

The Use of Material Flow Cost Accounting in Supporting the Cost of a Sustainable Product to Achieving Green Productivity¹

Hasan Nayab Dhahi, Dr. Hanan Suhabat Abdullah

College of Administration and Economics – University of Baghdad, Iraq.

DOI:10.37648/ijrssh.v13i01.017

Received: 15 December 2022; Accepted: 02 February 2023; Published: 08 February 2023

ABSTRACT

The current study sought to measure the cost of the sustainable product and demonstrate its role in increasing green productivity through the application of the material flow cost accounting technique, which works on the optimal utilization of materials and energy and the reduction of environmental impacts. The research aims to clarify the knowledge foundations for material flow cost accounting and how to measure the cost of a sustainable product, in addition to studying the material flow cost accounting technique that helps reduce the cost of products and increase green productivity. The study concluded that material flow cost accounting contributes to measuring the cost of a sustainable product, which helps the economic unit to reduce costs and determine the environmental costs represented by waste and emissions generated from the production process.

INTRODUCTION

The contemporary business environment is witnessing rapid changes in all economic, social, environmental and technological fields, which has led to increasing depletion of natural resources, increased environmental degradation, pollution (air, soil and water) and large consumption of energy during the production processes of economic units, which prompted environmental organizations and government agencies to work on the need to raise awareness The environment of individuals and society, as it has become necessary for economic units to improve their methods, methods, and production techniques to reduce the depletion of natural resources and energy consumption, reduce the amount of waste generated, sustain products, and reduce the environmental risks and impacts of their production activities. It has become necessary to manufacture sustainable products characterized by their low cost as well as their high quality, and in order for the economic units to be able to achieve this, contemporary technologies should be used, foremost of which is the Material Flow Cost Accounting technology, as it is one of the contemporary technologies capable of facing the challenges of competition and responding to aspirations The economic unit aims to reduce the cost of its products and improve their quality due to its ability to reduce the use of material and energy flows and reduce waste. It also provides information that contributes to helping the economic unit to produce products of high quality by excluding activities that do not add value. As work is being done to find and activate methods of improvement to raise the quality of the positive product and reduce its cost, while seeking to reduce the negative product and work to get rid of it, and then helps the economic unit to keep abreast of contemporary developments because of what it contains of economic and environmental information that supports the processes of cost reduction and quality improvement, which It leads to a sustainable product that meets the customer's desires and takes into account environmental conditions.

THE FIRST TOPIC: RESEARCH METHODOLOGY

In this section, the research methodology will be addressed by defining the research problem, the importance of the research, the research objectives, the research hypothesis, as well as the sources of data collection as follows:

¹ How to cite the article: Dhahi H.N., Abdullah H.S., The Use of Material Flow Cost Accounting in Supporting the Cost of a Sustainable Product to Achieving Green Productivity, IJRSSH, Jan-Mar 2023, Vol 13, Issue 1, 189-204, DOI: <http://doi.org/10.37648/ijrssh.v13i01.017>

Research Problem:

In view of the increasing interest of the economic units in sustainability, as it has become one of the necessary requirements at the present time and in view of the environmental impacts of the Iraqi economic units resulting from the diversity of industries, the increase in pollution rates and the decrease in natural resources, which should be reduced in their consumption, as the economic units need to think about adopting technologies Contemporary projects that address waste at its source and ensure a more efficient use of resources, in order to ensure their sustainability and improve productivity.

The research problem lies in the weakness of keeping pace with the Iraqi industrial economic units with technological changes, increased costs, low quality, increased pollution rates, and the fact that they do not realize and use strategic costing techniques, including the Material Flow Cost Accounting (MFCA) technique, as well as the improper measurement of the cost of a sustainable product and the extent of consistency of these techniques. in increasing productivity.

Which called for the search for proper measurement of the cost of the sustainable product and work to increase green productivity, improve product quality and reduce costs through the use of material flow cost accounting (MFCA) technology and provide environmentally friendly and sustainable products.

Research Objectives:

In light of the research problem presented, the research aims to study measuring the cost of sustainable manufacturing using material flow cost accounting to increase green productivity.

This objective can be achieved by achieving the following sub-objectives:

- 1- A statement of the knowledge foundations for accounting for material flow costs and how to measure the cost of sustainable manufacturing according to this technology.
- 2- Studying the material flow cost accounting technique in measuring the cost of sustainable manufacturing that helps reduce the cost of products.
- 3- Demonstrating the material flow cost accounting technique in measuring the cost of sustainable manufacturing in providing information that helps increase green productivity.

Research Importance:

The importance of the research stems from the novelty of the topic of measuring the cost of sustainable manufacturing using material flow cost accounting to increase green productivity.

- 1- The use of material flow cost accounting can contribute to the optimal utilization of materials and energy, leading to cost reduction and improving product quality. It also provides appropriate information in a timely manner to assist the administration in carrying out its functions.
- 2- Sustainable products are among the important topics at the present time, which have become a necessary requirement as a result of the impact that economic units cause on the environment as a result of misuse of resources and energy, which led to their decline and thus their impact on future generations.

Hypothesis Research:

In light of the nature of the research problem, its objectives and importance, the basic hypothesis can be formulated as follows:

The main hypothesis of the research:

"The application of material flow cost accounting helps to measure the cost of sustainable manufacturing, which leads to increased green productivity".

THE SECOND TOPIC: ACCOUNTING OF MATERIAL FLOW COSTS - A CONCEPTUAL APPROACH

Material flow cost accounting is one of the recent trends in the field of environmental management accounting, as it provides important data for economic, social and environmental decision-making. And because of the scarcity of

resources, the high prices of raw materials, and the exacerbation of environmental pollution, which is mostly sourced from industrial economic units and the resulting emissions and wastes that are reflected in the environment, because of the obvious shortcomings in traditional accounting tools in providing detailed data on environmental performance, which prompted many economic units to use modern techniques for environmental management accounting, including material flow cost accounting to increase efficiency and optimal utilization of available resources and energy, and reduce waste that affects the environment and society, as well For intense competition in the business environment, and in order to be able to survive and continue in a competitive work environment, you need a balance between environmental and economic goals.

Historical Development of Material Flow Cost Accounting

Most of the literature on environmental management accounting and strategic cost management emphasizes the origin of Material Flow Cost Accounting (MFCA), which was developed by Professor (Bernd Wagner) and his colleagues in the late nineties of the last century at the Institute for Management and Environment in Augsburg in Germany (Institut für Management Umwelt) under Name "flow cost accounting" and "environmental cost accounting".

It began to be used in the industrial and service sectors in Germany and Japan, as these two countries have strong competence in industry and modern technology, which paved the way for its development and dissemination (Nakajima, 2015: 1305).

According to (Kokubu & Tachikawa, 2013:353); (Christ & Burritt, 2015: 1380); (Wohlgemuth & Lutje, 2018: 3); (Tran & Herzig, 2020: 2); (ISO, 14052, 2017:7) can be summarized as follows:

- 1- A project to enhance environmental management accounting began in 1999, and in 2000 the Japanese Ministry of Economy, Trade and Industry (METI) began making great efforts to develop this technology in the Japanese business sector.
- 2- The Japanese Ministry of Economy, Trade and Industry (METI) started in 2001 the project to introduce this technology and test it in four Japanese companies (Canon, and Nitto Denko, Tanabe, Seiyaku) and there were two versions of (MFCA) the German version was more interested in management on The level of economic unity and the Japanese version was mainly concerned with production lines and processes, and the country of Japan was more successful in applying and developing it.
- 3- The Japanese Ministry of Economy, Trade and Industry (METI) proposed in 2007 the development of a new standard such as unifying principles and general frameworks for material flow cost accounting (MFCA), which is the standard (ISO 14051) within the ISO 14000 family, and many countries participated in developing this standard alongside Next to Germany and Japan, such as: Finland, Malaysia, Mexico, Brazil, the United Kingdom and South Africa.
- 4- With the support of the Japanese government, nearly 300 Japanese companies implemented it in 2010, and most of them were able to achieve quick and new results. This standard (ISO 14051) was adopted under the title "Environmental Management - Material Flow Cost Accounting - General Framework".
- 5- Preparation began in 2014 to develop a new standard for expanding the entrance to material flow cost accounting to include the supply chain due to potential savings from material flow when there is closer cooperation between suppliers and buyers.
- 6- Another standard (ISO 14052) was issued in 2017 under the title Environmental Management - Material Flow Cost Accounting - Guidelines for Practical Application in the Supply Chain.
- 7- Developed in 2020 the third standard (ISO 14053) for material flow cost accounting to include small and medium-sized enterprises (SMES) and (MFCA) received great interest in academic practices as it gathered a wide range of different perspectives such as cleaner production, environmental economics, management accounting and Microfinance Law.

The Concept of Material Flow Cost Accounting:

Material Flow Cost Accounting (MFCA), developed in Germany in the late 1990s and widely adopted in Japan since then, focuses on tracking waste, emissions, and defective products and can help enhance an economic unit's economic and environmental performance.

As (MFCA) is considered one of the main tools for Environmental Management Accounting (EMA). It is a set of procedures used within economic units to link environmental considerations to economic objectives. At the present time, economic units cannot ignore the environmental aspects of their activities. Thus, economic units search They are looking for management tools to link concern for the environment with their bottom line.

MFCA is a management tool that promotes the most efficient use of materials, contributing to the reduction of waste, emissions and toxins. MFCA increases the transparency of the material flow, which is the key to successful problem solving. Economic units can increase the productivity of their resources and reduce costs at the same time. (Hiroshi Tachikawa, 2014: 5)

Material Flow Cost Accounting (MFCA) has been described as an Environmental Management Accounting (EMA) tool whose main objective is to reduce both environmental impact and cost. In addition, MFCA is also a tool used in decision-making in economic units that aims to improve the productivity of their business by reducing costs and reducing waste. MFCA measures the flow of raw materials in both physical and monetary units. It consists of material, energy, system and waste management costs.

MFCA in Japan which aims to reduce material losses rather than recycle waste. Lower material input and material cost is a direct result of reduced waste generation. This ultimately leads to improved efficiency in the waste treatment cost. Hence, two major environmental management activities are waste generation reduction and resource reduction in order to reduce the environmental impact of the manufacturing process. The MFCA determines the source of waste generation as well as the quantities and costs of waste generated from the process. . Moreover, MFCA can be considered as an effectiveness management tool used to help management better understand environmental aspects by improving material yield and reducing costs. The MFCA tracks and calculates both physical and monetary values of material flows for products and waste (Mishelle Doorasamy, 2015:71).

Main Elements of Material Flow Cost Accounting

There are three components that cost accounting consists of material flow (Hiroshi tachikawa, 2014:4).

1-Cost Accounting: According to Material Flow Cost Accounting (MFCA), the flows and stocks of materials within the economic unit are tracked and their quantity is determined in physical units (for example, mass and volume) and then the associated costs are assigned, which are divided into four types of costs: (material, system, energy and waste management costs). Each cost is determined as follows:

A- The cost of materials: It is expressed in a quantitative center (the unit of measurement of inputs and outputs for MFCA analysis). Purchase cost is used as material cost.

B- Energy cost: It represents energy sources such as electricity, fuel, steam, heat and compressed air.

C - System cost: The cost incurred in the internal operations and material flows, excluding the cost of materials, the cost of energy and the cost of waste management.

D - The cost of waste management: It represents the cost of dealing with material losses.

2- Flow: The MFCA tracks all input materials that flow through production processes and measures products and material loss (waste) in physical units using the following equation:

$$\text{Inputs} = \text{Products} + \text{Material Loss (Waste)}$$

The MFCA's starting point is to measure the amount of physical losses based on physical balance. And it is illustrated in Figure (4) In this case, the amount of material loss (30 tons) is calculated based on the amount of total inputs and products in a specific part of a process in which the inputs and outputs are determined. This part of the process is defined as a quantity center in (MFCA), i.e. (Material Loss = Inputs - Products).

3- Materials: Materials refer to any raw materials or auxiliary materials that are used in the manufacture of the product, that is, materials that do not become part of the final product are material losses, wastes, and loss of resources that occur during the production process, including

A- Loss of materials during processing, defective products, impurities.

B- Loss of remaining materials in manufacturing equipment after preparation operations

C - Auxiliaries such as solvents and detergents for washing equipment and water

D - Raw materials that become unusable for any reason.

Benefits of Material Flow Cost Accounting:

The development of Material Flow Cost Accounting (MFCA) led to improved decisions and waste reduction, in addition to reducing costs for the economic units that applied this technology. For example, in Japan, many economic units have improved their resource efficiency through MFCA accreditation.

Material Flow Cost Accounting (MFCA) technology includes several benefits, including: (Doorasamy, 2014 60)

- 1- **Identifying problems:** Recognizing the existence of hidden economic loss under cash cost accounting, where traditionally uncontrollable material losses of which only on-site operators are aware are highlighted. It also helps in identifying options to reduce material losses.
- 2- **Identification of improvement points:** There are no appropriate improvement measures applied even though the company is aware of material losses and the reasons for not taking improvement measures.

Differences between Material Flow Cost Accounting (MFCA) and Traditional Accounting Systems.

Many writers and researchers believe that there is a difference between material flow cost accounting (MFCA) and traditional accounting systems (TCA) in many aspects. Table (2) shows this difference.

The differences	(TCA)	Material Flow Cost Accounting (MFCA)
Material losses	In traditional accounting systems, there is no concept of material losses and their costs, as all costs are generally spent on production. Costs are recovered from sales and the recognition of losses in terms of quantity is neglected. These losses are included as part of the total cost of production.	MFCA focuses on classification between associated costs (products) and material losses recognized as economic losses. Losses are not ignored in MFCA, which encourages management to search for ways to reduce material losses and improve business efficiency.
Compare inputs to outputs	It does not compare the material inputs and outputs, and therefore there is no concept of material balance.	In it, a comparison is made between material inputs and outputs, and the differences and the reasons that led to that are identified, and there is the concept of material balance.
Producing units	Economic units produce non-defective (intact) products only, and there is no concept of defective products (waste) in traditional cost accounting.	Economic units produce two types of products: a good product and a defective product, which is waste.
Environmental aspect	It focuses on the economic aspect only and works to reduce costs and increase profits	It focuses on the economic and environmental aspects by working to reduce costs and limit environmental impacts represented by emissions, solid waste, waste and waste water.
Data	It does not require determining the cost and quantity of materials that have been transformed into products or waste that have been disposed of, although it recognizes these wastes quantitatively and includes their costs within the total cost of outputs under the name of material losses.	It focuses on distinguishing and identifying costs associated with products and physical losses and assessing material loss as an economic loss.
Cost classification	Costs are calculated on the products in full, which are divided into: material costs, wage costs, and indirect industrial costs.	Costs are calculated on good and defective products. The costs for the good and defective product are divided into: material costs, energy costs, system costs, and waste management costs.
Environmental costs	In the traditional cost accounting system, the environmental costs are not visible, which leads to inaccurate decisions because the decision-making process is based on providing an integrated	In the material flow cost accounting system, the environmental costs are more transparent and visible, which helps to make correct decisions, due to the presence of a complete quantitative and material data management system.

	management system in providing evidence, and here the traditional systems lack that.	
Actual production	Weaknesses in production and defects are also identified by comparing the current products with the planned ones in order to identify the causes and work to address them.	The difference in production is identified by tracking the flow of materials and energy, starting from the inputs to the end of the production process, in order to identify weaknesses and work to address them.

The Concept of Loss According to Material Flow Cost Accounting:

One of the most prominent characteristics of material flow cost accounting is that it gives a new concept of loss that differs from what came in traditional accounting systems because it focuses on the relationship between inputs and outputs, where the loss was defined according to material flow cost accounting (MFCA) as the difference between the inputs and outputs of the production process (Tagelawi, 2016: 114).

Where material flow cost accounting works to identify normal losses, for example (scrap and poor-quality products) as part of material flows and report them at all manufacturing stages as economically and environmentally undesirable material waste, which enables the management of the economic unit to carry out a set of procedures Before designing processes that will identify areas for cost savings (Doorasomy, 2014:59).

Accordingly, the main losses generated during the production process can be limited to the following: (Ameri, 2017:35)

- 1- Loss of materials during processing (such as scheduling and lathing), defective products and impurities.
- 2- Loss of auxiliary materials (such as solvents, volatile substances and detergents used to wash equipment).
- 3- Loss of materials remaining in manufacturing equipment after preparation.

The concept of loss provides accurate information about the cost of the positive and negative product in production activities. Material flow cost accounting identifies outputs into two types, positive and negative.

Steps to Implement (Application) Material Flow Cost Accounting:

The international standard (ISO, 14051,2011) indicated that there are a set of steps that can be implemented based on the continuous improvement cycle (plan-do-check-correct) (PDCA) (plan-do-check-act). The following is an illustration of these steps:

1- Plan:

This step includes a set of procedures:

A- The participation of senior management: Material Flow Cost Accounting (MFCA) technology needs the participation and support of the management of the economic unit for its success (Singh, 2015:4).

B- Determining the required experience: The application of material flow cost accounting technology requires a multi-experienced team, which can provide the information required for analysis. These experiences are represented in operational expertise, accounting expertise, environment and quality control.

C- Determine the limits of implementation and the time period: the limits of the system of flows must be defined. Limits can basically extend to one or several operations (operations) of the entire economic unit or even entire supply chains as a basis for the analysis of the regulator. Moreover, defining the time period is necessary to obtain data task and the time period should be long enough. Thus seasonal fluctuations and changes inherent in the process can be recognized and take into account data changes and the time period can be for example a month or a year (ISO, 2011:11).

D - Define quantity centers: Quantity centers are spatial units or a function that stores the process or transfers materials in another way (such as material stores, production units, outgoing good stores, or disposal systems that are

linked to material flows. Operations such as receiving, cutting, assembling, heating, packing, etc. can be defined as quantity centers Figure 1 illustrates these steps



Figure (1)

Departments involved in the implementation of material flow cost accounting

2- Do.

This step includes a set of procedures, as follows:

A- Determine the inputs and outputs for each quantity center: the inputs must be determined by the quantity centers such as (materials, energy and water) and the outputs (good products and waste). For this, material flows are measured within each quantity center and the energy use between the different quantity centers during a specific period (Johannes Kepler, 2020: 30).

B- Measurement of flows quantitatively: based on the flow structure, material flows must be measured in physical units such as (mass, length, volume, or number of pieces) using a standard unit such as (mass) a physical balance can be established for each quantity center (ISO, 2011: 12).

C - Measuring cash flows: the quantitative measurement of flows may shed light on shortcomings in the use of materials and energy, but the negative economic effects of these flows are still unknown. Therefore, the next step is the financial assessment of material, energy and inventory flows and to measure material, energy and inventory flows financially (flow costs The costs are divided into four categories: (sygulla, et al, 2014:108)

- **Material cost:** includes the cost of main and auxiliary materials
- **Energy cost:** includes the cost of electricity, fuel, steam, heat and compressed air.
- **System cost:** includes labor cost, depreciation cost, maintenance and transportation cost.
- **The cost of waste management:** It includes the cost of disposing of the resulting products in the quantity centers.

3- Check:

This step depends on the following:

A- Summarizing the data and analyzing the results: A summary of the outputs is prepared and analyzed and interpreted by preparing a chart that combines the costs of the good product and the losses in all operations called the material flow cost matrix. environmentally and financially.

B- Communicating the results: Upon completion of the analysis of the results, the results of the analysis must be reported to the senior management in the unit to take the appropriate measures, as the management can use the results of the analysis to support a variety of appropriate decisions aimed at improving the environmental and financial performance of the economic unit (Dekamin et al, 2019 :5).

4- Correct Act

Finally, and based on transparency in material and energy flows, opportunities to improve environmental and financial performance are identified and evaluated before the cycle begins again (Kawalla, et al, 2018:195).

Measures taken to achieve these improvements may include replacement of materials, modification of processes, production lines or products, and intensification of research and development activities related to efficiency in the use of energy and materials.).

The four steps of the Continuous Improvement Cycle (PDCA) for the application of material flow cost accounting and how they can be integrated can be summarized through Figure (2)

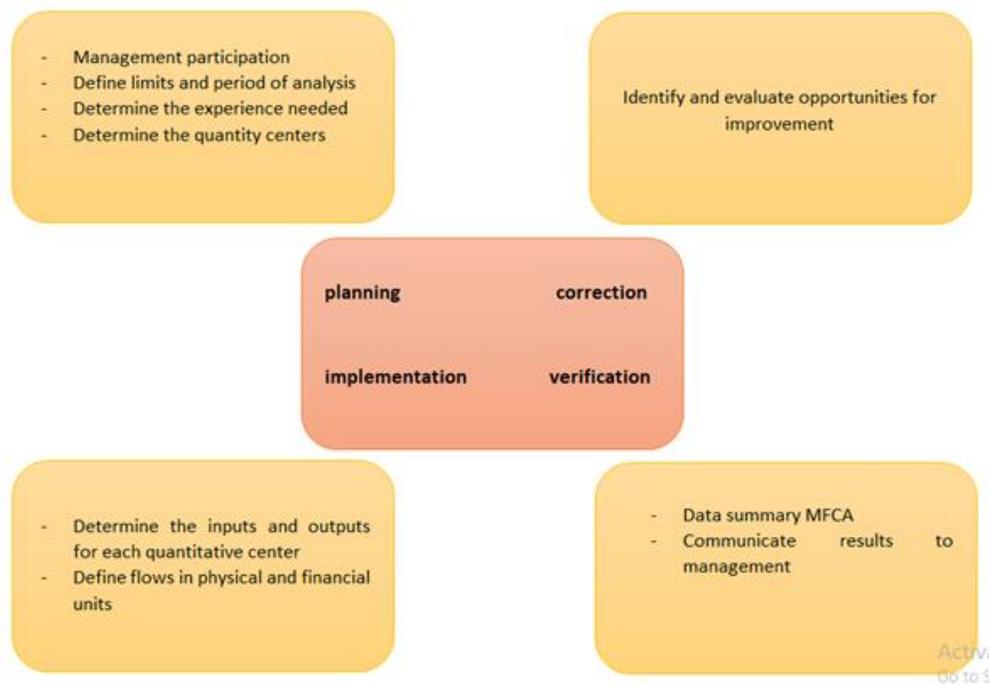


Figure (2)

Steps to implement material flow cost accounting through the continuous improvement cycle.

Source: Dekamin, M., Barmaki, M. (2019). Implementation of material flow cost accounting (MFCA) in soybean production. Journal of Cleaner Production, 210, 459- 465. P 5

Another step can be added to the previous steps when implementing material flow cost accounting, which is to reduce the environmental impact and work to solve environmental problems (emissions, solid waste, greenhouse gases, and waste water) by improving the efficiency of materials, energy, process processing in production lines, and work to produce Green products that are environmentally friendly and can be recycled at the end of their life, thus reducing damage to the environment (Huang et al, 2019: 9).

THE THIRD TOPIC: THE COST OF THE SUSTAINABLE PRODUCT

The direct or indirect consumption of resources leads to a lot of environmental pressures and waste and to the depletion of resources, and everyone is increasingly aware of the fact that those resources are limited on this planet, and therefore environmental awareness began to increase all over the world, as many units began describing themselves as environmentally friendly. By providing green products with less harmful effects on the environment, while achieving other benefits for the end user (such as manufacturing these products from less harmful components, which leads to saving energy and materials), and acting in an environmentally friendly manner is today a necessity for the purpose of producing sustainable products (Hojnik et al, 2019: 1-2).

We may find two products that meet the same need, that is, they are acquired to satisfy the same needs by customers, but we find a sustainable product and the other is ordinary. The sustainable product in this case is an ordinary product that has been subject to a set of modifications to become an environmentally friendly product by reducing the resources used in productivity and reducing the proportion of its negative effects on the environment (Faleh et al., 2019: 186).

The Concept of a Sustainable Product

It is difficult to give a comprehensive and accurate concept of a sustainable product, as this depends on many things, including culture, the time factor, and the provision of raw materials, but in general it can be said that a sustainable product is that product that uses environmentally friendly materials that can self-degrade. With the need to follow it through the stages of its life cycle to ensure that it remains within the environmental commitment, and this includes: (Faleh et al., 2019: 187)

- Do not use harmful preservatives.
- Use minimum energy.
- Use the minimum amount of raw materials.
- Do not use toxic substances.
- Use recyclable packaging or use it after completing the content of the packaging.

Sustainable production depends on reducing the generation of waste from the source, instead of leaving the waste until it is produced and then thinking about its treatment and disposal after that. Less waste, and sustainable production also includes recovering some useful waste instead of disposing of it. Many modern economic units are trying to implement the principle of sustainable production, as it relieves them of many environmental responsibilities and brings them many economic benefits (Borzik, 2010: 46).

The sustainable product is applied to processes, products and services as follows: (Ilham, 2012:45).

- Production processes (industrial) include the preservation of raw materials and energy, the elimination of toxic raw materials and the reduction of the quantity and toxicity of waste and radiation.
- Products: The strategy focuses on minimizing harmful effects throughout the life cycle of the product, starting with extracting the raw materials needed for its production until its final disposal.
- Services: Incorporating environmental concerns into the design and delivery of services.

The Importance of a Sustainable Product

Wyckoff sees the importance of a sustainable product as follows: (Wyckoff, 2011:4)

- 1- Improving efficiency and productivity by reducing resource consumption, reducing waste, and reducing burdens.
- 2- Reducing dependence on high-cost or dangerous resources by exploring sustainable alternatives, inventing them, and introducing them into production processes.
- 3- Increasing the percentage of sales by anticipating the sustainable product and meeting the economic, environmental and social requirements in a better way than the competing economic units.

Kurniawan believes that the sustainability of the product is the guarantee of the sustainability of the competitive state within the concept of a sustainable product that does not represent additional costs, but rather is a source of obtaining sustainable competitive advantages for the economic unit (Kurniawan, 2011:8).

Machado et al indicated that the sustainable product plays an important role in limiting or reducing the depletion of natural resources and works to improve product quality and meet social and environmental requirements (Machado et al, 2019:4).

Characteristics of a Sustainable Product

Sustainable products have the following characteristics: (Hashem, 2015: 1318)

- 1- Customer satisfaction: That is, products or services that do not meet the customer's needs will not continue in the market in the long term.
- 2- Compared to ecological products: sustainable products focus on both ecological and social importance.
- 3- Sustainable products are environmentally friendly during their life cycle, as they do not cause any harm to the environment.
- 4- Sustainable products must contribute to dealing with social and environmental problems at the global level, or provide measurable improvements in the social and environmental performance of the product.
- 5- Continuous improvement for environmental and social changes.

Competing bids: Sustainable products may still be a long way off, or competing products may serve as an indicator of social and environmental performance.

Sustainable Production Stages

The stages of a sustainable product include design, manufacturing, marketing and distribution, use, and recycling. An explanation of these stages follows:

First: sustainable product design

Manufactured products affect all aspects of sustainability (economic, environmental and society) throughout their life cycle such as material use, manufacturing, marketing, use and disposal. It has been found that about 80% of sustainability impacts are identified in the design stage, and therefore this stage is an important strategy to achieve product sustainability that is defined It is the ability of the product to operate continuously while ensuring the lowest level of environmental impacts and providing economic and social benefits to stakeholders, so the three aspects of sustainability should be considered an integral part of sustainable design (Ahmad et al, 2018:49).

Accordingly, sustainable design has become one of the concepts of great importance that seeks to develop products along the product life cycle, with a focus on reducing costs during manufacturing and distribution, reducing the use of materials and energy, preventing gas emissions and reducing waste, and this is what drives most economic units to move towards sustainable practices, In addition to the intensity of competition and the business environment, and the fact that sustainable design works to improve the economic, environmental and social performance of the economic unit (Klaczek, 2017:4).

Second: Sustainable Manufacturing

Manufacturing in particular is one of the main drivers of sustainable manufacturing. Sustainable manufacturing is a rapidly evolving field and a growing body of knowledge is expected. The literature shows evidence of sustainable work in the areas of supply chain product design, production technology, and waste avoidance activities. Manufacturers indicate metrics that show improvements. Great environmental performance at a high level.

Sustainable manufacturing works on the concepts of waste-free manufacturing and green manufacturing and provides a new way to design innovative products and deploy manufacturing processes using methodologies that reduce harmful environmental impacts, improve energy and resource efficiency, generate the minimum amount of waste, improve operation and maintain the health of workers, with Maintain or improve process and product quality while benefiting from total life cycle costs (Jafar & Mazhar, 2021: 641-642).

(Hamia et al, 2015: 191) believes that the concept of sustainable manufacturing can be defined and diagnosed through three levels, which are the level of the product, processes, and system.

Third: Sustainable Marketing

The concept of sustainable marketing has emerged towards achieving sustainability as a goal pursued by economic units to address environmental impacts and meet sustainable customer behavior while providing societal well-being, all within an appropriate economic framework through the provision of sustainable marketing practices.

Etzel emphasized that marketing is directed towards the customer according to the marketing activities to achieve the objectives of the economic unit, just as traditional marketing is concerned with the process (exchange) between the economic unit and the customer (Etzel et al, 2007: 9).

Blyth also confirms that marketing focuses on the customer and the production of products that satisfy him and then lead to the acquisition of new customers (Blyth, 2008:280).

(Kumar, et al, 2013:605) indicated that it is a structure for maintaining sustainable relationships with customers, the social environment, and the natural environment.

explained (Noo-urai & Jaroenwisana, 2016:118) that it is planning, organizing, implementing and controlling resources and marketing programs to meet the needs and desires of customers, taking into account the standards of society and the environment in order to achieve the goal of economic unity.

added (Kortam & Mahrous, 2020:174) that it is to create, produce and provide sustainable solutions with a higher sustainable net value while constantly satisfying customers and other stakeholders.

(Mukif et al, 2020: 1627) indicated that it is a modern organizational, marketing and strategic directive aimed at meeting the customer's requirements with high professionalism while preserving the natural environment and good use of its resources and reaching high performance that would help the economic unit to reduce the impact of competing products and address disturbances and problems Marketing.

Fourth: Product use

It is related to the period of time in which the product is used by the customer, as during this stage he may consume auxiliary products such as energy, and therefore the traditional requirements are energy efficiency, safety, reliability, ease of operation, maintenance or repair, and the interaction of the product with the user and his behavior affects performance The sustainable development of the product at its use stage (Schwarz, 2017:18).

Fifth: Recycling

The idea of recycling began during World War I and II, when countries were suffering from a severe shortage of some basic materials, which prompted them to collect these materials from waste for reuse. Years later, the recycling process became one of the most important methods used in solid waste management, due to the many environmental benefits of this method. For many years, direct recycling through the producers of materials and waste (scrap) was the main form of recycling. As with the beginning of the nineties, the focus began on indirect recycling, and this means the manufacture of waste materials to provide other products that depend on the same raw material, such as (recycling of paper, cardboard, plastic, metal) and other materials that are recycled in the current period. As the interest in environmental issues It has been reflected through environmental awareness programs and campaigns carried out by associations interested in the environment, and the economic units have found that if recycling programs are taken seriously, they will help reduce the cost of raw materials and operating costs, as well as improve their image as a permanent concern for environmental pollution.

THE FOURTH TOPIC: THE APPLICATION OF MATERIAL FLOW COST ACCOUNTING IN ORDER TO SUPPORT THE SUSTAINABLE PRODUCT TO INCREASE GREEN PRODUCTIVITY

The wide spread of various industries led to a very large increase in the consumption of materials and energy, which led to a decrease in resources, climate change and an increase in environmental problems, in addition to the pressures facing economic units in order to improve the production process while working to reduce environmental impacts. Sustainable products have become a tool Important and effective economic and environmental issues are a crucial element for the survival of economic units in light of global competition (Chygryn et al, 2021:23).

Improving the performance of operations achieves, as a result, an increase in productivity rates through the optimal utilization of inputs, which gives high-quality outputs at the lowest costs (Sorour, 2017: 242).

As the use of material flow cost accounting works to reduce costs and work to achieve efficiency in production processes, by monitoring places of waste in materials and energy within each stage and speeding up its treatment or reducing it, working on designing products, finding good manufacturing equipment, reducing waste, and diagnosing the gap that led to the occurrence The difference between the input and output of materials (Mishelei, 2019:16).

The Concept of Green Productivity

Industries all over the world are undergoing a fundamental transformation process that involves the formula of Liberalization, Privatization and Globalization, meaning liberalization, privatization, and globalization. These changes have introduced more competition between economic units as well as environmental impact. There is a concern that globalization may not incorporate environmental impact decisions of resource consumption, waste generation, and therefore tools and concepts have been developed to improve and protect the environment.

Despite the ambiguity and confusion of the concept of productivity, there are several features and characteristics that characterize this concept. It has been defined in general as the relationship between outputs (productive goods and services) and inputs (consumed resources) when carrying out the industrial transformation process (Tangen, 2002:1).

As productivity is a basic measure of the performance of all economies, industries, operations and projects, as productivity is improved through the management of operations of all economic units, the implementation of plans to develop their operations, supply chain management, and competition at the local and foreign levels (Krajewski, et.al, 2010, 39).

As for green productivity, it includes environmental protection and economic development, as green productivity has achieved great importance in improving productivity and reducing the environmental impact of the activities of economic units for several reasons, the most important of which are: scarcity of resources, economic competition, environmental efficiency, professionalism and health risk, industrial policies, international environmental treaties, Environment, Trade and Consumer Demands (Avishek, at.el, 2008:3).

Green productivity is defined as a term created and used by the Asian Productivity Organization (APO) and according to (APO) it is a strategy to improve productivity and environmental performance for global social and economic development (Dayanna, 2019:2).

It is also defined as the ratio of a system's productivity to its environmental impact (Salloum, 2022: 82).

Application of Material Flow Cost Accounting in Supporting the Cost of a Sustainable Product

The contemporary business environment is witnessing many rapid and continuous changes, the most important of which are environmental, economic and technology, as well as competition between economic units, which constitutes a challenge for economic units. Reducing product costs and improving productivity and environmental performance, as well as supporting the sustainable product through the product life cycle that begins (product innovation, product design, product manufacturing, marketing and recycling) with the need to pay attention to the environmental aspect because these industries have a direct impact on the environment, which makes it imperative for the economic unit to preserve it through optimal consumption of resources and prevention pollution.

Through the foregoing, the sustainable product can be measured using the material flow cost accounting technique through:

- 1- Determine the inputs and outputs in a physical (quantitative) way.
- 2- Determine the inputs and outputs financially (monetary)

Determine the Inputs and Outputs in a Physical (Quantitative) Way.

The material flow cost accounting technique tracks all the material inputs and outputs of the economic unit related to the production processes and defines them accurately to ensure accounting for them, as the inputs consist of a group of elements and include:

Material inputs include:

- 1- Raw and auxiliary materials
- 2- The goods
- 3- Operational materials
- 4- Packaging materials
- 5- Water

Production outputs include:

- 1- Basic products, including packaging

- 2- Incidental products, including packaging
- 3- Non-commodity outputs (waste and emissions)

They include:

- A- solid waste
- b- Gaseous emissions
- C - Hazardous waste
- D - Waste water

These quantitative categories can also be modified as needed to suit specific sectors or individual economic units, as defining them helps to limit the flows of materials and energy for a specific period and analyze them in order to know the causes that generate the negative product of waste and emissions in order to take the necessary measures by the economic unit to reduce them.

Determine the Inputs and Outputs Financially (Monetary)

Inputs and outputs are determined financially using material flow cost accounting, which is divided into four types:

- 1- Material costs: It includes the costs of main and subsidiary materials and assistance involved in the production process.
- 2- Energy costs: It includes the costs of electricity, water and fuel.
- 3- System costs: It includes treatment costs, represented by labor costs, depreciation and any other general costs.
- 4- Waste management costs: It includes waste treatment costs.

Employing material flow cost accounting in supporting sustainable product stages**1- Sustainable design**

The material flow cost accounting technique provides information to the management about the flows of materials and energy and to identify the gap that led to the increased consumption of materials and energy to support organizational decisions related to the replacement of material inputs, process planning, product redesign, quality control, supply chain management, recycling or use of products, and achieving environmental improvements in products and processes (kokub & kitada, 2014:5).

As the material flow cost accounting technique is considered one of the best techniques that can be linked and coordinated in order to design and manufacture sustainable products, given the importance of the information it provides to the management of the economic unit that enables them to design products characterized by high quality, low production costs and the provision of products free of environmental waste (219 : Schaltegger, 2018).

The use of material flow cost accounting technology in supporting sustainable design will enable the economic unit to achieve economic and environmental aspects, as material flow cost accounting works to reduce costs in addition to its role in reducing waste from inputs to outputs, and this helps to design sustainable products with Low costs and free from environmental impacts (Huang & ta el, 2019: 5).

2- Sustainable manufacturing

Sustainable manufacturing is an important practice of sustainability practices and technologies to reduce energy consumption and consumption of system flow resources in order to reduce the use of natural resources and reduce waste of resources and energy that occur due to increasing defects that must be avoided or due to improper design and the use of less energy resources (Dube & Gawande, 2011: 5).

Sustainable manufacturing leads to a reduction in the costs of raw materials, reduction of environmental expenses, insurance of occupational safety, achievement of production efficiency, and improvement of the image of the economic unit. Sustainable manufacturing aims to reduce environmental damage by using appropriate resources and technology (Huiyu, 2010:15).

3- Sustainable Marketing

The concept of sustainable marketing has emerged towards achieving sustainability as a goal pursued by companies to address environmental impacts and meet sustainable customer behavior while providing the welfare of society, all within an appropriate economic framework through the provision of sustainable marketing practices.

Sustainable marketing is a more comprehensive and market-aware approach that seeks to meet all costs. Environmental production and consumption to create a sustainable economy environment (Peattie, 2001: 129).

4- Sustainable distribution

Material flow cost accounting works on the stage of sustainable distribution by taking the necessary measures to ensure that the product is distributed using less fuel, and setting points of sale in a way that makes customers consume as little time and fuel as possible (Al-Zamili, 2022: 47)

5- Recycling

Material flow cost accounting provides information that focuses on reducing the quantities of materials and energy consumed in the manufacturing process, which will reduce the volume of waste and emissions that affect the environment, and then the environment will be preserved from pollution as a result of reducing waste and emissions and producing defect-free products, as it represents Material flow cost accounting is an important technique for environmental management, as environmental benefits are improved through it even if the economic unit has no intention of doing so.

THE FIFTH TOPIC: CONCLUSIONS AND RECOMMENDATIONS

Conclusions :

- 1- Material flow cost accounting enables economic units to track physical and financial inputs and outputs through the idea of balance between inputs and outputs and identifying the positive product and the negative product (waste), which contributes to reducing waste.
- 2- The sustainable product is one of the most important success factors, as it offers high quality products and the fact that most customers seek to obtain sustainable and environmentally friendly products.
- 3- The sustainable product leads to improving productivity in the economic units, as it includes addressing the environmental, social and economic impacts of the product.
- 4- Material flow cost accounting contributes to measuring the cost of a sustainable product, which helps the economic unit to reduce costs and determine the environmental costs represented by waste and emissions generated from the production process.
- 5- Measuring the cost of a sustainable product helps to increase green productivity through the use of material flow cost accounting that works to reduce the use of materials and energy, which leads to lower costs and improves quality during the production process, which leads to increased green productivity that is environmentally friendly and meets the desires of the customer.

Recommendations:

- 1- Increasing awareness and interest in the sustainable product through the publication of research and case studies, as it is a contemporary topic.
- 2- Work on developing the unified accounting system applied in economic units in order to be compatible with contemporary management accounting techniques and work on benefiting from environmental information and disclosing it in the financial statements.
- 3- It is necessary to take advantage of the material flow cost accounting for the purpose of limiting the material losses incurred by the economic unit during the production process for the purpose of eliminating or limiting them.
- 4- Work on searching for energy alternatives or that this material is the most expensive in the industry, whether (electrical, oil and thermal energy), as most countries tended to use alternative and environmentally friendly energy such as (water, air and solar cells) to generate electricity

Financial support and sponsorship: Nil

Conflict of Interest: None

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