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## The Role of Value Stream in Measuring Environmental Costs and Reducing Costs

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### Abstract:

Most economic units suffer from high rates of environmental pollution and a shortage of available resources and energy. This leads to a significant increase in production costs. In addition, the economic units lack of using modern cost methods through which environmental costs and production costs are identified, allocated and measured. One of these methods is the value flow method, which works to track production processes, analyze inputs and outputs, and classify them into sound products and unhealthy products (waste). This in turn enables management to identify value-added activities and non-value-added activities, and works to reduce environmental impacts, the amount of waste, and reduce losses that occur during production. Therefore, the production process and optimal exploitation of resources, reduce product costs and producing environmentally friendly products, and this leads to improving environmental performance in Iraqi economic units. The research aims to restructure the economic unit, which is managed through its departments and manage it according to the value flow method and to calculate environmental costs. For the purpose of achieving the objectives of this study and testing the hypotheses, the General Company for Heavy Engineering Equipment was chosen. The sample is one of the companies of the Ministry of Oil, relying on the financial and non-financial data that it included. Reports and records for the year 2021-2022, as well as field consultation and deliberation of questions with engineers, specialists and workers to benefit from their accumulated experience. The collected data are analysed according to value flow cost accounting in order to improve the production process, and in order to reduce environmental impacts, the amount of waste and emissions, and optimal exploitation of resources and energy. The most important conclusions reached by the researcher were the ability of the value flow to calculate the environmental costs of each flow within the economic unit, as well as providing more accurate and objective data and information for making decisions and measuring the performance of the economic unit to contribute to monitoring environmental activities and the possibility of reducing the costs of those activities.

**Paper type:** Research paper

**Keywords:** Value stream, cost reduction

## 1.Introduction:

The environmental pollution is one of the phenomena that has received increasing attention recently, especially in light of the industrial progress witnessed in the contemporary world. Although this phenomenon is not new and has existed since ancient times . The new is the multiplicity and diversity of sources of pollution and its harmful effects, as well as an attempt to Industrial economic units get rid of their waste that is harmful to the environment by releasing it into the air, throwing it into the sea, or burying it in the ground, which had a negative impact on environmental life. In addition, protecting the environment has become an international demand, and spending to protect the environment has become one of the priorities of economic units. Hence this Environmental Accounting in general, and (Environmental Cost Accounting) in particular, has emerged. Cost accounting systems play a role in enhancing management philosophy because of the important information they provide in the decision-making process. Despite this importance, accounting systems Traditional costing has been subjected to many criticisms because .Traditional cost accounting systems lacks accuracy and relevance, especially in the field of disclosure of environmental costs. In light of these criticisms of traditional costing systems, researchers presented a new method known as (Value-stream -Costing) .The flow costing method is based Value by calculating all industrial costs and environmental costs within the value flow paths in a way that leads to providing a method for calculating environmental costs and preparing financial statements according to the value flow approach. The research aims to know the role of the value flow of environmental costs in reducing costs. The value stream method includes classifying costs and production processes according to value streams to work on identifying areas of waste and losses represented by raw materials, working time, and labor, and reducing waste, thus reducing general costs and environmental costs in particular, in addition to contributing to the quality of the product.

### 1.1 Literature Review:

There are several studies that have discussed value stream

Lodding and Koch (2020) explained analyzing the value flow and design of companies upon request for the purpose of proposing an experimental approach to ordering production and innovating a method for the flow of materials and information and linking the goal to the manufacturing tasks associated with it.

Rupp (2021) highlighted the developed leadership. Using the value stream for the purpose of determining how to combine DEVOPS (Development Operations) and value stream management and provide the best value to customers and ensure organizational performance.

Faraj (2021) pointed to Using the value stream costing system to support a loss-free production environment to achieve the sustainable strategy of facilities.explining the shortcomings associated with traditional cost accounting systems.

Muhamad (2022) aproposed framework to activate the approach to measuring value-guided flow cost information in the services sector in order to develop the level of cost information.

There are several studies that examined environmental costs:

Simhem (2018) ) examined accounting measurement of environmental costs for the purpose of analyzing environmental costs in terms of their concept, the problems of measuring them, ways of paying attention to them, and their types in general, and identifying the reality of environmental costs and measuring them.

Jawad (2019) suggested that he importance of disclosing environmental information and its impact on the sustainability of environmental assets through analyzing the importance of having standards for disclosing environmental accounting information and the extent of the impact of environmental assets on environmental accounting disclosure.

Ibrahim (2019 ) ) referred to the impact of measuring environmental costs on rationalizing administrative decisions for the purpose of identifying types of environmental costs and analyzing the relationship between rationalizing administrative decisions and measuring environmental costs and the extent of management's interest in the environment..

Kratzer (2021) explained the transparency of environmental reports in Russian and European oil and gas companies for the purpose of analyzing differences in environmental transparency, and multiple levels of transparency can be identified in disclosing environmental performance and creating environmental responsibility.

There are some studies that have linked value flow and costs environmental.

Mhammad (2022) pointed to a proposed framework to activate the approach to measuring costs of the guided value stream with the aim of developing cost information in the services sector for the purpose of proposing an integrated accounting framework that ensures increased effectiveness of the use of the current system for measuring costs based on value paths in service sector environment.

Finally, Wahba (2023) suggested the impact of integration between the value stream system and the six sigma strategy on the production environment, with the aim of identifying the ability of the integration of the value stream system and the six sigma strategy in improving the production environment by reducing waste and helping the facility reduce the cost and improve the quality of the product in the design and manufacturing stages. the product.

The importance of the research is that environmental costs have a direct impact on the performance of the economic unit through the costs incurred by the economic unit to produce environmentally friendly products, which are spent in order to preserve the environment and society

The problem of research is that economic units do not use modern methods to calculate environmental costs which provide subjective information. Environmental costs are not included in the financial statements separately. The research problem is embaded in the main question which is. does the value stream method contribute to calculating environmental costs?

The objectives of the research aims to restructure the economic unit that is managed through departments to manage it according to the value flow and calculate environmental costs according to the value flow.

## **2. Material and Methods:**

### **2-1 The sample:**

The General Company for Heavy Engineering Equipment considered one of the giant companies in the industrial sector in addition to having an ISO 9001 certificate for producing environmentally friendly products that conform to international specifications for product quality. The General Company for Heavy Engineering Equipment includes a group of different factories that occupy a large area of the company's site and can be explained as follows: -

a- Heavy Equipment Factory / Department of the Martyr Fadel Jihad Fattah

It is one of the largest factories in the company and contains (6) lines. In this factory, parts of pressure tanks with a capacity of (100,000) cubic meters, bridge supports, towers, salt insulators, wet oil insulators, equipment for refining units, filters, and iron structures are manufactured and operated.

b- Heat exchangers factory/Martyr Abdul Hassan Jabr Jassim Department

The following types of exchangers are manufactured in this factory:

1-Fixed heat exchangers

2-Floating heat exchangers

3-Tube exchangers (U)

4-Boiler exchangers

The work is carried out in accordance with the international design system TEMA & ASTM, taking into account that the work and production are compatible with the international quality system.

c- Containers and Tanks Factory / Department of the Martyr Bassem Saadoun Aziz

This factory manufactures typical tanks of sizes (65 cubic metres) and (55 cubic metres). It manufactures parts for strategic tanks with a capacity of (one meter and up to 150,000 cubic metres). A specialized work team from the unit installs them on site, and a mechanical operation workshop is also connected to the factory.

d- Steam Boilers Factory/Martyr Zaki Odeh Abdel Jalil Department

It manufactures, operates and maintains fire tube boilers with capacities (0.5 tons to 15 tons/hour) and pressures up to (15 bar). In addition to manufacturing and maintaining hot water boilers with a capacity of (6665 kilowatts), as well as maintaining and manufacturing parts for Water Tube type boilers used in electric power generation plants. The heavy equipment factory was chosen as a sample for the research.

### **2-2 The research community and its sample:**

The General Company for Heavy Engineering Equipment was chosen as one of the formations of the Ministry of Oil.

### **2-3 Research hypothesis:**

Economic units do not calculate environmental costs and do not prepare their financial statements according to environmental costs. The flow of value helps in measuring environmental costs.

### **2-4 Importance of the research:**

The importance of the research is that environmental costs have a direct impact on the performance of the economic unit through the costs that the unit bears to produce environmentally friendly products and through the costs that are spent by In order to preserve the environment and society.

### **2-5 Research boundaries:**

The time limits included: The financial statements for the year 2021 were relied upon.

### **2-6 Data collection method:**

Theoretical side of the research rely on foreign and Arab sources of books, and university dissertations related to the subject of the research, as well as the Internet. In addition, the study depends on the laws and instructions issued by the relevant professional organizations, and on the practical side, on personal interviews with managers and officials within the company, reports, documents and records of the company and the factory, documents, books and magazines of the company.

## **2-7 Theoretical and conceptual framework of value flow :**

### **2-7-1 The concept of flow:**

Flow means that the product should flow regularly without any interruption through the flow of value and in a smooth manner starting from receiving the order until it is prepared to the customer and in the manner in which operations occur quickly and without interruption. This is done by removing bottlenecks that prevent the flow of production (Carrison et al ,2008). Flow represents one of the very important factors in eliminating waste and waste. If the value chain stops for any reason, it will occur Waste. The basic idea of creating a value stream is that the product (or raw materials, components) will never stop flowing through the production process. by synchronizing every aspect of production and delivery completely with other elements. A carefully designed flow will tend to flow through This means that workers must understand the connection between their work and previous work before in the production process as well as subsequent work, which contributes to determining the responsibility of individuals and evaluating their performance, and avoiding repeating the same activities more than once ( Al-Rubaie ,2019) .The researcher that flow means the ability of the economic unit to produce the product regularly and continuously without any interruption occurs. This is done by organizing production processes from obtaining raw materials to customer requests. This organization prevents any waste or loss that may occur during production processes.

### 2-7-2 Value flow

The value flow method represents one of the tools through which products that generate value for customers can be identified. It is also considered one of the useful tools because it creates a visualization of the current state and helps identify the gaps between the current state and the ideal state. The value stream represents all the activities that must be performed to reach the desired value from customers, and these activities include obtaining orders (Thuresson and Ostman, 2017). It also represents the value flow method (Customers, production activities, warehousing, delivery and supply). The value stream information is characterized by realism accuracy, modernity and obtained in a timely manner. The main measure related to value flow is the time measure. The value flow aims to achieve the following: (Abdeen and Rashwan, 2018; Chple and Narkhede, 2017)

1. Measure the extent of implementing the planned results.
2. Reducing the time between placing the order by the customer and the time the product is delivered
3. Evaluating the critical factors necessary to achieve results.
4. Develop plans and improvements related to critical success factors.
5. Effective monitoring of continuous improvement initiatives.
6. Modifying continuous improvement initiatives as appropriate and in light of the value stream.

The economic unit is divided into a number of value streams and each value stream includes the value stream (manager, individuals working in the production process, individuals supporting the production process such as administrators, cost accountants, marketing personnel, purchasing employees, and workers in the field of quality assurance. And all other individuals who participate in the production process). In order to divide the economic unit into value streams, the organizational structure of that unit must be gradually changed, as each value stream includes a certain number of products or services that create value in order to determine the environmental costs that relate to each production process (Fullerton et al, 2010). The value stream includes individuals working from the starting point related to designing a new product and receiving the customer's order to delivering the product Or service to the customer, and of course this requires a gradual change in the organizational structure of the economic unit that is managed through departments to managing it through value flows ( Coroline et al, 2016) . Economic units seek to reduce product losses, increase their sales, reduce costs and better control product quality and environmental safety (Al-Janabi and Al-Nuaimi , 2019) . Ali et al (2019) indicated that (TDABC) and the event approach helps in integration and leads to the provision of detailed financial and non-financial information based on time to distribute costs to the factory more accurately, which leads to the cost of the product being more accurate than using other products.

### 2-7-3 Value flow management:

Value flow management is visual management that is a means of communicating organizational goals and documenting relationships between production scheduling and production information. The essence of value flow management is through clarifying, understanding, and drawing a map of the current state and a map of the future state (Bonaccorsi et al ,2011) . The management must value flow change the organizational structure of the economic unit, which is a pictorial representation of all production processes within.the economic unit aims to provide a clear visualization of business cycle times, as well as a clear picture of the transformation of raw materials into finished goods, The value flow method illustrates the relationships that take place between processes in a typical manner (AreyK et al, 2021).

#### 2-7-4 Types of value streams :

There are three types of value streams, which are as follows: (Al-Naimi, 2013; Sarah, 2018)

##### 1- The value stream for completed orders:

The Orders Fulfillment Value Stream The value stream for completed orders focuses on providing current products. For existing customers, this includes all the steps necessary to provide current products to existing customers, starting from the time the customer's order is received to the time the customer is provided with the products.

##### 2-The New Product Value Stream:

The New Product Value Stream represents the value flow for developing new products for new customers, which includes (design engineering, production engineering, process engineering, marketing operations, and targeted costs...)

##### 3-The Value Stream for sales and marketin

Sales and Marketing Value Stream This type of value stream focuses on acquiring new customers for existing products and on acquiring existing customers for new products.

#### 2-7-5 Value flow costs:

Value flow costs include all costs of (labor, machinery, materials, support services, and facilities spent) during a specific period they are allocated on the basis of the value flow and not on the basis of the products when calculating the cost of one unit , most of the costs become direct and the amount decreases significantly it is significant when following the value stream method, where the income statement is prepared for each value stream on a weekly or monthly basis, and revenues are represented by sales of products that are manufactured within the value stream and the types of costs that occur during the value stream can be explained as follows (Abdeen and Rashwan, 2018 ; Li,2014 ; Ibrahim-2019 ;Sobhat et al., 2018)

1-Material cost: The cost of raw materials for the value stream is calculated based on the actual materials used by the value stream of actual purchases or the actual issuance of materials from stores to the value stream

2-The cost of workers' wages: Workers are allocated to the value stream based on the size of the value stream and the diversity of products manufactured in the value stream , no distinction is made between direct and indirect work , A person within the value stream is a direct worker.

3-The cost of machines: The cost of machines includesde (preciation expenses for machines within the value stream, maintenance expenses, spare parts, and any other expenses).

4-External costs: These are the actual costs of work completed by another value stream.

5-Facilities cost: This is the cost of (rent maintenance and consumption of the factory building, security, guarding). The cost of the facilities is charged to the value stream based on the area because it motivates the value stream work team to reduce the space used by the value stream.

6-Other costs: These include costs ( office supplies, tools and equipment, travel costs, and daily direct costs) that are allocated to the value stream. Product cost is calculated by dividing the total value stream costs by the number of units shipped (sold), not produced.

7-Environmental costs: These are the implicit costs that the economic unit bears in order to protect the environment from damage resulting from various activities that lead to negative effects on the environment. Environmental costs are considered one of the negative indicators that may lead to stopping work within the economic unit due to the existing pollution .

8-Environmental quality: Quality in its general sense means compliance with requirements the degree to which it is achieved and performance that meets expectations. Environmental quality aims to preserve the components of the environment including ( air, water, soil, plants, and animals) within acceptable limits by improving( air quality, providing clean, high-quality water, and preparing programswhich public health).

The environmental costs of the value stream are calculated on a weekly or monthly basis, taking into account all environmental costs within the direct and indirect value stream. The value stream costs include all labor costs, direct costs, and indirect costs, as well as the salaries of employees and workers in the value stream. The costs of production materials are calculated in a manner A year of the amount of materials purchased during the week or during the month, that is, every time materials are brought to the factory, their cost is allocated to the value flow, and the total costs of the value flow is the sum of what was purchased during the week or during the month. The environmental costs for each product are recorded during that period. Environmental costs are allocated to each value stream, which determines the environmental costs within the value stream more accurately(Maskeii and Baggaley).

#### **2-7-6 The concept of the value stream map:**

The value stream map was originally developed within the Toyota production system. The concept of the value stream map was introduced for the first time in the philosophy of lean production in 1995. The value stream map has become more popular and has been introduced as a distinctive methodology since the publication of the book *Learning to See* by Rother and Shook, (1998) this book explained First all the steps and guidelines for applying the value stream map in the manufacturing environment , The value stream map contributes to defining and improving processes and identifying waste in the production process to contribut to identifying and solving problems . The value flow map helps to visualize the flow of materials and information comprehensively instead of a single or isolated process and control production processes and waste. The goal of the value flow map is to reduce activities that do not add value to the minimum possible and improve the flow. . (Al-Rubaie, 2019)

#### **2-8 The concept of environmental costs :**

##### **2-8-1 The environmental costs:**

Environmental costs are considered the basic tool that provides the volume of information and the value of the efficiency necessary for managers at the various hierarchical levels of the economic unit to assess, identify, analyze and record the impact resulting from economic activity on the environment, and use this information in the financial process and make the necessary decisions investors are not only taking into account financial indicators, but also paying attention to non-financial indicators in order to make strategic decisions ,because financial indicators are insufficient to evaluate the work of the economic unit, as non-financial information reflects the full range of relationships between all components of the economic unit (strategic, operational, administrative, financial and non-financial). Several definitions of environmental costs have been provided depending on the angle from which they are viewed. It has been pointed out Nwakaego et al (2020) which are the sacrifices that the economic unit bears to ensure that its activities do not cause harm to the environment or the costs that the economic unit incurs in order to remove the pollution resulting from its various activities. Youssef (2023) suggest out, it is the amount of expenses incurred by the economic unit that are not required by the economic activity and include the company not obtaining a direct economic benefit or return in return for them, but the economic unit bears those costs in order to prevent pollution as a result of It carries out its activities and removes harmful effects on the environment voluntarily or in application of laws and regulations. Al-Janabi and Al-Naimi (2020) indicated that evaluating performance, monitoring the business, optimal exploitation of the resources available to the economic unit, and disposal of all types of waste will lead to the provision of low-cost products that meet the desires of customers.

### 2-8-2 Problems and limitations of measuring environmental costs:

The process of measuring environmental costs faces many problems that can be summarized as follows: (Latif and Abd 2019; Musa 2018; Hamad 2014; Talba 2018)

a-Distance: Distance is one of the main obstacles in determining the source of the resulting damage affecting the environment and the place where the damage occurred, such as atmospheric (air pollution or smoke. Pollutants, radiation, or waste), as these pollutants have no limits and it is difficult to estimate compensation for the resulting damage in many cases, as in the case of chemical damage the effects of which do not appear directly but rather those effects appear after many years, This results in difficulties in quantifying the extent of damages and losses when they occur.

b-The difficulty of determining the effects of pollution: Scientifically, sources of pollution do not produce similar pollution effects the overlap of natural conditions, as they play an important role in this field, such as waste that is thrown into rivers cause different pollution during the period of water movement, and other natural factors such as heat, wind, and fog, which also affect the pollution. It is difficult to attribute the damage to a specific source, which is why it is difficult to measure the resulting damage.

c- The difficulty of separating environmental costs from social and economic costs: The overlap between environmental, social and economic processes and activities leads to one of the basic problems in the process of measuring the environmental performance of economic units objectively. For example, research and development costs are one of the costs that the economic unit bears with the aim of increasing the degree of safety of the product provided. To customers

### 2-8-3 Classification of environmental costs:

For the purpose of preparing reports on environmental costs in a way that serves different administrative levels, measuring environmental costs, reducing environmental expenses, increasing revenues, and improving environmental performance, it is necessary to know how to classify and classify these costs, then measure them. Environmental costs are classified into environmental costs according to activities, and these costs are divided into the following:- (Ammar and Ben Wadh, 2018; Drury, 2018)

1- Protection (prevention) activities costs: These are the costs resulting from all the activities carried out by the unit for the purpose of reducing or eliminating the causes of pollution that could lead to negative environmental effects in the future. These costs can be limited to the cost of redesigning production processes, so that Using environmentally friendly materials that do not produce gaseous, liquid, or solid waste for the purpose of providing the desired environmental safety, or using chemicals and means that work to reduce pollution.

2- Costs of environmental assessment activities: These are the costs incurred by the economic unit that comply with regulatory laws and voluntary standards, such as inspecting products and processes to ensure regulatory compliance, reviewing environmental activities, and conducting pollution tests.

3- The costs of internal environmental failure activities: These are the costs resulting from the misuse of resources involved in the manufacturing process and the misuse of natural resources of air, water, etc. They are also known as the costs of removing environmental damage and the costs of treating production wastes that are harmful to the environment, whether these wastes are liquid or gaseous. Or solid, in addition to the fines resulting from the unit's violation of environmental instructions.

4- Costs of external environmental failure activities: These are the costs that the economic unit bears on the activities carried out after discharging waste from the environment. Examples of this include the costs of cleaning up oil spills, discharging waste, cleaning the soil, and returning the land to its natural state. These costs are among the costs that have a negative impact on Economic unit.



### 3-Discussion of Results:

Environmental cost calculation through the value stream and its role in reducing costs When managing the factory through the value flow, the operational equipment factory is converted into production cells and service cells. The production cells are divided into seven production cells, which are as follows

- 1-Sandstorm Cell
- 2- Separation cell and application
- 3- Milling and planing Cell
- 4-Forming and assembly Cell
- 5-Rolling mill and turning Cell
- 6-Transfer Cell
- 7-Punching Cell

As for the service cells, they have been divided into twelve cells that begin with the purchasing and receiving materials cell and end with the environmental cost management cell. The environmental commissioning management cell includes a group of activities represented by environmental factory activities, environmental assessment activities, internal environmental failure activities, and environmental external failure activities, and the month of December is chosen. For the year (2021) as a research sample, the total costs of opening the tank for the month of December (2021) are calculated in the traditional method, then the costs for opening the tank are calculated according to the value flow for month of 2021, and then the costs are compared through the traditional method with the costs according to the value flow and my agencies :

#### 3-1-Calculating the total costs of the heavy equipment factory using the traditional method:

The costs of the activities that contribute to the manufacture of the product within the heavy equipment factory are determined for the month of December, which are represented by production and service activities. the factory's share of the total costs of the General Company for Heavy Engineering Equipment is calculated through the percentage of iron used within the factory, which amounts to 15%.

**Table 1** Total current costs

Percentage of Total%	Annual Amount	Activities	Sequence
78%	318102627	Production activity	<b>1</b>
0.79 %	2120000	Material purchasing activity	<b>2</b>
0.6%	2500000	Production scheduling activity	<b>3</b>
1%	6250000	activity Research and development	<b>4</b>
1%	6820000	activity Design	<b>5</b>
2.79 %	5753000	activity Quality control	<b>6</b>
1.5%	3755054	activity Marketing	<b>7</b>
1.3%	3654284	activity Financial control	<b>8</b>
1.3%	6268116	activity Maintenance	<b>9</b>
1.6%	5182324	activity After-sales services	<b>10</b>
1.4%	4808552	activity Warehouse	<b>11</b>
1.2%	3480238	activity Legal	<b>12</b>
7%	40523256	Safety, health, and environment activity	<b>13</b>
100 %	409217452	Total	

**Source:** Prepared by the researcher based on the records of the Costs Division

### 3-2 Calculating costs according to the value stream :

After converting the heavy equipment factory into production cells and service cells according to the value flow method and redistributing the functional personnel working in the factory to value flows. In addition to determining the spaces that are occupied at each stage of production and eliminating non-value adding activities and identifying and summarizing Environmental costs and showing them in the financial statements.

**Table 2** Annual after-sales service cell costs for the heavy equipment factory's value stream

Total costs	Equipment	Depreciation Machinery and equipment	Facilities costs	Wages	Indirect materials	Direct materials	Cells
1287621		7401	27720	1250000	2500		Value Stream Manager
1037621		7401	27720	1000000	2500		Assistant Value Stream Manager
1565121		7401	52720	1500000	5000		Secretarial
156318820		715465	2587933	102153376	232500	50629546	Production Cells
2261967		7401	52720	2196846	5000	_____	Material Purchasing and Receiving Cell
2261967		7401	52720	2196846	5000	_____	-Production scheduling cell
2265341		9868	53627	2196846	5000	-----	Research and development cell
2265341		9868	53627	2196846	5000	-----	Design cell
2261967		7401	52720	2196846	5000	-----	Quality control cell
2361967		7401	152720	2196846	5000	-----	Marketing cell
2265341		9868	53627	2196846	5000	-----	Maintenance cell
2261967		7401	52720	2196846	5000	-----	Control cell
2611967	250000	7401	152720	2196846	5000	-----	Maintenance cell After-sales services
2288914		9868	77200	2196846	5000	-----	cell Warehouse
2261967		7401	52720	2196846	5000	-----	cell Legal
11476807		51807	750000	9750000	925000		cell Environmental cost management
197054696							cell Total costs according to value flow

Source : prepared by the researcher

Table 2 represents the total costs for the month of December 2021 according to the proposed value stream. These costs:

- 1-The appointment of a value flow manager, as well as the assistant director, in addition to the secretariat.
- 2-After converting the production activities to cells, the number of redundant workers was reduced according to the value flow method, so the costs of the production cells became (156,318,820 ) after it was (318,102,627).
- 3-Determining the spaces for each of the cells and occupying the remaining spaces.
- 4- employees were appointed to serve the heavy equipment factory only and within the heavy equipment factory, so the factory's share of the costs of the service centers became. ( 40,735,876) after it was (91,114,825).

The environmental costs, they were calculated as follows:

1- Costs of environmental prevention activities for the month of December 2021 for the proposed value stream for the heavy equipment factory: These are all the costs that the factory bears in order to carry out its activities that aim to provide a safe working environment for workers inside the factory to avoid the company bearing fines and compensation for workers' injuries, and these activities include

a - Emergency plans costs: These are the costs that are spent in order to confront emergency situations such as fires, natural and unnatural disasters, and others in order to provide a safe work environment. These costs appear in the Civil Defense Unit of the Safety, Health and Environment Division of the company. These costs are represented by the salaries and wages of workers in the Defense Unit. Civil defense supplies, as well as commodity supplies represented by all types of fire extinguishers, gloves, special firefighting clothing, and masks, as well as alarm devices, medical materials, and used stationery, as well as service costs that include maintenance services for buildings, machinery, and private vehicles for civil defense, as well as the depreciation amount on machinery, machinery, equipment, fire trucks, office equipment, transportation, and electricity.

b- Safety, health and environment costs, which are represented by commodity supplies, such as gloves, shoes, work suits, glasses, protective masks, materials and fuel used for machinery and generators, stationery, advertising publications for the purpose of prevention, etc., and service supplies, represented by transportation and electricity. As well as the loss of desks and office equipment

c-Environmental equipment maintenance unit costs, which include the costs of maintaining the factory's equipment and machinery and treating the pollution resulting from their use. It includes the equipment used for maintenance, as well as paws, safety tools, service supplies, the obsolescence of machines and machines for maintenance, office equipment, buildings, transportation, and electricity. Below are the costs of the environmental equipment maintenance unit for the environmental cost management cell and the value flow for the month of December.

d-Costs of environmental training and development courses: These are the courses carried out by the value stream of the heavy equipment factory, represented by environmental safety courses in order to spread cultural awareness among employees, as well as courses on methods of dealing with fires and how to use fire extinguishers. These courses consisted of giving lectures by internal lecturers, and sometimes external lecturers were used. The costs of the courses are represented by the lecturers' wages, used stationery, means of illustration, and transportation fees for lecturers and workers if the courses were out of flow. Below are the costs of the training, development, and environmental courses for the Environmental Costs Management Cell for the Value Stream for the month of December.

Total environmental prevention costs for the Environmental Cost Management Cell for the month of December

**Table 3**

Type of cost	Monthly amount
Costs of developing emergency plans	1757401
Safety, health and environment costs	1732401
Equipment maintenance costs	1957401
Training course costs	857401
Total prevention costs	6304604

**Source** : prepared by the researcher.

## 2- Costs of environmental assessment activities:

These are the costs incurred by the value stream in order to evaluate and determine the operation of the factory activities and the extent of their compliance with the standards required for a safe work environment. They are represented by the following:

a- The costs of auditing environmental safety procedures, which are represented by the extent to which workers inside the factory adhere to safety, health, and environmental procedures, which are carried out by the Quality Control Department. The commodity supplies are represented by the materials used for examination, such as solutions, fuel, oils, and stationery. As for the service supplies, they are represented by electricity, transportation, and the use of used devices, offices, and buildings.

b- Costs of auditing the work of the machines and removing pollution: They are represented by the costs of auditing the work of the machines and removing pollution within the value stream of the heavy equipment factory and ensuring the removal and treatment of pollution resulting from the activities of these machines and equipment. The engineering inspection committee carries out the audit, and these costs are represented by commodity supplies such as spare tools and fuel. Oils, stationery, and publications. As for service supplies, they include maintenance of equipment, buildings, machines, and means of transportation, as well as deterioration, which includes the disappearance of the building, office equipment, means of transportation, and electricity.

Total environmental assessment costs for December.

**Table 4**

Type of costs	Monthly amounts
Costs of auditing safety procedures	1557401
Costs of auditing the operation of machines	1857401
Total environmental assessment costs	3414802

**Source** : prepared by the researcher

## 3- Costs of external failure:

These are the costs incurred by the economic unit as a result of the factory's practice of environmentally harmful activities that are put outside the factory, through which the heavy equipment factory bears financial fines and external compensation, as well as the lawsuits that are filed against the factory as a result of environmental violations, which are paid by the flow of value to the parties that incurred the damage, which are These costs are as follows:

A- The costs of environmental lawsuits borne by the factory.

B- Fines and compensation paid to the party that was exposed to environmental damage.

Through the interviews conducted and conversations with specialists, it was found that the factory does not have any external failure costs during the year 2021.

## 4- Costs of internal failure activities:

These are all the costs incurred by the value stream for producing an environmentally unfriendly product or the compensation given to workers due to damages they suffer during work, which are as follows:

A- Costs of medicines and medical supplies to treat workers inside the heavy equipment factory

B- Costs of workers' compensation for damages they suffer while working inside the factory.

T- The costs of treating the waste water, which supplies the heavy equipment factory with potable water, and the water is treated in order to prevent cases of poisoning and fatigue within the company. They are represented by the costs of salaries and wages for workers in the water purification unit, as well as commodity costs represented by private cars to transport water to the company's departments, salts, used fuel, electricity, and stationery. Filtered materials such as gravel and sand, as well as special bottles for filling and distributing water. As for the service costs, they included maintenance services, machinery, machines, the building, refrigeration and air conditioning equipment, transportation, and electricity.

As well as the failures that included the building, cars, and special machinery for the water purification plant. The internal failure costs for the month of December.

**Table 5**

Type of cost	Monthly amounts
Salaries and wages	1500000
Commodity supplies	150000
Service supplies	100000
Extinction	7401
Total	1757401

**Source** : prepared by the researcher

The total costs of the environmental cost management cell for the month of December for the value stream of the heavy equipment factory are calculated as follows

**Table 6**

Costs of the Environmental Cost Management Cell for December 2021

	Reduced monthly costs
Environmental costs of prevention	6304604
Environmental assessment costs	3414802
External failure costs _____	_____
Internal failure costs	1757401
Total	11476807

**Source** : prepared by the researcher

### 3-3 Comparing traditional costs for December 2021 with value stream costs:

After calculating the tank costs according to the traditional method, as well as calculating the costs according to the value flow, these costs will be compared and the impact of using the value flow method on reducing production costs will be demonstrated.

**Table 7**

Comparison of the tank product costs according to the traditional method with the value flow method for the month of Decembe

The difference	the costs of production according to the value of value flow	production costs, according to the traditional method	Details
212162756	197054696	409217452	The total cost of the heavy equipment factory for the month of December of the year 2021

**Source:** Prepared by the researcher based on the records of the Costs Division

Table 3 notes that applying the value flow method leads to reducing production costs for the month of December 2021 by an amount,(212162756) which is due to the process of rationalizing the number of workers in the factory, as well as identifying the losses that occur during production operations, allocating environmental costs to production costs, including them within the product costs, and disclosing them in the prepared income statement. According to the value stream, which shows the company's interest in environmental costs and providing environmentally friendly products.

### **5-Conclusion:**

1. The ability of the value flow method to determine and measure environmental costs that traditional systems are unable to identify and measure.
2. The value flow method tracks actual production costs represented by the cost of materials, labor, machinery and facilities costs, and other costs that are directly related to the value flow.
3. The value flow method provides data And more accurate and objective information for making decisions and measuring the performance of the economic unit, because it contains actual costs and there are no estimated costs in it.
4. The difficulty of collecting and measuring the environmental costs of the factory and resorting to estimated values for the elements of environmental costs.

### **Authors Declaration:**

Conflicts of Interest: None

-We Hereby Confirm That All The Figures and Tables In The Manuscript Are Mine and Ours. Besides, The Figures and Images, Which are Not Mine, Have Been Permitted Republication and Attached to The Manuscript.

- Ethical Clearance: The Research Was Approved By The Local Ethical Committee in The University.

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## دور تدفق القيمة في قياس التكاليف البيئية على تخفيض التكاليف

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هذا العمل مرخص تحت اتفاقية المشاع الابداعي نَسب المُصنَّف - غير تجاري - الترخيص العمومي الدولي 4.0  
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### مستخلص البحث:

تعاني اغلب الوحدات الاقتصادية من ارتفاع نسب التلوث البيئي ونقص بالموارد المتاحة والطاقة والذي ينتج عنه ارتفاع كبير في تكاليف الإنتاج بالإضافة الى افتقار الوحدات الاقتصادية الى استعمال أساليب كلفوية حديثة من خلالها يتم تحديد وتخصيص وقياس التكاليف البيئية وتكاليف الإنتاج. ومن هذه الأساليب أسلوب تدفق القيمة الذي يعمل على تتبع عمليات الإنتاج وتحليل المدخلات والمخرجات وتصنيفها الى منتجات سليمة ومنتجات غير سليمة (مخلفات)، والتي تمكن الإدارة من تحديد الأنشطة المضيئة للقيمة والأنشطة الغير مضيئة للقيمة وتعمل على تخفيض الاثار البيئية وكمية المخلفات وتقليل الضياعات التي تحدث اثناء عملية الإنتاج والاستغلال الأمثل للموارد وبالتالي تخفيض تكاليف المنتج وإنتاج منتجات صديقة للبيئة، وهذا يؤدي الى تحسين الأداء البيئي في الوحدات الاقتصادية العراقية. ويهدف البحث الى إعادة هيكلة الوحدة الاقتصادية والتي تدار من خلال اقسامها وادارتها وفق أسلوب تدفق القيمة. واحتساب التكاليف البيئية ولغرض تحقيق اهداف تلك الدراسة واختبار الفرضيات تم اختيار الشركة العامة للمعدات الهندسية الثقيلة احدى تشكيلات وزارة النفط محل البحث، والاعتماد على البيانات المالية وغير المالية التي تضمنتها التقارير والسجلات لعام 2021-2022 والمعاشية الميدانية والمداولة الأسئلة مع المهندسين والمختصين والعاملين للاستفادة من خبراتهم المتراكمة، وجمع وتحليل البيانات وفق محاسبة تكاليف تدفق القيمة من اجل تحسين العملية الإنتاجية، ومن اجل تخفيض الاثار البيئية وكمية المخلفات والانبعاثات والاستغلال الأمثل للموارد والطاقة. وكانت اهم الاستنتاجات التي توصل اليها الباحث قدرة تدفق القيمة على احتساب التكاليف البيئية الخاصة لكل تدفق داخل الوحدة الاقتصادية وكذلك توفير بيانات ومعلومات اكثر دقة وموضوعية لاتخاذ القرارات وقياس الاداء للوحدة الاقتصادية للمساهمة في الرقابة على الأنشطة البيئية وامكانية تخفيض التكاليف الخاصة بتلك الأنشطة.

نوع البحث: ورقة بحثية  
المصطلحات الرئيسية للبحث: تدفق القيمة، تخفيض التكاليف

\*البحث مستل من رسالة ماجستير