

The role of cleaner production costs to reducing failure costs

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Abstract

Economic units can benefit from the cleaner production strategy, which aims to reduce the environmental impact of economic activities while improving efficiency and profitability. Accordingly, the aim of the research was to clarify the knowledge foundations of cleaner production costs and to indicate their role in reducing the costs of poor quality (the costs of failure). A set of conclusions has been reached, the most important of which is that cleaner production has achieved a reduction in the costs of external failure, represented by the costs of guarantee, by an amount of 12,339,000 dinars. Contributes to reducing the costs of failure, and based on the conclusions, a set of recommendations were presented, the most important of which is the need to focus economic units on the use of environmentally friendly materials, as they contribute to the production of products that meet the desires of customers, which leads to reducing costs, improving product quality, and reducing failure costs internally and externally.

Keywords: cleaner production, costs of failure.

Introduction

The local industrial economic units suffer from the high number of failed units. One of the reasons for this failure is the aging of the production machines and the lack of periodic maintenance for them, in addition to the poor quality of the raw materials used in production processes, as well as the failure of the departments in the industrial economic units to keep pace with modern technological developments, in addition to the lack of Paying attention to the optimal use of available resources by adopting systems and technologies that prevent or reduce waste in production processes, that the presence of some or all of these causes leads to the product not conforming to the specifications and thus leads to the presence of damage in production, which is reflected in the economic units bearing the costs of the product not conforming to the

specifications, which negatively affects the economic units, where the trend has been towards improving quality by investing in prevention costs as (value-adding activities) represented in cleaner production costs, and that cleaner production seeks to improve product quality by reducing the environmental impact of production processes as a result of avoiding the use of hazardous materials (highly toxic or harmful to the environment) and reduce waste and reduce emissions and pollution to water, air and soil, which leads to an improvement in the internal work environment, and that the economic units that adopt cleaner production will be able to obtain a larger market share and achieve a higher profit than their competitors as a result of reducing costs and protecting the environment.

Research methodology

First: Research problem

The local industrial economic units suffer from a high number of failed units internally and externally as a result of poor quality and for many other reasons, including the lack of availability of materials and energy, the difficulty of competition due to the presence of advanced products in the markets, lack of financial resources, weak human skills, poor level of manufacturing technology used, and the failure to adopt modern systems that achieve the optimal economic use of resources. It manufactures environmentally and consumer-friendly products that do not generate waste and pollutants, as well as the use of low-quality raw materials, which leads to production processes that do not add value to products and are environmentally polluted, high product costs, and thus the loss of economic units and the customer's orientation towards foreign goods and products. The research problem can be formulated through the following question :

Does the use of cleaner production costs help the management of the economic unit to reduce the costs of failure?

Second: Research importance

The importance of research emerges from the theoretical side in reducing the costs of failure, both internal and external, by adopting the strategy and costs of cleaner production with their tools and objectives.

As for the practical side, the importance of research is in helping the economic unit to reduce the costs of failure in order to create and improve the reputation of the economic unit by moving to production management techniques instead of traditional techniques and helping the economic unit management to progress and raise the level of products and services provided to customers through the use of production strategy cleaner.

Third: Research objectives

1. Statement of the knowledge bases for the costs of cleaner production, as well as the knowledge bases for the costs of failure.
2. Identifying the role of cleaner production in reducing the costs of failure in the economic unit, the research sample.

The first topic

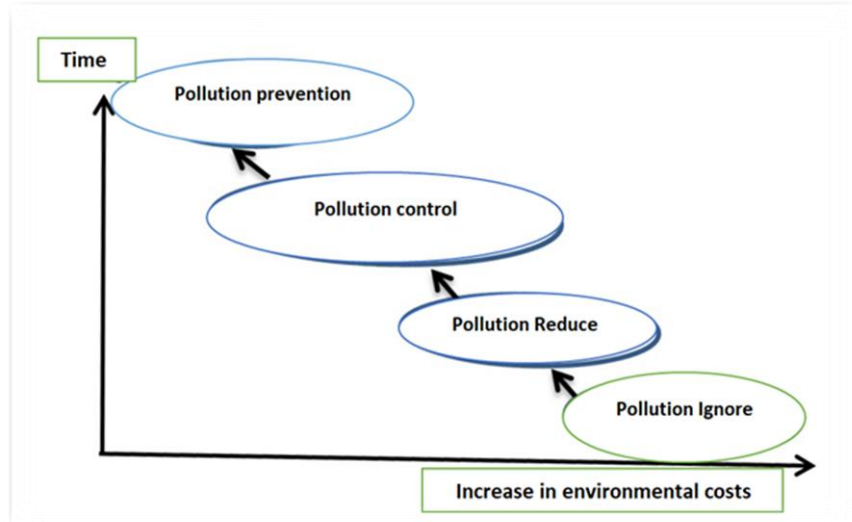
Cleaner production

First: the concept and objectives of cleaner production

Cleaner production is one of the latest methods and strategies reached by environmental protection systems in the world, and one of the most effective. In 1994, the first European conferences on cleaner production programs defined the concept of cleaner production as a conceptual and procedural approach to production that requires that all stages of the product life cycle aim And the productive process aims to prevent short and long-term risks to humans and the environment, and in 1998 the International Declaration of Cleaner Production encouraged the United Nations Environment Program (UNEP) to make slight changes to develop this strategy, and industrialized countries responded to pollution and environmental degradation in four distinct ways. (da Silva & Gouveia, 2020 2), (20: 2007, Nilson et al.)

1. Ignoring the problem: Ignoring the problems of pollution and environmental degradation leads to maximum damage to the environment, as this damage is not limited to the local scale, but rather extends to the regional level and in some cases even to the global level.
2. Reducing pollution: that is, reducing the amount of pollution or reducing its concentration so that its effects are less harmful.
3. Pollution control: Remediation of contamination using filters or disinfection processes, or through an end-of-pipe approach.
4. Pollution prevention: through the application of cleaner production, which is a set of preventive environmental strategies aimed at preventing pollution from its sources, including the best utilization of resources. As shown in Figure (1)

Figure (1) Stages of development of the concept of cleaner production



Source: Al-Jabri, Muhammad Diwan Shniwer (2021), Employing consistency between effective manufacturing strategies and cleaner production to enhance sustainable competitive advantage, applied research in the General Company for the Automotive Industry and Equipment, the Batteries Factory in Al-Waziriyah, Baghdad, Master Thesis, Council of the College of Administration and Economics, University of Karbala, Page 66.

Figure (1) shows that the gradual progress in the development of cleaner production concepts from “ignoring” to “prevention” has reached its climax in the realization that it is possible to achieve economic savings for the industry in addition to a safe environment for society. Where the United Nations Environmental Program defined cleaner production as the continuous application of an integrated preventive environmental strategy on products, production processes, and services to increase economic efficiency and reduce risks to humans and the environment (Basappji et al, 2015:5), and it is applied as follows: (3: et al, 2021 Ramos)

1. Production processes (industrial): Cleaner production focuses on reducing the use of any type of inputs such as raw materials, water and energy, as well as replacing toxic and dangerous materials with less dangerous ones.
2. Products: Cleaner production focuses on reducing harmful effects over the life cycle of the product, which starts from.
3. Services: When applying cleaner production, direct and indirect environmental impacts are reduced in the establishment and performance of services. (2007: 17, Nilson et al) referred to the concept

of cleaner production applied to services as integrating environmental concerns into the design and provision of services.

Cleaner production aims to reduce negative impacts on the environment and operating costs alike, as it works on an integrated preventive treatment instead of ending solutions. (22: 2007, Nilson et al.), and that the main objective of cleaner production is the possibility of obtaining savings, financial returns, and environmental improvements at low costs, in addition to the following objectives. (130: 2021, Jayasinghe et al) , (El-tanboly, 2022: 3)

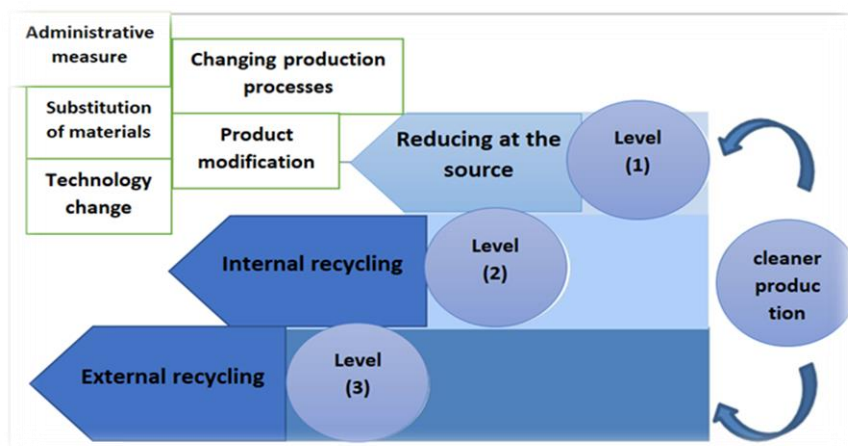
1. Rationalizing the consumption of raw materials and energy and preserving the safety of workers, consumers and the environment.
2. Excluding hazardous materials and replacing them with less dangerous materials.
3. Increasing environmental efficiency and productivity through optimal utilization of available resources, use of modern technology in production processes, and reduction of emissions and environmental pollutants at their source.
4. Reducing the costs of defective and damaged products by improving the quality of products.

The researchers believe that the goal of cleaner production is to achieve a contribution to the sustainability of industrial products by increasing the long-term competitiveness of companies and reducing environmental pollution resulting from them.

Second: Cleaner production tools

Principles need tools or practices to be adopted in order to implement cleaner production and achieve its goals. These practices can be divided into three levels, as shown in Figure (2).

Figure (2) Levels of cleaner production tools



Source: Silva , Aadriana .S. &Medeiros, Carla.F. & Vieira,Raimundo Kennedy(2017),Cleaner Production and PDCA cycle: Practical application for reducing the Cans Loss Index in a beverage company, Journal of Cleaner Production,vol 150, p327

The first level: Reducing at the source: It means preventing the generation of waste instead of generating it and working to reduce it, and it is mainly related to the means used to manufacture the product, not the product itself. Thus, it is imperative that productive means promote the reduction of emissions and pollutants (da Silva & gouveia, 2020:155), and this is done through the following actions:

1. Changing production processes: This is done by modifying work procedures and procedures for keeping a record of operations with the aim of providing appropriate information for operating equipment and machines and implementing productive processes with high efficiency (sirait, 2018: 3) and it includes:

A. Administrative measure: It is considered one of the simplest, cheapest and most effective ways to apply cleaner production. Ahmad, 2020:5)) This can be implemented in all sections of the economic unit, including the following: (Al-Halam, 64, 2020)

- Special practices for management and workers, including training and encouraging workers to reduce pollution.
- Improving handling of stored materials to reduce their damage and their various effects on the environment.
- Reducing emissions of pollutants resulting from the obsolescence of machinery and equipment.
- The practices of classifying and separating waste and dealing with each type according to its degree of danger:
- Calculating the costs allocated for waste treatment and disposal.

B- Substituting materials: This is done by excluding or replacing hazardous toxic materials with less dangerous ones, by using materials that can be developed with the aim of reducing environmental pollutants from the source and providing environmentally and consumer-friendly products (Vasquez, 2017:65).

C- Changing technology: It is done by replacing or developing the technology used with the aim of reducing resource consumption and reducing waste generation by improving the efficiency of production processes. This procedure often requires capital intensive, but payback periods are very short (El-tanboly, 2022: 3).

2. Product modification: Changes are made to the components of the product to reduce waste during product use or when disposing of it. These changes can lead to a redesign of the product and its technical

configuration to reduce environmental impacts throughout the product life cycle. These changes are made by changing the quality specifications, a change in the components of the product, and the development or replacement of the product (Hamad, 2021: 8).

Second level: Recycling within the economic unit: it is implemented within the economic unit due to the presence of some defects and waste resulting from the production process so that it is returned to the production line in certain proportions so as not to affect the characteristics of the product and it is prepared for use for a second time.

Third level: Recycling outside the economic unit: It is done through the products that the consumer used and disposed of to become waste that is recycled and other products with new uses are produced (6: 2021 Borges et al,).

Third: cleaner production costs

Cleaner production costs are the costs incurred by the economic unit as a result of its commitment to implement a set of activities and procedures aimed at protecting the environment and people from environmental pollution and providing a product free of pollutants. Cleaner production costs can be divided into:

1. In terms of the inputs and outputs of the production process: it is classified into the following groups (Al-Shabasi, 2017: 37) (Sorour and Muhammad, 2020: 65)

The first group: the costs of reducing or limiting losses in the materials involved in production:

It includes the costs of excluding hazardous materials with less dangerous or non-hazardous ones, and the costs of reducing energy consumption through making adjustments in production methods, which results in a reduction in the amount of water and energy consumed.

The second group: the costs of reducing and recycling solid waste.

The economic unit bears the costs of purchasing new raw materials instead of recycling the waste of production processes, as well as the costs of failing products that should be reprocessed, or the costs of disposing of these products and treating them as solid waste, or selling them at prices lower than what can be obtained when selling high-quality products, in addition to wages. Workers handling and transporting waste.

The third group: the costs of reducing pollutants and emissions from the source:

It is represented in the costs of reducing greenhouse gases, emissions, dust and industrial pollutants, in addition to the costs incurred by the economic unit as a result of its commitment to environmental laws and regulations, which are imposed in order to protect the environment, as well as the costs of obtaining the ISO quality certificate to produce environmentally friendly products with international quality specifications and standards.

2. Cleaner production costs in terms of their causes, including: (Al-Sultani, 46: 2020)

A - Legal costs: These are the costs incurred by the economic unit for its compliance with the environmental legislation and laws that are imposed on it in order to protect the environment, such as the costs associated with waste treatment and disposal and the prevention of harmful emissions to the air. These costs are not optional, meaning they are mandatory.

B - Social costs: These are optional costs incurred by the economic unit to improve its reputation and image and strengthen its relationship with society as it is an economic unit that is environmentally friendly, which increases its capacity. Examples of these costs are the costs of environmental reports, the costs of environmentally friendly materials and the costs of warning programs.

C - Costs related to the consumer: These are costs incurred by the economic unit to meet the desires and needs of the consumer in using environmentally friendly products that are easy to dispose of and recycle. An example of this is the cost of choosing industrial materials that do not cause harm to the consumer.

3. Cleaner production costs in relation to total quality:

These are the costs borne by the economic unit in order to improve the quality of the product and reduce the costs of failure, and they can be divided into two types (Alawi, 2021: 43):

A- Quality control costs: These include prevention and evaluation costs.

B- Quality Assurance: It includes the costs of obtaining a local and international quality certificate.

4. Cleaner production costs in terms of time range (Salem, 2023: 65)

A - Capital costs: These are the costs incurred by the economic unit in return for providing machinery, equipment and supplies that contribute to reducing pollution and treating its effects. Examples of these are:

1- The costs of installing air purifiers to reduce harmful emissions.

2- The costs of establishing plants to treat factory water.

3- The costs of the parts added to the assets to protect them from the environmental effects resulting from the factory activity or to reduce the environmental effects resulting from the use of the asset in the activity.

B - Operational costs: They are considered period costs, meaning that they do not achieve substantial future benefits, such as operating costs, checking inputs and outputs, and maintenance costs for capital equipment related to the environment.

When applying cleaner production, the following costs are excluded (Ali & Saeed, 2022: 1132-1133))

- Costs resulting from avoiding environmental fines and compensation as a result of compliance with environmental requirements.
- The costs of avoiding treating workers as a result of providing a safe and healthy work environment.
- Sanitary burial costs as a result of replacing them with recycling.
- Reducing costs with the revenues of emissions reduction certificates.
- Reducing costs with revenues from recycling projects.

The researchers believe that cleaner production is an integrated preventive methodology whose significance is summarized in three aspects, the first of which is the reduction and control of the negative impact of human activities from its source. The second aspect is improving the level of quality of products, which leads to achieving an increase in profits as a result of reducing the costs of low-quality products. Sustainable development and that the main objective of cleaner production is to achieve environmental quality through the production of environmentally and consumer-friendly products with high quality, low costs and the least time as a result of the efficient use of resources and the reduction of waste in production processes.

The second topic

The cost of failure

First: the concept of cost of failure

The concept of failure is the inability of an item, product, or service to perform the required functions when requested due to one or more defects, and leads to non-conformity, which is the failure to meet the specified requirements (Törnblom, 2022:12), and in general, the goal of every customer is to obtain A defect-free product or service at a reasonable cost, and the goal of each economic unit is to maintain its competitiveness, satisfy its customers, and increase its profits through production at the lowest cost, and this can only be achieved through efficient production, the use of good quality management, and keeping

failure costs to a minimum, and that The quality of products and services is now a prerequisite for staying in the competition, and the costs of failure can lead to a significant increase in the cost of the product or service, which leads to the loss of the reputation of the economic unit and its business (Mahmood et al, 2010: 1).

The costs of internal and external failure are called costs of non-conformity, and they are defined as the costs resulting from products or services that do not comply with the established standards. The costs of failure are classified into two types, internal and external (Asada et al, 2021:560).

Failure costs are defined as all that is incurred to help the employee perform his tasks correctly every time and the cost of determining whether the final result is acceptable, in addition to any cost incurred by the economic unit and the customer as a result of outputs that do not meet the specifications or expectations of customers (Mahmood & Kureshi, 2014 : 2).

Second: Types of failure costs

1. Internal failure costs:

These costs occur when work results fail to reach quality standards and are discovered before the product is dispatched to the customer, are associated with defective production processes, equipment, products and product materials or do not meet quality standards or requirements, and are associated with failure of products and components to meet quality requirements prior to transfer. Ownership belongs to the customer, and these costs will disappear in the absence of defects in the product. (Asada et al, 2021:561)

The researchers believe that the costs of internal failure are the costs incurred by the economic unit as a result of defective products that were discovered during or after production processes and before delivery to customers.

Elements of apparent internal failure costs include the following (Fadhil, 2022:2).

A- Remanufacture: the cost of processing defective products to bring them to an acceptable or usable level.

B- Scrap: the cost of defective products that cannot be repaired and reformulated and includes parts, components, assemblies or finished products, and thus becomes scrap or scrap and includes the costs of materials, wages and indirect industrial costs that were spent on the item that was canceled.

C- Re-examination: It is the cost of re-testing the products after re-manufacturing.

D- Failure Analysis: The cost of analyzing goods or services that do not comply with quality to determine the main cause of the problem or defect and troubleshooting it. It includes the costs of analyzing defective materials, components or products, determining remedial actions and making the decision to dispose of them.

E - Machinery downtime: the cost of losing sufficient manufacturing capacity as a result of breakdowns and quality problems.

F- Loss of Revenue: Inability to fulfill current orders and loss of future orders.

2. External failure costs:

These costs arise due to the failure of the product after delivery to the customer within the warranty period or the period of liability for defects. Examples of this include deterioration of the work carried out, complaints of malfunctioning devices and complaints related to repair, replacement of defective parts that do not conform, warranty fees, adjustments to customer complaints, and returned goods. , product recalls, and product liability costs are also external failure costs and include direct and indirect costs such as labor and travel associated with the investigation of customer complaints, on-site warranty inspections, and tests and repairs (Mahmoud, 2021: 55).

The researchers believe that the costs of external failure are the costs incurred by the economic unit as a result of defective products that were delivered to customers.

And Fadhil believes that the elements of the apparent tangible costs of external failure are the following: Fadhil, 2022: 3):

A- Complaints: These are the costs incurred by the economic unit as a result of verifying and amending complaints related to defects.

B- Warranties: These are the costs of replacing or repairing and shipping defective products.

C - Replacement of rejected products: These are the costs associated with receiving and replacing the defective product.

D - Lost revenue: It is the loss of future profits for the economic unit as a result of canceled contracts and the transfer to another product or another economic unit that produces the same product due to poor quality.

Third: The role of cleaner production costs in reducing failure costs

The economic units suffer from high costs of failure as a result of the low level of quality and the lack of use of modern technology in the manufacturing processes in addition to the lack of skills necessary to use and maintain machines and thus produce products with high cost and low quality, hence the importance of using modern methods of

manufacturing, including the cleaner production strategy to reduce the costs of failure. Which aims to achieve environmental quality by reducing the amount of toxic materials used in production processes and replacing them with materials that are less harmful or environmentally harmless, as well as reducing the negative effects of manufacturing processes, recycling industrial waste and damaged units in order to reduce material and energy consumption, reduce costs, pollutants and emissions, as well as reduce The number of damaged and defective units, which leads to a reduction in failure costs (Goyal et al, 2019: 3), and cleaner production improves the internal work environment of the economic unit by reducing emissions associated with production processes from the source. This is done by replacing machinery, equipment or internal parts with negative effects that are considered environmentally polluted, which enhances the reduction of damaged units that need to be remanufactured and re-examined as well as the costs of getting rid of damaged products. The environmental quality of products and the provision of new products in accordance with the requirements and needs of customers, which leads to a reduction in the costs of non-conforming products (Abbas, 2020:2).

The researchers believe that investing in prevention costs represented by cleaner production costs leads to preventing failure instead of treating it, because cleaner production works to achieve environmental quality through the disposal of environmental waste, reprocessing and use, increasing the efficiency of production processes, and purchasing renewable materials that are not harmful to the environment and the consumer. Which improves the quality of products and thus reduces damaged, defective and non-conforming products, and increases customer satisfaction in obtaining environmentally safe products at low cost and reducing failure costs.

Fourth: Applying the technique of cleaner production of quality at the source to achieve the reduction in the cost of failure

After Diyala Company in general and distribution transformers in particular were selected as a sample for the research, the mechanism of transformers work will be clarified, as follows: Distribution transformers are used in electrical power distribution networks. From a power system to another power system with voltage and current often differs in value from the previous values before the conversion by electromagnetic induction, and that the change of voltage is accompanied by a change in the value of the current, so when the voltage is raised the current decreases at the same time and vice versa, and the work of the transformer is the same whether it is Distribution transformers or power transformers, and the main function of distribution transformers is to convert the value of high voltage (voltage) to the voltage needed by the consumer while raising the value of the current.

Mineral oil is considered one of the main parts of the transformer because this oil performs two basic functions (physical and electrical). The physical function is electrical insulation, as it prevents contact with copper tapes inside the transformer and the occurrence of problems that cause loss and damage to the internal parts of the transformer. The electrical function is cooling the transformer and preventing surges. The temperature inside it, and it is considered the most important function, because the internal heat in the transformer if left can cause severe danger, and it is not better than oil or gas in transporting it to the outside, and sulfur hexafluoride (SF6) is one of the most common gases used as an insulating medium in electrical transformers thanks to the strength of insulation. The high and supercooling of the electric arc (spark), but the only drawback of this gas is its negative impact on the environment,

Where SF6 is considered one of the most powerful greenhouse gases that cause an increase in global warming, its particles are very resistant to any attack from the atmosphere, so that the self-cleaning feature of the atmosphere cannot deal with such particles, however, the environmental impact of SF6 gas increases by about 23500 times Carbon monoxide, CO2, and once it escapes, can remain in the atmosphere for up to 3,200 years.

As a result, GE (General Electric) announced in 2014 its innovative environmentally friendly solution represented by green gas (G3) green gas for grid, which consists of a gaseous mixture of three gases: nitrogen, oxygen, and a small amount of carbon dioxide to be the ideal solution for power stations, and the user As an alternative to SF6 oil and gas and has 98% lower greenhouse effect than SF6 with similar performance to SF6, it is suitable for the development of new generation of clean high and low voltage equipment. Thus, the researcher chose the 11/250 transformer in the distribution transformer factory as a sample for research, because the company has strategic plans to protect the environment through product development, and this product is one of the necessary products for the distribution of electric power to consumers, so a working group was formed to develop the 11/250 transformer to study Producing a newly developed model to compete with similar products in the local market at a competitive cost and to meet the needs of the environment. Table No. (1) shows the characteristics of each of the mineral oil used in the transformer and the gas proposed to be used as an oil substitute.

Table No. (1) Comparison between mineral oil and G3 gas.

N	G3 gas	Mineral oil
1	Non-flammable, chemically inert, and non-toxic.	It is flammable and contains harmful substances
2	No explosion is generated	It may cause an explosion as a result of

		the interaction of the leaked air with the gases produced from the oil.
3	Recycling	Not recyclable
4	Thermally stable gas up to 800°C, which is much higher than the maximum temperature of oil-insulated transformers.	The blockage of the cooling pipes causes a rise in the converted temperature, which leads to the formation of gases of different types, including: 1. At high temperatures, ethane gas is produced, accompanied by an electric arc (spark). 2. When the temperature rises, acetylene gas is produced. 3. At low temperature methane gas is produced All of them are flammable gases, and the dissolution of these gases in the transformer oil causes corrosion or breakdown of the insulating materials.
5	Gas-insulated transformers do not require maintenance, because the transformers are completely closed, as there is no contact with the outside air, thus eliminating the problems of aging of insulation materials or pollution caused by moisture or dust accumulation, and thus prolonging the life of the transformer	Oil-insulated transformers require continuous maintenance, which causes damage to the attempt and increases the cost of raw materials.
6	Environmentally non-polluting	It has a negative impact on the environment by leaking oil and gas emissions.

Source: Prepared by the two researchers based on <https://www.electricalindia.in/towards-the-green-way/> and personal interviews with the development team.

G3 gas is a technically and economically viable alternative to oil with insulating and cooling properties used in electrical transformers. The first project was implemented in the United Kingdom in 2017, which is the manufacture of an electric power plant with green gas. Since then, the number of projects has increased in multiple countries, due to the lack of gas Green The researcher, along with the development team, relied, by default, on the application of green gas instead of oil as an insulation and cooling medium in transformer 11/250. The following

table shows the cost of the transformer 11/250 before applying the cleaner production.

Table No. (2) Cost and price of the transformer capacity 11/250

N	Subject	Unit	Quantity (1)	Price (2)	Total value (1)+(2)
1	Iron	Kg	620.762	4357.385	2704899
2	High compression files	Kg	12.168	6500	79092
3	Low compression files	Kg	14.704	5584.784	82118.663
4	Copper	Kg	194.588	22000	4280936
5	Oil	Liter	287	4500	1291500
6	Nuts and bolts	Number	314	772.1	242439.4
7	Thermometer	Number	1	10500	10500
8	Oil level gauge	Number	1	10500	10500
9	Label plate	Number	1	3000	3000
10	Valve	Number	2	4750	9500
11	Stopper	Number	1	1400	1400
12	Cover	Number	1	5000	5000
13	Wooden channel	Number	456	64.3	29320.8
14	Welding wire	Number	1.15	1300	1495
15	Paint	Liter	19.6099	4683.3	91839
16	Tape	Rolla	2.8799	508.1	1463.277
17	Steel wire	Kg	3.505	2350	8236.75
18	Rubber gasket	Number	1	12000	12000
19	Iron bar	Kg	0.7	2500	1750
20	Oxygen gas	Bottle	0.3470	5220	1811.34
21	Acetylene gas	Bottle	0.76	18000	13680
22	Nitrogen gas	Bottle	0.0322	5085	163.737
23	Co ² gas	Kg	14.75	2750	40562.5
24	Arcon gas	M ³	0.6750	2125	1434.375
The cost of raw materials					8924642
Wage cost					898527
Industrial costs					783133
Total manufacturing cost					10606302
Total marketing and administrative costs					1059646
Total cost					11665948
The profit margin is 0.03					334052.48
Final selling price					12000000

Source: prepared by the researchers based on the data of the Costs Division

It appears from the data of Table No. (2) that the calculation of wage costs, industrial costs, marketing and administrative costs is carried out separately and not on the basis of a percentage of raw materials. It can be calculated roughly and represents 7.7% of wages and 8.8% of industrial costs. As for administrative and marketing costs It represents approximately 9.9% of the total manufacturing costs. It is noticed that the total cost of the transformer 11/250 increased by the amount of 11,665,948, which causes an increase in the selling price by an amount of 12,000,000 dinars, which represents a high price compared to imported products, and the reason is due to the high cost of raw materials involved in the manufacture of the transformer. The development and design department manager with the researcher, given that the price of g3 gas is close to the price of sulfur hexafluoride (SF6) because they have similar characteristics as follows:

Cost per bottle = quantity x price

= 40 kg x \$2.85 = \$114

The cost of one liter = the cost of one bottle / the number of liters

= \$114/44 liters = \$2.539 per liter

The cost of a liter in dinars = a liter in dollars x the exchange rate of the dollar

= 2.539 x 1460 = 3707

The cost of g3 gas = the amount of oil used for the transformer x the price of a liter in dinars

= 287 liters x 3707 = 1063909 dinars

The amount of reduction in the cost of raw materials = the cost of oil as shown in Table 2 - the cost of g3 gas

= 1,291,500 – 1063909 = 227591 dinars

It turns out that the cost of raw materials decreased by 227591 dinars . Among the technical advantages of g3 gas, it is suitable for all voltage levels, while the dimensions of the product remain the same. There is no significant increase in raw materials. Through the interview with the director of the maintenance department in the company It was found that the company incurred costs of external failure, represented by guarantee costs, in the amount of 5,000,000, as shown in the following table

Table No. (3) Costs of warranty failure (failure) incurred by the economic unit during the year 2022.

Product Type	Number (1)	The amount of oil consumed per transformer (2)	Number of liters (1)×(2)	Price per liter	Total value
Transformer capacity 11/250	6	287	1722	4500	7749000
Transformer capacity 11/400	3	340	1020	4500	4590000
Total			2742	4500	12339000

Source: prepared by the researchers based on the data of the Maintenance Division

In light of the foregoing, it is clear that the application of the research proposal for cleaner production, which is the conversion of oil-insulated transformers into green gas-insulated transformers, leads to a reduction in costs in general and failure costs in particular, because green gas is characterized by recycling after consumption, while oil is not characterized by this. The application of cleaner production in the future will reduce the costs of failure, the costs of poor quality, by an amount of 12,339,000 dinars, which is proven in the table above, and thus the goal of the research was achieved by clarifying the role of cleaner production in reducing the costs of failure.

The fourth topic

conclusions and recommendations

First: Conclusions

The researchers reached a number of conclusions, including the following:

1. The cleaner production achieved a reduction in the costs of external failure, represented by the costs of the guarantee, with an amount of 12,339,000 dinars. This indicates that there is a relationship between CP costs as prevention costs and elements of failure costs, as investment in prevention activities contributes to reducing failure costs.
2. Cleaner production costs contribute to reducing emissions and pollutants, reducing the consumption of resources used in production processes, achieving production efficiency, and thus reducing the costs of internal and external failure.
3. The application of cleaner production is one of the most appropriate ways to help economic units reduce the cost of raw materials and waste, by using environmentally safe and recyclable materials that do not consume energy.

4. Measuring cleaner production costs and costs of failure and disclosing them contributes to determining environmental obligations and costs that can be avoided when adhering to environmental legislation.

Second: Recommendations

The researchers recommend the following:

1. The need for economic units to focus on the use of environmentally friendly materials, as they contribute to the production of products that meet the desires of customers, which leads to a reduction in failure costs internally and externally.
2. Conducting a comprehensive evaluation of the production processes in the economic units to determine the areas where waste and pollution can be reduced.
3. Develop a plan to implement cleaner production practices, such as the use of renewable energy sources, reduce water use, and reduce waste, as well as provide training and education to employees about the importance of cleaner production practices and how they can contribute to achieving customer satisfaction.
4. The need to use modern technologies to keep pace with the development of industries in the world, move away from traditional production methods and support innovation and modern technology in production processes to help economic units rationalize resource consumption, reduce pollutants and emissions, and thus reduce costs and achieve financial savings.

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