b>	<b>Rp 5.215.234</b>	<b>Rp 5.350.232</b>
<b>Environmental Detection Cost</b>			
-			
<b>Total Environmental Detection Cost</b>	<b>Rp -</b>	<b>Rp -</b>	<b>Rp -</b>
<b>Environmental Internal Failure Cost</b>			
- Chemical cost	Rp 2.500.000	Rp 2.150.000	Rp 3.000.000
- Maintenance cost of pipe water sanitation	Rp 125.000	Rp 125.000	Rp 125.000
- Storage cost for tofu solid waste	Rp 100.000	Rp 100.000	Rp 100.000
- Maintenance cost of air filter equipment	Rp 125.000	Rp 125.000	Rp 125.000
- Maintenance cost of waste water treatment equipment	Rp 75.000	Rp 75.000	Rp 75.000
- Maintenance cost of IPAL equipment	Rp 150.000	Rp 150.000	Rp 150.000
<b>Total Environmental Internal Failure Cost</b>	<b>Rp 3.075.000</b>	<b>Rp 2.725.000</b>	<b>Rp 3.575.000</b>
<b>Environmental External Failure Cost</b>			
-			
<b>Total Environmental External Failure Cost</b>	<b>Rp -</b>	<b>Rp -</b>	<b>Rp -</b>
<b>Total Environmental Costs</b>	<b>Rp 8.290.234</b>	<b>Rp 7.940.234</b>	<b>Rp 8.925.232</b>

Source: Interview with Tofu Manufacturers in PRIMKOPTI South Jakarta, November 2016 (processed)

### Step 3: Presenting and Disclosing Environmental Costs

The third step is to present and disclosure of the environmental costs into environmental cost quality report as presented in Figure B. Tofu manufacturers can do presenting and disclosure of the environmental cost allocation together with other units cost grouping. Presentation and disclosure are done together as a sub-sub cost in maintenance and upkeep costs account. This presentation is done because the cost of environmental management is considered part of the means of supporting the production process know, so it does not need to do a presentation in particular. So the allocation of environmental costs which serve as maintenance and upkeep costs calculated in the income statement and can reduce the factory's operating income.

PRIMKOPTI Tofu Production Center, South Jakarta Environmental Quality Cost Report For the Month Ended in November 30, 2016					
	Tofu Manufacturer "X" Environmental Cost	Tofu Manufacturer "Y" Environmental Cost	Tofu Manufacturer "Z" Environmental Cost	Total Costs	Percentage
<b>Environmental Prevention Cost</b>					
Environmental certification cost	Rp 3.500.000	Rp 3.500.000	Rp 3.500.000	Rp 10.500.000	
Electricity cost of air filter equipment	Rp 150.000	Rp 150.000	Rp 225.000	Rp 525.000	
Depreciation cost of pipe water sanitation	Rp 102.400	Rp 102.400	Rp 102.400	Rp 307.200	
Depreciation cost of air filter equipment	Rp 200.000	Rp 200.000	Rp 200.000	Rp 600.000	
Depreciation cost of warehouse	Rp 20.833	Rp 20.833	Rp 20.834	Rp 62.500	
Depreciation cost of fiber bucket	Rp 83.335	Rp 83.335	Rp 125.000	Rp 291.670	
Depreciation cost of plastic drum	Rp 36.666	Rp 36.666	Rp 54.998	Rp 128.330	
Depreciation cost of IPAL equipment	Rp 72.000	Rp 72.000	Rp 72.000	Rp 216.000	
Labor cost for management of tofu liquid waste	Rp 250.000	Rp 250.000	Rp 250.000	Rp 750.000	
Labor cost for management of waste gas factory	Rp 250.000	Rp 250.000	Rp 250.000	Rp 750.000	
Labor cost for management of tofu solid waste	Rp 250.000	Rp 250.000	Rp 250.000	Rp 750.000	
Labor cost for maintenance of IPAL equipment	Rp 300.000	Rp 300.000	Rp 300.000	Rp 900.000	
<b>Total Environmental Prevention Cost</b>	<b>Rp 5.215.234</b>	<b>Rp 5.215.234</b>	<b>Rp 5.350.232</b>	<b>Rp 15.780.700</b>	<b>62,73%</b>
<b>Environmental Detection Cost</b>					
-					
<b>Environmental Internal Failure Cost</b>					
Chemical cost	Rp 2.500.000	Rp 2.150.000	Rp 3.000.000	Rp 7.650.000	
Maintenance cost of pipe water sanitation	Rp 125.000	Rp 125.000	Rp 125.000	Rp 375.000	
Storage cost for tofu solid waste	Rp 100.000	Rp 100.000	Rp 100.000	Rp 300.000	
Maintenance cost of waste gas factory	Rp 125.000	Rp 125.000	Rp 125.000	Rp 375.000	
Maintenance cost of waste water treatment equipment	Rp 75.000	Rp 75.000	Rp 75.000	Rp 225.000	
Maintenance cost of IPAL equipment	Rp 150.000	Rp 150.000	Rp 150.000	Rp 450.000	
<b>Total Environmental Internal Failure Cost</b>	<b>Rp 3.075.000</b>	<b>Rp 2.725.000</b>	<b>Rp 3.575.000</b>	<b>Rp 9.375.000</b>	<b>37,27%</b>
<b>Environmental External Failure Cost</b>					
-					
<b>Total Environmental Quality Cost</b>	<b>Rp 8.290.234</b>	<b>Rp 7.940.234</b>	<b>Rp 8.925.232</b>	<b>Rp 25.155.700</b>	<b>100%</b>

Figure B. Environmental Quality Cost Report  
 Source: Interview with Tofu Manufacturers in PRIMKOPTI South Jakarta, November 2016 (processed)

## CONCLUSION

Based on results and discussion above, obtained information that raw material costs into positive output (product) of 88,74% and negative output (material losses) from raw material costs of 11,26%. While energy costs used in the tofu production process that become positive output (product) of 86,40% and negative output (material losses) of energy costs of 13,60%. Then system costs in the form of labor who set each production process into positive output (product) of 90,85% and negative output (material losses) of 9,15%. Also, the costs of waste treatment/disposal issued tofu factory entirely of 100% to negative output (material losses). Of the overall total costs incurred in producing tofu is Rp33.434.013,-, which is the actual production cost was Rp28.300.655,- or 84,65% while the company has material losses amounting to Rp5.133.358,- or 15,35%. It can be concluded that all tofu manufacturers in PRIMKOPTI tofu production center, South Jakarta still have not made use of raw materials and energy in production processes optimally. Also, the activities carried out by tofu manufacturers related to environmental management has not been identified and presented in environmental quality cost report in order to find out environment costs that can be minimized and repairs.

Thus, the concept of Environmental Management Accounting with Material Flow Cost Accounting is able to provide great benefits for all tofu manufacturers in PRIMKOPTI tofu production center, South Jakarta consists of 3 (three) manufacturers in improving the transparency of related activities environmental management in the production process as well as in improving production practices in the flow of materials in the form of raw materials, energy, and systems that affect production process in physical and monetary units and converted into products or material losses to be done sustained improvement in order to minimize negative impact to environment.

## REFERENCE:

- Asian Productivity Organization (APO). 2014. Manual on Material Flow Cost Accounting: ISO 14051. Japan.
- Chang et al. 2015. "Material Flow Cost Accounting System for Decision Making: The Case of Taiwan SME in the Metal Processing Industry." *Asian Journal of Finance & Accounting*.
- Furukawa, Y. 2008. Material Flow Cost Accounting. Japan.

- Hansen, Don R., and Mowen, Maryanne M. 2007. *Managerial Accounting*. 8th edition. South-Western, USA: Thomson Learning.
- Haryanto, Widiari. 2010. Analisis Penerapan Akuntansi Lingkungan di RSU PKU Muhammadiyah Yogyakarta. <<http://www.pustakaskripsi.com/analisa-penerapan-akuntansi-lingkungan-1442.html>>. [16 Desember 2016]
- IFAC. 2005. *International Guidelines on Environmental Management Accounting*. New York: International Federation of Accountants.
- Ikhsan, Arfan. 2009. *Akuntansi Manajemen Lingkungan*. Yogyakarta : Graha Ilmu.
- Kementrian Koperasi dan UKM. 2013. Perkembangan Data Usaha Mikro, Kecil, Menengah (UMKM) dan Usaha Besar (UB), [Online] Tersedia: <http://www.depkop.go.id/berita-informasi/data-umkm/>. [16 Desember 2016]
- Meilanawati, R. 2013. "Analisis Pengungkapan Biaya Lingkungan (Environmental Costs) pada PT. Semen Indonesia Persero, Tbk". Universitas Negeri Surabaya
- Ministry of Economy, Trade and Industry (METI). 2010. *Material Flow Cost Accounting MFCA Case Examples*. Japan.
- Schmidt and Nakajima. 2013. "Material Flow Cost Accounting as an Approach to Improve Resource Efficiency in Manufacturing Companies." *International Resources Journal*.
- Schmidt, A., Hache, B., and Herold, F. 2013. "Material Flow Cost Accounting with Umberto." *Jurnal IT Support for Material Flow Cost Accounting*.
- United Nations Division for Sustainable Development (UN DSD). 2001. *Environmental Management Accounting – Procedures and Principles*. New York: United Nations.

## APPENDIX

**Table 1. Difference between MFCA with *Conventional Cost Accounting***

<b>MFCA</b>		<b><i>Conventional Cost Accounting</i></b>	
<i>Sales</i>	15.000.000	<i>Sales</i>	15.000.000
<i>Product Cost</i>	3.000.000	<i>Cost of Sales</i>	4.500.000
<i>Material Loss Cost</i>	1.500.000	<i>N/A</i>	<i>N/A</i>
<i>Gross Profit</i>	10.500.000	<i>Gross Profit</i>	10.500.000
<i>Selling&amp;Admin. Exp.</i>	8.000.000	<i>Selling&amp;Admin. Exp.</i>	8.000.000
<i>Operating Profit</i>	2.500.000	<i>Operating Profit</i>	2.500.000

*Source: Asian Productivity Organization (APO), 2014*

**Table 2. Matrix of Material Cost Flow**

Cost	Material	Energy	System	Waste management	Total
Product	Amount (65%)	Amount (65%)	Amount (65%)	N/A	Total product (60%)
Material loss	Amount (35%)	Amount (35%)	Amount (35%)	Amount (100%)	Total material loss (40%)
Total	Amount (100%)	Amount (100%)	Amount (100%)	Amount (100%)	Total (100%)

*Source: Ministry of Economy Trade and Industry, 2010*