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https://www.jisem-journal.com/ **Research Article**

Application of Material Flow Cost Accounting Technology to Support Green Productivity and Its Reflection in Achieving Sustainable Development

Hassan Nayib Dahi [1*], Hanan Suhbat Abdullah [2]

[1] Researcher, College of Administration and Economics, University of Baghdad, Baghdad, Iraq
[2] Professor, Doctor, College of Administration and Economics, University of Baghdad, Baghdad, Iraq
* **Corresponding Author:** hasan.nayib1106a@coadec.uobaghdad.edu.iq

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ABSTRACT

As material flow cost accounting technology focuses on the most efficient use of resources like energy and materials while minimizing negative environmental effects, the research aims to show how this technology can be applied to promote green productivity and its reflection in attaining sustainable development. In addition to studying sustainability, which helps to reduce environmental impacts and increase green productivity, the research aims to demonstrate the knowledge bases for accounting for the costs of material flow and green productivity. It also studies the technology of accounting for the costs of material flow in achieving sustainable development and the role of green productivity in achieving sustainable development. According to the study, material flow cost accounting technology contributes to green productivity by lowering energy and material consumption, which lowers costs and improves quality during production. This, in turn, leads to higher levels of environmentally friendly, customer-satisfied, and sustainable development productivity.

Keywords: Material Flow, Green Productivity, Sustainable Development.

INTRODUCTION

Given the global trends that economic units are facing, they should seek to reduce waste and environmental pollutants by creating solutions and remedies for these issues. This is because economic units, particularly industrial ones, have not given enough attention to achieving aspects of sustainability, which leads to an increase in waste generation and accumulation. To achieve sustainability, economic units must employ cutting-edge systems and techniques, the most important of which is material flow accounting, which aims to achieve efficiency in the flows of energy and materials by identifying The application of green productivity integrates the ideas of green production and awareness of environmental risks with green productivity, and then works to minimize resource depletion and achieve sustainable development. Paying attention to green productivity improves aspects of sustainability.

Research Problem

The difficulty in determining Iraqi industrial economic units' inability to adapt to changes in technology, rising costs, poor quality, and rising pollution rates stems from their ignorance of and poor application of strategic cost techniques, such as the material flow cost accounting technique (MFCA).

This prompted the need to find a statement outlining how material flow cost accounting, or MFCA, is applied to promote green productivity in the pursuit of sustainable development.

In the light of the foregoing, the research problem can be explained by the main question:

The application of material flow cost accounting technology to support green productivity contributes to achieving sustainable development in Iraqi economic units.

Research Objectives

The research intends to explore the use of accounting for material flow costs to assist green productivity in attaining sustainable development—an applied study in the Iraqi economic units—in light of the research topic given.

This goal can be achieved by achieving the following sub-goals:

1. Statement of the knowledge bases for accounting the costs of material flow and its impact on green productivity according to this technique.

2. Studying the technique of accounting for the costs of material flow in achieving sustainable development

3. Statement of the role of green productivity in achieving sustainable development.

Importance of Research

The topic's novelty—applying material flow cost accounting to green productivity to promote sustainable development—makes the research significant.

1. The use of material flow Cost accounting may assist reduce costs and improving product quality by maximizing the use of energy and resources. It can also deliver pertinent information in a timely manner to support the administration in performing its duties.

2. To the best of the researcher's knowledge, no studies have addressed the use of material flow cost accounting to boost green productivity in the pursuit of sustainable development, which would have enhanced theoretical and practical research on the subject.

Research Hypothesis

Given the nature of the study challenge, its goals, and its significance, the following fundamental hypothesis may be made:

The main hypothesis of the research—"Material flow cost accounting is a useful tool for promoting green productivity and achieving sustainable development".

APPLICATION OF MATERIAL FLOW COST ACCOUNTING TO SUPPORT GREEN PRODUCTIVITY IN ACHIEVING SUSTAINABLE DEVELOPMENT

The Concept of Material Flow Cost Accounting Technique

One of the most recent developments in the field of environmental management accounting is the accounting for material flow costs. This is because it offers crucial information for making decisions that affect the economy, society, and environment. Increasing resource scarcity, rising raw material costs, and worsening environmental pollution—which is primarily caused by industrial economic units and the waste and emissions they produce that end up in the environment—have forced many economic units to adopt new environmental management accounting techniques, such as accounting for material flow costs to boost productivity and make the best use of their available resources. Reducing waste that has an impact on society and the environment, as well as the fierce rivalry in the business world, needs striking a balance between environmental and economic objectives in order to thrive.

Policy support by senior management, in turn, leads to motivation and self-confidence, which has a significant impact on improving productivity using strategic cost management tools and methods (Al Salam Khalil &Hamid, 2021).

Material Flow Cost Accounting (MFCA), which was created in Germany in the late 1990s and has since gained widespread usage in Japan, is a technique that tracks waste, emissions, and faulty goods. It may improve an economic unit's performance both environmentally and economically.

One of the Environmental Management Accounting (EMA) instruments that primarily aims to reduce costs and environmental effects is material flow cost accounting, or MFCA. Furthermore, economic units employ MFCA as a tool in their decision-making process in an effort to increase corporate productivity through cost and waste reduction. The raw material flow is measured by the MFCA in both monetary and physical quantities. It includes waste management, system, energy, and material costs.

Material flow cost accounting focuses on improving productivity and producing high-quality products through continuous improvement in its production processes (Jawad & Al-Rabia'i, 2021).

One of the newest and most useful technologies created by international organizations is accounting for material flow costs. Its goals are to maximize the use of energy and resources, minimize waste, and restrict the use of any materials that have an adverse effect on the environment or society (Soror & Ahmed, 2023).

By raising material productivity and cutting expenses, MFCA is a useful management tool that aids in management's understanding of environmental issues. Material and financial values of product and waste material flows are tracked and computed by MFCA.

Accounting for material flow costs makes products safe and healthy and does not affect the environment through the optimal use of materials and energy (fewer inputs and an increase in productivity), and thus the economic unit is more sustainable (Al-Khafaji & Al-Taie, 2020).

MFCA can provide internal benefits to the economic unit by enhancing competitiveness, increasing profits and productivity while identifying problems and losses that occur due to the application of traditional cost accounting (Ahmed Nouri, 2018).

Material flow cost accounting is defined as a set of activities related to the identification, collection, analysis and reporting of information about materials, energy, costs, their flows and cost information related to the environment.

Key Elements of Material Flow Cost Accounting

Material flow is one of the three components of cost accounting (Tachikawa, 2014).

1. Cost Accounting: The Material Flow Cost Accounting System (MFCA) tracks and quantifies material flows and stocks within an economic unit in physical units, such as mass and volume. It then assigns associated costs, which are broken down into four categories: materials, system, energy, and waste management costs. Moreover, each expense is calculated as follows:

a. The cost of materials is stated quantitatively (using output measurements and outputs for MFCA analysis as units of measurement). Additionally, the purchase price serves as the material cost.

b. Energy sources include gasoline, electricity, compressed air, steam, and heat. This is represented by the term (energy cost).

c. System cost: the price paid for the internal material flow processes, excluding the price of materials, energy, and waste disposal.

d. The cost of waste management: represents the cost of processing material losses.

2. Flow: The following equation is used by MFCA to track all input materials that flow during manufacturing operations and to quantify products and material loss (waste) in physical units:

Inputs = products + material loss (waste)

3. Materials: Materials are any raw or auxiliary materials utilized in the manufacturing process; materials that are not used in the finished product constitute a material loss. During the production process, waste and resource loss occur, including:

a. Resources lost during production, faulty goods, and contaminants.

b. Loss of residual materials in the manufacturing equipment after the preparation processes.

c. Auxiliary substances such as solvents and detergents for washing equipment and water.

Steps of Implementation (Application) of Material Flow Cost Accounting Steps to Implementation (Implementation) Material Flow Cost Accounting

An explanation of the processes that may be done based on the plan-execute-check-correct (PDCA) (plan-do-check-act) continuous improvement cycle is provided by the international standard (ISO, 14051, 2011).

1 - Plans

This step includes a set of actions:

1. Participation of senior management: For the Material Flow Cost Accounting (MFCA) system to be successful, the economic unit management must be involved and supportive.

2. Determining the required expertise: Applying material flow cost accounting technology calls for a multi-disciplinary team that can supply the data needed for analysis. These areas of competence include quality control, operations, accounting, and the environment.

As a foundation for the organizer's analysis, the boundaries of the system of flows can essentially encompass one or more processes (S) of the entire economic unit or even the entire supply chain. Additionally, determining the time period is essential to gather crucial data, and the time period ought to be sufficient. As a result, the process's intrinsic seasonal swings and changes may be identified and taken into consideration as data changes. The time interval can be, for instance, a month or a year (ISO, 2011:11).

3. Identification of quantity centers: Quantity centers, which include material warehouses, manufacturing units, good-outgoing warehouses, and disposal systems related to material flows, are physical spaces or functions that store processes or change materials in various ways. These actions are depicted in **Figure 1**.

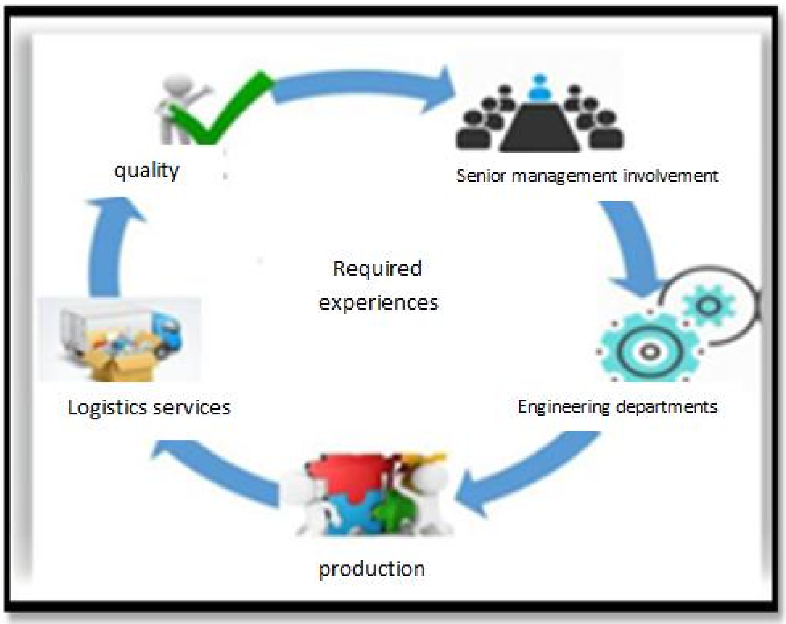

Figure 1. Departments Engaged in Material Flow Cost Accounting Implementation [Source: Cecílio (2017), P9]

2 - Do

This step includes a set of procedures represented by the following:

1. Determination of inputs and outputs for each quantity Center: It is necessary to identify the inputs. amount centers like materials, energy, and water, as well as outputs like goods and waste products. To do this, measurements are made of the flows of materials inside each quantity center and the energy used in transferring between them during a certain time period.

2. Quantification of flows: Using a standard unit like mass, a physical balance may be constructed for each center of quantity. Material flows should be quantified in physical units like mass, length, volume, or number of pieces dependent on the flow structure (ISO, 2011: 12).

3. Measuring flows in monetary terms: The next step is to financially assess the flows of materials, energy, and inventories and measure the flows in terms of money (flow costs). While quantitative measurement of flows may highlight inefficiencies in the use of materials and energy, the negative economic effects of these flows are still unknown. There are four categories for the costs (Sygulla, Gotze, & Bierer, 2014).

Material cost: Comprises the price of the primary and supporting elements. Energy cost: Includes the price of fuel, steam, heat, electricity, and compressed air. System cost: Include the costs of labor, maintenance, depreciation, and transportation. The cost of waste management: Comprises the price of discarding the material that results in the quantitative centers.

3 - Check

This step depends on the following:

1. Summarizing the data and analyzing the results: A material flow cost matrix, which is a chart that combines the costs of a good product and losses in all processes, is created in order to produce, evaluate, and understand a summary of the outputs. Generally speaking, the management may examine the information in this matrix to determine the amount centers where there is a loss that has an impact on the environment and the economy.

2. Communication of the results: When the results of the analysis are complete, they should be reported to the senior management of the unit so they can take the proper action. The management can use the analysis's results to support a range of appropriate decisions meant to improve the economic unit's financial and environmental performance (Dekamin & Barmaki, 2019).

4 - Act

Lastly, before the cycle repeats, chances to enhance financial and environmental performance are found and assessed based on the transparency of material and energy flows.

The replacement of materials, adjustments to manufacturing lines, products, or processes, increased energy and material efficiency research and development, and assessments based on material flow are some of the steps that may be performed to attain these improvements. Cost-benefit analysis can be supported by cost accounting technology (Kokubu & Tachikawa, 2013).

Figure 2 summarizes the four stages of the continuous improvement cycle (PDCA) for material flow cost accounting application and their integration.

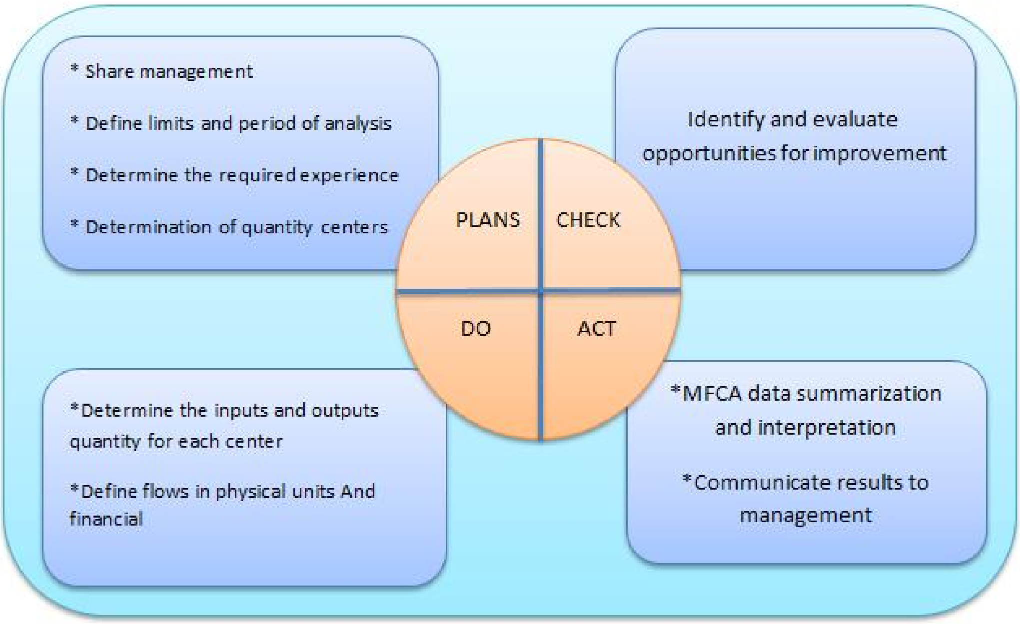

Figure 2. A Cycle of Continual Improvement for Adopting Material Flow Cost Accounting [Source: Dekamin & Barmaki (2019), P5]

When implementing material flow cost accounting, reducing the environmental impact and working toward solving environmental problems (emissions, solid waste, greenhouse gases, wastewater) can be added as a step. These can be achieved by increasing the efficiency of energy and materials, streamlining production line processing, and developing environmentally friendly green products that can be recycled after their expiration, thereby reducing environmental damage.

The researchers believe that in order to apply the steps of applying (implementing) the cost accounting of material flows correctly, cooperation between departments within the economic unit must be carried out due to the need for information from all departments for the purpose of analyzing the MFCA.in addition, the most important step in the application of the MFCA is planning, where the limits are set for the MFCA and determining the Centers of quantities and time for collecting data on material and energy flows.

Nature and Concept of Green Productivity

Globalization, privatization, and liberalization are the three key transformation processes that industries are going through right now. Globalization, privatization, and other developments have increased rivalry between economic entities and had an influence on the environment. Tools and concepts have been developed to enhance and safeguard the environment since there is fear that globalization may not incorporate environmental effects decisions for resource use and waste creation.

In order to increase green productivity, modern technologies must also emerge in tandem with the developments that accompanied the modern manufacturing environment, large production, contemporary technologies, and the need of economic entities for appropriate data related to the costs of their products (Rahman, Ali, & Hussein, 2019).

Most economic units seek to use modern technologies in manufacturing and organizing production processes, and then increase and improve productivity at low costs (Wahab, 2021).

Green productivity is one of those concepts, as it includes environmental protection and economic development (Mohan Das Gandhi, Selladurai, & Santhi, 2006).

The use of modern technologies works to improve productivity and reduce costs, which will have an impact on increasing green productivity and achieving sustainable development (Aljanabi & Nouri, 2019).

Green productivity has become increasingly important in increasing productivity and lowering the environmental impact of economic units' operations for a number of reasons, the most significant of which are resource scarcity, competitive economic environment, environmental efficiency, risk to health and professionalism, and industrial policies. the necessity to build ecological links, the global environment, trade, international environmental treaties, and consumer needs (Avishek, Nathawat, & Pathak, 2008).

By making the best use of inputs to improve operational performance, productivity rates rise and high-quality outputs are produced at the lowest possible cost.

Furthermore, green productivity is attained by organizational actions that enhance each stage of the production process, from raw material processing to the finished product's delivery to the client (Abdullah, Salman, & Ahmed, 2019).

Governments and economic entities are reevaluating their growth and economic development strategies in response to growing public concern and understanding of the detrimental consequences on the environment and the foundation of natural resources. Because of this, the majority of Asian nations are working extremely hard to strike a balance between environmental requirements and growth while taking into account their own economic circumstances. Green productivity strategies, which vary from basic housekeeping practices to green product design, are utilized to implement improvements that will increase environmental performance and productivity. (Logaa & Zailani, 2013).

Improving the productivity of the organization and making its production green contributes to continuous improvement and will therefore contribute to environmental protection and environmental sustainability (Daoud, 2017: 333).

Main Pillars (Principles) of Green Productivity

The GP Concept demonstrates that every development plan must prioritize (quality, profitability, and environment) in order to be sustainable.

Quality: Focuses on meeting the needs of the client for both products and services. Green productivity promotes the use of safer, more modern materials, boosts production and processing efficiency, and enhances working conditions in an effort to assure quality. Thus, "doing more with fewer resources" refers to the concept of "green productivity," which is delivering more performance and value to the client while consuming less energy and producing less waste.

Environment: Green Productivity works to preserve natural resources, reduce environmental degradation in several ways, and reduce emissions and toxins as a result of production processes.

Profitability: Profitability is ensured by green productivity, which lowers production costs. Savings can also come from avoiding the cost of potential environmental requirements or from reduced waste management expenses (Tachikaw, 2014). **Figure 3** shows these three pillars.

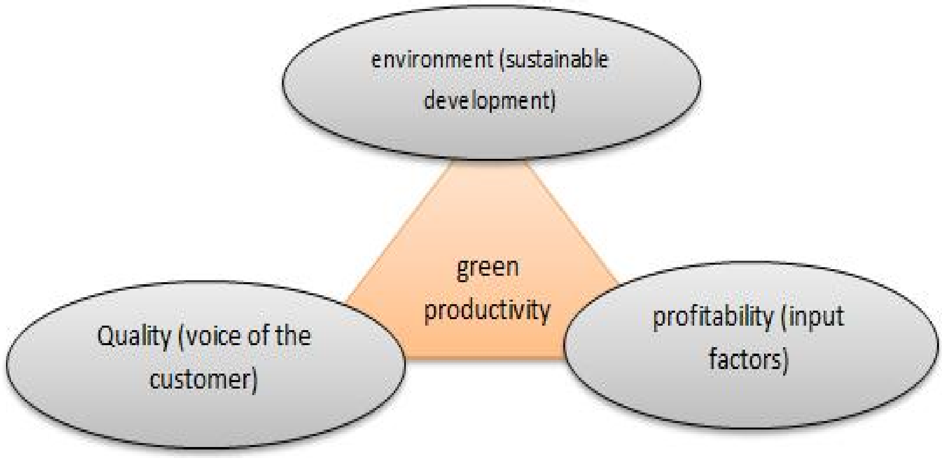

Figure 3. Main Pillars (Principles) of Green Productivity [Source: APO Material Flow Cost Accounting: ISO 14051 (2014), P4]

Green Productivity Steps

There are numerous phases for green productivity, which are as follows: the primary component of the GP green productivity approach is to review and reassess production processes and products to lessen their environmental effect and concentrate on methods to increase productivity and product quality.

The First Step: Getting Started

The establishment of a GP team and the execution of an extensive survey to gather fundamental data and pinpoint issue areas mark the start of the GP green manufacturing process. At this point, getting top management's backing is essential to guarantee that there will be enough labor and resources available for the effective implementation of GP (Tachikaw, 2014).

The Second Step: Planning

At this stage, the economic unit should apply a set of planning models such as (reference comparison, Ishikawa diagram, environmental planning) to the information obtained in the first stage.

Step Three: Create and Evaluate GP Options

This step involves reviewing previously created or implemented pollution prevention and control methods, developing new choices, and developing solutions to meet the aims and objectives set forth during the planning stage. The solutions are analyzed, ranked according to their technical and financial viability as well as any prospective advantages, and then combined into the execution plan (Tachikaw, 2014).

The Fourth Step: The Implementation of Green Productivity Options

To ensure the success of the implementation of the options, the work involves preparing employees through awareness-raising, training, and skill-building. The implementation plan needs to include a detailed activity plan, inputs, the necessary time frame, and the individuals in charge of the implementation (Balist, Sargazi, Hoveidi, & Faryadi, 2016).

The Fifth Step: Monitoring and Review

It's important to assess if the chosen GP alternatives are producing the intended outcomes once they've been put into practice. this entails keeping an eye on the entire GP system to make sure things are heading in the correct way and that the objectives are being met in line with the implementation strategy. The findings are submitted for management assessment.

Step Six: GP Sustainability

Corrective measures can be taken in light of the GP evaluation results to keep the GP program on track. In some cases, the same goals and objectives should be adjusted as the program moves forward. A feedback system should be put in place so that new issues are brought to light and addressed. In this way, the GP cycle will return to the pertinent steps to carry out the continuous improvement process and guarantee the GP work's continued relevance and effectiveness (Tachikaw, 2014).

The Concept of Sustainable Development

The concept of sustainability developed significantly in the 1980s with the publication of a report entitled "Our Common Future," also known as the Brundtland report (Brundtland report) World Commission on Environment and Development (WCED), which defined sustainability as meeting people's needs and protecting their lives in the present without compromising the lives of future generations. The report's request was made in 1967 by the UNESCO organization, which directed all economic units in various sectors to take into account and pay attention to environmental aspects in a way that does not affect society in the future (Simon et al., 2020).

Basically, the environmental aspect is one of the most important elements of sustainability in the economic unit, as it is one of the critical determinants of the economic unit's performance (Hameed, Al-Taie, & Al-Mashhadani, 2019).

Gutowski (2011) also sees sustainability as seeking to significantly and continuously reduce the consumption of Natural Resources and energy and make radical changes in the prevailing patterns of energy consumption and production, and that the ultimate goal of sustainability is the continuation of the level of well-being of individuals in the future.

Orastean pointed out that the concept of sustainability consists of making economic and social changes by coordinating trends of technological progress and investment in the use of Natural Resources and making changes in some processes in order to preserve the environment, meet the needs of the current generation and not compromise the life of the next generation.

The term "sustainable development", has been used frequently in recent development literature. Sustainability is a pattern of development that is rational and rational in that it addresses economic activities meant to achieve growth, protect the environment and natural resources, and enhance community well-being.

In order to meet the needs of both the present and future generations while maintaining the highest possible level of economic efficiency and ensuring that those needs do not jeopardize material, natural, or essential processes, sustainable development must take into account both the availability of renewable resources and the capacity of the environment to absorb them.

To achieve development, you must choose three basic principles of environmental justice (equality between generations), small efficiencies (protection and management of resources), and environmental effectiveness (reducing waste, reducing energy consumption and using it optimally) (Alaa, 2013).

Dimensions of Sustainable Development Dimensions of Sustainable Development

The use of sustainable development principles has become increasingly important and necessary to preserve the environment and ensure natural resources for all generations (Maseer, Zghair, & Flayyih, 2022).

Sustainability is a process in which the economy, the environment and society are combined in a balanced way, by reconciling the conflicts among these three dimensions, and sustainability depends on the success in maintaining and strengthening these dimensions, namely.

Environmental Sustainability (Environmental Sustainability)

As environmentally sustainable units are ones that consume resources to the extent that their natural systems can handle them, it entails safeguarding the continuation of natural resources, biodiversity, human health, air, water, and soil quality, as well as protecting plant and animal life. It also entails working to reduce environmental impacts like waste and emissions from operational activities (Kayahan, 2014).

Environmental functions refer to environmental services, including the disposal of waste and emissions, the supply of Natural Resources and life support (Al-Jelhawi, 2020).

Economic Sustainability (Sustainability Economic)

The goal of sustainable development is to raise the proportion of essential commodities and services that humans consume, and this goal can only be accomplished by having the following resources available: The system provides the necessary production elements for the production process. The goal of putting development policies and programs into practice is to increase people's effectiveness and efficiency. The aim is to increase growth rates in various fields of production, to increase per capita income rates and to activate feedback between inputs and outputs (Khalifa, 2019).

Social Sustainability (Social Sustainability)

The basic idea of sustainable development according to this dimension is to focus on meeting the needs and requirements of the current generation to also ensure the needs of future generations to secure a well-off and luxurious life, but members of the current generation and members of future generations. This is achieved through the fair distribution of wealth, providing support to civil society and combating poverty by providing job and employment opportunities for all members of society and providing social security requirements for all (Wal-Jazzar, Al-Amir Ghazi, & Al-Sayed, 2020).

Technological Sustainability (Technological Sustainability)

The technological dimension, in addition to the other three, aims to transform industrial societies into clean technology that protects the environment from pollution. After all, technological advancement is a crucial way to strike a balance between environmental constraints and development objectives, ensuring that the former does not come at the expense of the latter (Bassiouni, 2021).

The two researchers observed that sustainable development is predicated on factors that are interconnected and have a great deal of overlap with one another. Depending on the economic theory that the society has adopted, the economy is one of the primary drivers of society and a major factor in defining whether it is an industrial or agricultural society. Society also shapes the economy and is responsible for the majority of the economic patterns that exist within it. The overall framework that affects and is influenced by economic activity is known as the environment. Every successful sustainable development program must achieve harmony between these three elements and aim to raise the quality levels of all three together, i.e., achieve economic growth, meet community needs, ensure environmental safety, and protect future generations' rights to natural resources. Community behaviors also have an impact on the environment, which in turn affects health conditions and various activities carried out by community members.

The Role of Material Flow Cost Accounting in Supporting Green Productivity for Sustainable Development

Environmental Protection has become one of the dimensions of sustainability by introducing new and creative ideas that primarily serve the protection of the environment and the strategic goals of the economic unit at the same time, as this is embodied in environmentally friendly products distinct from traditional products.

Therefore, the material flow cost accounting technique is one of the environmental management departments' tools for tracking production processes and locating material losses and waste in materials and energy that result in the production of subpar products and waste, so the economic unit's management must consider measures that improve resource and energy efficiency and then lessen environmental impacts in order to prepare for the production of acceptable-quality environmentally friendly products as well as improve environmental and economic outcomes, which increase the product's sustainability (Hyršlová, Bednaříková, & Hájek, 2009).

The material flow cost accounting technique helps the economic units that use it to improve economic and environmental performance by knowing the results of the production process into positive and negative products. This is because the technique is based on reducing environmental impacts and costs at the same time, and it tracks unwanted emissions and waste during the production process for managers to use in their decision-making to reduce the costs incurred by the economic unit by working to reduce emissions, waste, and unwanted products to improve the productivity of economic units from available resources (Fakoya & van der Pol, 2014).

The foundation of the material flow cost accounting technique is the idea that addressing all negative production outputs, or the material and non-material losses represented by waste, scraps, emissions, and used lubricants, will encourage managers and engineers to reevaluate production processes and make use of available resources in order to increase the efficiency of the production process. This is because, while reducing waste and emissions also serves environmental goals, managing these negative outputs can be an important and effective way to achieve sustainability. The product that the majority of businesses in the same industry are trying to sell (Schimidt et al., 2015).

Since the accounting of material flow costs recognizes waste and emissions as an undesirable negative by-product that has their own costs, but it significantly helps to reduce the generation of these wastes as well as the consumption of available resources in an optimal way, and this is one of the main activities in environmental management to reduce and get rid of the bad environmental impact, through this technique it is possible to obtain accurate information about waste and emissions through the preparation of transparent reports on costs and places of waste in production so that the senior management in the economic unit can make appropriate decisions to reduce them, as reducing waste improves environmental quality and achieves savings on Costs MFCA is also continuously delivering many economic and environmental benefits (Kokubo, 2010).

From the foregoing, it is evident that material flow cost accounting technology lessens the effects on the environment because it monitors the movement and use of energy and materials during the production process. This makes it a crucial instrument for environmental management, helping to cut down on production-related waste and emissions. As a result, production processes would be more effective, which would raise product quality and show it as flawless and ecologically friendly. This would assist the economic unit in achieving product sustainability.

APPLIED ASPECT

The link between inputs and outputs is expressed by productivity, and green productivity may be calculated by utilizing material flow cost accounting technology and determining how this technology affects productivity within the economic unit.

Productivity can be measured in three aspects, namely: the operational aspect, the financial aspect and the green side. The three aspects will be based on the quantitative method of productivity. Measuring the productivity of a research sample.

Operational Productivity

Operational productivity shows the relationship between the outputs and inputs of operations and also expresses the relationship between the number of units produced and the production elements and can be calculated for each element separately. The operational productivity shows the human resources working in the distribution transformer plant the relationship between the products and the number of employees and is calculated through the following equation:

Total operational productivity= Number of units produced ÷ Number of employees

=2380÷ 250 = 9.52

The operational productivity of the two time elements can also be expressed by the relationship between the number of products and the number of hours needed to produce them. the natural downtime that occurs at work is subtracted from the working hours, which works with two meals a day. there is a downtime hour for each meal for periodic maintenance. This will be the time available annually 14×365 =5110 hours and is calculated by the following equation:

Operational productivity of time = Number of units produced ÷ Working hours

= 2380 ÷ 5110 = 0.46

To calculate the operational productivity (human resources) of the KVA/11/250 converter with the previously mentioned production elements is calculated by the following equation:

Operational productivity of the distribution transformer KVA/11/250 = Number of production units ÷ Number of employees

= 1594 ÷ 250 = 6.376

Financial Productivity

Financial productivity is meant as the relationship between financial outputs and inputs, or in other words, the relationship between total revenues and total costs, so the financial productivity of a distribution plant can be reached through the following equation:

Financial productivity of the distribution plant = Revenues ÷ Costs

= 41915767134 ÷ 40214386479 =1.042

As for the product KVA/11/250, the financial productivity for 2021 is calculated as follows:

Financial productivity of the distribution transformer KVA/11/250 = Selling price of the transformer ÷ Production costs per transformer

=8000000 ÷ 6835631 = 1.170

As for the total financial productivity of the distribution converter KVA/11/250 = Revenue–Costs

=12359350000 – 11039544065 = 1.119

It can be seen from the above that the financial productivity of the distribution transformer KVA/11/250 on the basis of gross amounts is lower than the financial productivity of the product unit due to the decrease in the amount of sales, which affects revenues, which requires the distribution laboratory to find appropriate solutions for the purpose of marketing production to increase financial productivity.

Green Productivity

Green productivity expresses the method of converting inputs into outputs in a way that does not cause any environmental damage or pollution by calculating the outputs of this system from waste of all kinds and weighing the environmental impact, and green productivity can be calculated in the case of the current situation of the laboratory through the following equation:

Green productivity index = Economic index ÷ Environmental Index

Which can be expressed according to the components that enter into each indicator

$$\frac{\text{Selling price} \div \text{Cost of the product}}{\text{Environmental weight of solid} + \text{Liquid} + \text{Gaseous waste}}$$

Economic Indicator

The previous data can be used in calculating the economic indicator if it is calculated at the total level when both revenues and total costs are included in its composition, and it can also be calculated at the level of one unit of the product

Economic indicator of the distribution transformer KVA/11/250 = Selling price per transformer ÷ Transformer production costs

= 8000000 ÷ 6835631 = 1.170

The selling price of one transformer is (8000000) dinars, and the company often sells the product to the Ministry of Electricity as the main consumer of transformers, and the cost of one transformer for the year 2021 was (6835631) dinars based on the data of the environmental division

And the economic indicator of the distribution transformer KVA/11/250 = Revenue ÷ Costs

= (Selling price × Number of transformers sold) ÷ (Cost × Number of units produced)

= (8000000 × 1615) ÷ (6835631× 1594)

= 12920000000 ÷ 10089599581 = 1.280

It turns out that the sales of the converted distribution for the year 2021 by multiplying the selling price by the quantity sold, as for the production costs by the cost in the number of units produced.

Where it is noted that the output of the converter at a good level is greater than true, and this is a good indicator by applying material flow cost accounting.

Environmental Indicator

The environmental indicator is concerned with all activities that ensure the preservation of the environment, which can find the environmental weights of these three types of waste, as follows:

The first step: The environmental damage of products is calculated by classifying them into solid waste, liquid waste and gas waste, as these pollutants enter into the equation of calculating green productivity and can also be adopted as indicators to improve the environment in its orientation towards reducing costs waste treatment and the environmental weights of the three types can be calculated by adopting the method of Environmental Sustainability Index (ESI), a method that weighs each indicator to weigh its impact on Environmental Quality and then collect these weights, where the weights of environmental indicators have been prepared for the Environmental Sustainability Index shown in **Table 1** the following:

Table 1. Weights of Environmental Indicators in the Environmental Sustainability Index (ESI)

Seq.	Environmental Indicator	Weight in (ESI)
1	Reduction of solid waste and consumption	0.05
2	Amount of water	0.05
	Water quality	0.05
3	Air quality	0.05
	Reducing greenhouse gas emissions	0.05
	Reduce air pollution	0.05

Source: Preparation of the researcher based on the information of the environmental division.

Through **Table 1**, the values of the three weights of the three environmental variables of the green productivity index can be derived, namely (solid waste, liquid waste and gas waste as shown in **Table 2** and as follows:

Table 2. Classification of Waste According to the Method of Sustainability Indicators (ESI)

Seq.	green productivity indicators	Sustainability indicators (ESI)	Weigh the environmental impact of the species	Combined weights of the types	Weight × environmental impact
1	Solid waste generation	Reduction of solid waste	0.05	0.05	0.17
2	Liquid waste generation	Amount of water Water quality	0.05 0.05	0.10	0.33
3	Gaseous waste generation	- Air quality - Reduce air pollution - Greenhouse gas emissions	0.05 0.05 0.05	0.15	0.50
Total			3	0.30	1.0

Source: Preparation of the researcher.

According to **Table 2**, the waste was classified into solid waste, liquid waste and gas waste, where an equal weight was placed for each type and weighted with the indicator corresponding to it, they were as follows:

Solid waste= 0.05 ÷ 3 = 0.17

Liquid waste= (0.05 + 0.05 + 0.05) ÷ 3 = 0.33

Gaseous waste= (0.05 + 0.05) ÷ 3 = 0.50

The second step is to find a value for each of these types to determine the outputs that can be included as solid, liquid or gas waste within a specific period of time, and then standardize the unit of measurement to be (kg) as the types of waste are collected according to the three types of sustainability and then the weight of each type of waste is weighted to the total:

Table 3. Weights of the Environmental Indicator of the Product KAV/250

Type	Weight(ton)	Accumulated environmental weights	Weigh the environmental impact of the item
Solid waste		9361	0.04
Iron	2391		
Brass	4782		
Paper	2188		
Liquid waste		21900	0.94
Water used in the factory (cooling, evaporation, cleaning)	219000		
Gaseous waste		3795	0.02
CO_2	1252		
CO	2241		
Methane, hydrogen and ethylene	16.7		
Nitrogen fluoride gas	286		
Total	232156	232156	1.0

Where the total liquid waste amounted to (219000) metric tons, and its weight represents (0.94), which is the highest environmental weight, as it represents the most types of waste generated by the production process of KAV/11/250 distribution transformers, which are the most dangerous to the environment and human health. Followed by solid waste, which totaled (9361) tons, and its environmental weight was 0.04 of the total waste. Although its weight seems less than liquid waste, it has an impact on the environment, which is difficult to dispose of easily, and then followed by gaseous waste, which totaled (3795), which is the most dangerous thing is that it floats in the air and is difficult to control (**Table 3**).

The environmental weights were calculated as follows:

Solid waste = (2391 + 4782 + 2188) ÷ 232156 = 0.04

Effluent = (219000) ÷ 232156 = 0.94

Gaseous waste = (1252 + 2241 + 16.7 + 286) ÷ 232156 = 0.02

Through this, the weight of the environmental impact of waste is obtained by multiplying the amount of waste by its weight, as follows:

(Amount of solid waste * Weight of environmental impact of solid waste) + (Amount of liquid waste * Weight of environmental impact of liquid waste) + (Amount of gaseous waste * Weight of environmental impact of gaseous waste)

= (9361 × 0.04) + (219000 × 0.094) + (3795 × 0.02)

Environmental index = environmental weight of solid waste + environmental weight of liquid waste + environmental weight of gaseous waste

= 374 + 205860 + 75.9

= 206309

By substituting into the equation for the green productivity index (GP), it is as follows:

Green Productivity Index (GP) of Distribution Transformer KVA/11/250 = Economic Index ÷ Environmental Index

= 1.17 ÷ 206309 = 0.0000056

From the foregoing, we note the low rate of green productivity of the KVA/11/250 distribution transformer. This is due to the generation of large quantities of emissions and waste, as the weight of the environmental impact of the gaseous waste is the highest due to the gaseous waste polluting the environment and human health, in addition to the liquid waste represented by polluted water, fuel and oils. Solid waste, which is represented by iron, copper and paper used in the production process, is difficult to dispose of easily.

CONCLUSION

Material flow cost accounting, which helps reduce waste, makes it possible for economic units to keep track of material and financial inputs and outputs by identifying the positive and negative products (waste) and maintaining a balance between inputs and outputs. The technology of material flow cost accounting contributes to increased green productivity by lowering energy and material consumption, which lowers costs and improves quality during the production process. This increases green productivity in a way that satisfies customer needs, is environmentally friendly, and promotes sustainable development. Using a variety of strategies, economic entities aim to achieve sustainable development. With its capacity to produce environmentally friendly green products, material flow cost accounting and green productivity can be two such techniques. Green productivity is an important factor in increasing the efficiency of economic units and improving their level of performance. Practical data has proven that there is an appropriate base for adopting and applying the principles and techniques of green productivity and accounting for material flow costs in the Diyala State Company, which leads to achieving many benefits. By using the concept of a physical balance between inputs and outputs, the material flow cost accounting technique tracks the material inputs and outputs of the economic unit and quantitatively calculates the amount of negative products, or waste, which helps set the necessary measures to reduce those waste and improve the performance of the economic unit.

RECOMMENDATIONS

Finding alternatives to energy is necessary because it is the most expensive resource in the industry. Developed nations have a tendency to favor environmentally friendly and alternative energy sources, such as using solar energy to generate the electrical energy that Iraq needs because it lacks the resources to save electrical energy. Work to develop laws that stipulate recycling in all industries and the exploitation of waste as an alternative material that is re-entered into industry and activate waste management. Publication case studies and research will raise interest in and awareness of green productivity as they are themes that are relevant to today's world. Work on utilizing environmental information and revealing it in the financial statements, as well as developing the unified accounting system used in the economic units to be suitable with modern management accounting procedures. In order to eliminate or significantly reduce the material losses that the economic unit experiences during the production process, it is imperative that the material flow cost accounting be utilized. Look for cheaper energy sources or materials that are the most expensive in the market, such as thermal, oil, and electrical energy. Most nations have a tendency to employ renewable, ecologically friendly energy sources, including solar cells, water, and air, to create power.

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