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Measuring the Role of Environmental and Quality Costs in Enhancing Product Quality

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Abstract

The present study aims to identify and measure environmental and quality costs accurately in the various stages of product life span. It also aims to explore processes, the nature and types of environmental and quality costs, and distribution of costs across the various activities and products. Based upon the general financial data available in the Iraq stock exchange for the period (2018-2022), The National Company for Chemical and Plastic Industries is the case study. In order to obtain the objectives, the present study adopts financial data analysis. The results reveal that adopting clean production leads to reducing pollution gradually. This gradual reduction in pollution is the outcome of compliance with the environmental criteria imposed by state units, such as fines and penalties imposed due to pollution, in addition to improving the relationship with society and environmental authorities. As a result, there is an increase in the profitability and competitiveness of the commercial unit. The resulting benefits are greater than waste management costs. The present study recommends commercial units to measure quality and environmental costs through distinguishing them from other costs to make use of them in the field of decision-making to serve the environment of the commercial unit operation field.

Keywords : Environmental Costs, Quality Costs, Product Quality.

1. Introduction

In the contemporary business landscape, quality in business is no longer just a characteristic of the end-product, but an integral part of the overall strategy of an organization. Similarly, being environmentally responsible is no longer a social duty, but it has turned into an economic and legal obligation. In this regard, the identification of environmental and quality costs turns out to be a strong tool that helps

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organizations achieve excellence in products, thereby increasing sustainable performance. Hence, environmental costs involve all the costs an organization incurs due to its activities in relation to environmental issues. These costs include pollution prevention costs, waste management and recycling, and compliance with environmental regulations, as well as potential costs arising from environmental incidents or reputational damage. Measuring these costs helps organizations understand the financial impact of their environmental activities and identify opportunities to reduce them and improve their environmental performance. Measuring these costs is not just an accounting practice. It is a vital strategic means of improving product quality by highlighting areas that are in need of improvement. Cost analysis enables the identification of those activities and processes that generate high environmental or quality costs, which then permits the focusing of the improvement efforts upon those areas of most critical concern. The cost data enables the assessment of the effectiveness of actions taken to improve the quality or reduce the environmental impact, thus enabling decisions to be made on whether to continue or modify actions. Emphasis on reducing environmental and quality costs can stimulate innovation in product and process design. The result should be better quality and more sustainable products. The attention paid to quality and the environment enhances the reputation of an organization among customers and other stakeholders, thus leading to increased sales and brand loyalty. A company that can manage its environmental and quality costs efficiently is better placed to maintain high-quality levels at competitive prices, gaining an advantage over competitors.

2. The Research Methodology

2.1 Problem Statement

1. What is the level of application of concepts of environmental and quality cost measurement among companies within the National Chemical and Plastic Industries Company?

2. What is the nature of the relationship between the measurement of environmental costs and improving the dimensions of product quality, such as performance, reliability, durability, and conformity to specifications, at the National Chemical and Plastic Industries Company?

3. What is the relationship between measuring quality costs and improving product quality dimensions in the National Chemical and Plastic Industries Company?

2.2 The Significance

1. **Supporting Decision-Making**: Providing accurate information to management to make informed decisions regarding operations and products, thereby improving efficiency and reducing waste.
2. **Directing Improvement Efforts**: Identifying activities and processes with high environmental and quality costs and directing improvement efforts toward them to maximize impact.

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3. **Performance Evaluation**: Providing measurable performance indicators to evaluate the effectiveness of quality and environmental initiatives and track progress.
4. **Enhancing Competitiveness and Image**: Improving competitive market position through high-quality products at lower costs and enhancing the organization's image and credibility with customers.
5. **Compliance and Innovation**: Assisting in compliance with environmental regulations and quality standards to avoid penalties and stimulating innovation in product and process design to reduce costs.

2.3 The Objectives

1. **Accurate Measurement and Identification**: Accurately identify and measure environmental and quality costs at all stages of the product and process lifecycle.
2. **Cost Understanding and Analysis**: Understand the nature, types, and allocation of these costs across different activities and products.
3. **Informing Management**: Support pricing decisions, product design, process improvement, and investment by providing management with reliable information.
4. **Monitoring and Controlling**: Establish environmental and quality performance standards and benchmarks and compare them to actual costs to identify deviations and take corrective action.
5. **Identifying Reduction Opportunities and Linking Them to Satisfaction**: Uncover cost reduction opportunities through process improvement and pollution prevention, and link these reductions to improved product features and customer satisfaction.

2.4 The Hypotheses

Hypothesis 1: The level of application of environmental cost and quality cost measurement concepts at the National Chemical and Plastic Industries Company is medium to low, and focuses primarily on recording failure costs rather than prevention costs.

Hypothesis 2: There is a direct (positive) relationship between the level of environmental cost measurement (especially tracking environmental prevention costs) and the improvement of product quality dimensions (such as conformity and durability) at the National Chemical and Plastic Industries Company.

Hypothesis 3: Quality cost measurement (especially prevention and evaluation costs) has a greater and more direct impact on improving product quality dimensions (such as performance and

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reliability) compared to environmental cost measurement at the National Chemical and Plastic Industries Company.

3.The Theoretical Framework : Environmental Costs

3.1The Concept of Environmental Costs

The concept of environmental costs refers to the cash value of the consumed resources or environmental degradations caused by commercial activities. In other words, such costs are those incurred by companies or individuals or the society as whole due to the negative impacts of their activities on the natural environment.

There are two perspectives regarding environmental costs (Santos et al., 2019):

Special Costs: They are those costs incurred by the entity carrying out the activity that directly causes pollution or environmental degradation. Such costs may include:

Pollution Prevention Costs; They include assembling air filters or waste management systems.

Costs of pollution treatment and cleaning the affected environment.

Costs of compliance to environmental regulations and rules, such as permit issuance and environmental taxation (Silva and Gouveia, 2020).

Costs of waste treatment and disposal.

Costs of studies and environmental assessments.

Costs of insurance against environmental risks.

Fines and compensations related to environmental violations.

Social Costs: They are the costs that the society as a whole bears due to environmental degradation. They are not directly reflected on the special costs incurred by the causing entity. These costs may include (Van Berkel, 2000):

Costs of health care for pollution related illnesses.

Costs of loss of productivity due to diseases or extreme weather conditions resulting from climate change.

Costs of damages related to infrastructure and property due to natural disasters resulting from environmental degradation.

Costs of loss of biodiversity and ecological system services, such as water purification and crop pollination.

Costs of deterioration of life conditions and overall wellbeing.

3.2 Importance of Environmental Costs (Nunes et al., 2019; Maama et al., 2021):

Informed Decision-Making; Understanding environmental costs helps in the process of taking more responsible and sustainable commercial decisions. This is done through comparing costs and actual activity benefits.

Achieving Sustainable Development; Integrating environmental costs in commercial accounts contributes to achieving sustainable development that takes commercial, social, and environmental dimensions into consideration.

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Stimulating Environmentally Responsible Attitudes; Environmental taxes, fees, and incentives can be used as mechanisms for encouraging companies and individuals to adopt ecofriendly attitudes and reduce environmental costs.

Assessing Environmental Performance; Tracking and analyzing environmental costs helps companies assess their environmental performance and identify aspects of enhancements and costs reduction.

3.3 Objectives of Environmental Costs (Xing and Tony, 2021):

Environmental cost aims to achieve a set of important objectives for companies and society alike as follows:

Identifying and Measuring Environmental Costs; The key objective is to identify and measure all costs related to the activities that directly or indirectly affect the environment. This includes pollution prevention costs, waste treatment, managing natural resources, cleaning polluted sites, environmental fines, and others.

Providing Information for Decision-Making; Environmental costs aim to provide accurate and detailed information to help the administration take informed decisions that take environmental costs and related environmental impacts into consideration. For instance, it may help select the most ecofriendly production operations or assess investment in clean technologies (Demirer, 2018).

Enhancing Resource Use Efficiency; By tracking costs related to using natural resources and waste disposal, companies can identify opportunities of enhancing efficiency and reducing waste, which leads to reducing environmental and operational costs.

Assessing Environmental Performance; Environmental costs help assess company performance in matters related to the environment and identify aspects that are in need for enhancement. Such information can be used in order to identify environmental targets and measure progress of achieving them (Ramos, 2018).

Accurate Pricing of Products and Services; By involving environmental costs in the cost of the product or the service, companies can determine more realistic pricing that reflects the real production cost and its impact on the environment.

Increasing Environmental Awareness; Calculating environmental costs contributes to increasing awareness of the importance of environmental matters and the impact of business activities within the organization or among stakeholders.

Contributing to Sustainable Development; Environmental costs aim to support sustainable development on the long term by encouraging companies to adopt ecofriendly practices that reduce the negative impacts on the environment and ensure a responsible resource consumption for next generations.

Enhancing Transparency and Accountability; Disclosing costs and performance enhances transparency and accountability toward stakeholders, including clients, investors, organizers, and the society.

Identifying Environmental Opportunities and Risks; It contributes to enhancing sustainable opportunities, such as developing environmentally friendly products and services, as well as reducing potential environmental risks that may lead to unbearable costs and harm the reputation of the company (Chen and Wang, 2016).

4. Quality Costs

4.1 The Concept of Quality Costs

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The concept of quality cost refers to the total expenses that an organization incurres in order to ensure producing products or providing services that meet customer requirements and specifications. In other words, this term refers to all costs related to preventing defects, assessing quality level, and treating failures that occur before or after delivering the product or service to the customer. In order to clarify the concept, it can be viewed from two aspects (Mishelle, Doorasamy,2016; Buccelli and Neto,2016); Ramos et al., 2021):

Cost of Effort to Ensure Quality: This perspective includes expenses of preventing problem occurrence and ensuring achieving quality, such as costs of quality training, designing operations and products in a way that ensures quality, and inspection operations.

Costs of Inability to Achieve Quality; This perspective includes costs resulting from failure to meet quality requirements, in addition to the occurrence of defects and errors, such as costs of rework to maintain the defective product, scrap and damaged merchandise, handling customer complaints, and loss of sales and reputation.

The core idea behind the concept of quality cost is that investment in problem prevention (prevention and assessment costs) costs less in the long term than correcting errors and defects (internal and external failure costs). To put it simply, it is possible to state that quality cost is not merely an additional cost, but it is an important investment to enhance performance, reduce waste, increase customer satisfaction, and enhance profitability on the long run. Understanding these costs and managing them in an active way is considered an essential part of total quality management. Quality cost is the total costs incurred by the organization to ensure producing products or providing services that meet customer requirements. They include all expenses related to preventing defects, assessing quality, and handling failures.

4.2 Types of Quality Costs (Chavalparit, 2006; Zainon, 2011; Vroom,2014):

Quality costs are usually divided into four major types (Shibelee and Naser, 2018):

Prevention Costs: They are the costs that are essentially spent to prevent the occurrence of defects. Such costs include quality planning, quality training of employees, designing products and processes to ensure quality, maintaining protective equipment, and assessing suppliers.

Appraisal Costs: They are the costs spent for assessing quality level and ensuring that the products or services are conformed to the specifications. Such costs include test and inspection of raw materials and end-products, standardization and checking inspection equipment, and quality checks.

Internal Failure Costs: They are the costs that result from discovering defects before delivering the product or service to the customer. Such costs include reworking to reproduce the defective products, scrap and damaged products, and retest and reinspect defective products that have been maintained, analyzing defects causes, and taking corrective measures.

External Failure Costs: They are the costs that result from discovering defects after delivering the product or service to the customer. Such costs include handling customer contemplates, maintaining or replacing the

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defective products as per insurance, return costs, loss of sales and reputation due to customer dissatisfaction, and lawsuits related to defective products.

4.3 Objectives of Quality Costs

The calculation of quality costs aims to achieve a set of important goals as follows (Aguilar et al., 2017; Van Hoof, 2013):

Identifying and Measuring Quality Costs; Accurate information regarding quality costs volume are provided. Providing Decision-Making Information; The administration can take informative decisions to enhance quality and reduce costs. Assessing Quality Maintenance Efforts; The extent of success of quality enhancement initiatives to reduce defect related costs is measured. Identifying Areas for Enhancement; Areas where the corporate incurs the highest costs because of defects in quality are identified. Increasing Awareness of the Importance of Quality; The quality financial effect on the corporate's profitability is highlighted. Improving Profitability; By reducing failure costs, the corporate can significantly improve its profitability. Enhancing Customer Satisfaction; Improving product and service quality leads to increasing the levels of customer satisfaction and loyalty. Improving Operational Efficiency; Focusing on quality often leads to facilitating operations and reducing waste.

5. Product Quality

5.1 The Concept of Product Quality

This concept refers to a set of features that determine the ability of a product to meet implicit and explicit customer expectations. In other words, product quality can be defined as the extent of conformity between the product and the specified features and standards, its ability to perform efficiently, and meeting customer satisfaction. Product quality can be viewed from various perspectives (Duflou and Kellens, 2016):

Performance: This dimension encompasses key product operational features, such as product speed, ease of use, and TV adds.

Features: This concept encompasses secondary or additional features that enhance the product benefit and attractiveness.

Reliability: This concept refers to the probability that the product will not malfunction or fail to perform its function within a specified period of time (Jain et al., 2017).

Conformance: It refers to the extent of conformance between the design and features of the product with the set features and standards.

Durability: It is the potential product operational age and its usability for a long time.

Serviceability: It is the ease of product maintenance and speed of handling customer contemplates.

Aesthetics: It is the sensory appearance of the product, such as design, colors, and shape that attracts senses.

Perceived Quality: It refers to the product reputation and trademark as perceived by customers based on prior experiences information about the product (Doorasamy, 2014).

6. The Analytical Framework

6.1 Environmental Efficiency

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This concept aims to minimize the environmental damage associated with the production and use of each product throughout its entire life cycle. Environmental efficiency is applied to reduce environmental impacts in order to achieve a certain level of economic results with the fewest undesirable environmental side effects. Environmental efficiency aligns closely with the current main objectives and approaches of cleaner production. Environmental-economic efficiency focuses on the relationship between economic performance and environmental costs, such as the added value of a product or process divided by its added environmental impact. Environmental-economic efficiency aims to achieve an acceptable level of economic performance to yield the best possible economic results from a given level of environmental impact. Environmental efficiency contributes to reducing environmental pollution and using ecofriendly raw materials instead of harmful ones.

Environmental cost = Quantity of production / Quantity of waste and emissions

6.2 Efficiency

Efficiency is a behavior, not a technical method. It tends towards an approach of environmental responsibility and is usually linked to the personal philosophy of individuals, not to the philosophy of the potential economic unit. In other words, it represents an environmental awareness of individuals. Therefore, efficiency adopts the goal of achieving cleaner production.

Efficiency effectiveness = Achieved goals / Planned goals

6.3 Productivity

Productivity is an average measure of production efficiency, representing the ratio of an output measure to a measure of some or all of the resources used to produce that output. In this way, one or more input measures can be taken and compared to one or more output measures.

Productivity = Output / Input

Table (1) Design capacity, available capacity, planned and actual production of the National Company for Chemical and Plastic Industries (2018-2022)

Year	Design Capacity	Available Capacity	Planned Production	Actual Production	The ratio between planned and actual production for the previous year	The ratio between actual production to			The ratio of change in production
						Design	Available	Planned	
2018	62099	45105	4470	1190	276.9	73%	84.0%	26%	33%
2019	57559	41191	3820	1144	1190	72%	53%	36%	74%
2020	111056	80278	1350	9079	1144	72%	5.1%	39%	71%
2021	62342	45281	3450	12628	9079	73%	61.5%	38%	41%

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2022	111055	75886	3400	1846	12628	68%	4.5%	54%	31%
Mean	80822.2	57548.2	3298	5177.4	4863.58	71%	42%	39%	50%
Maximum	111056	80278	4470	12628	12628	73%	84%	54%	74%
Minimum	57559	41191	1350	1144	276.9	68%	4%	26%	31%

Reference: The researcher based on financial reports published in the Iraq Stock Exchange for the period (2018-2022)

The table shows that the design capacity is the ability of the National Company for Chemical and Plastic Industries to produce large quantities of (sponge, agricultural covers, bags, pallets, and containers) if its capabilities and production capacity are utilized. The available capacity represents the number of units that can actually be produced based on the availability of the specified quantities of materials, personnel, and machinery, while also taking into account production losses and delays. The planned production is the planned manufacturing process for the production units at the National Company for Chemical and Plastic Industries, while the actual production is the quantity produced by the company. The ratio of actual production to planned production for 2019 is 74%, which is a good percentage for the company. However, in 2022, the production ratio decreased to 31% compared to 2019. This decrease is attributed to fluctuations in demand for the products of the company.

Table (2) Environmental Cost = Quantity of Production / Quantity of Waste and Emissions for the National Company for Chemical and Plastic Industries (2018-2022)

Year	Production Quantity	Waste and Emission Quantity	Percentage
2018	1190	148542	1%
2019	1144	149271	1%
2020	9079	5527016	0.2%
2021	12628	150000	8%
2022	1846	140000	1%
Mean	5177.4	1222965.8	2%
Maximum	12628	5527016	8%

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Minimum	1144	140000	0.2%

Reference: The researcher based on financial reports published in the Iraq Stock Exchange for the period (2018-2022).

In light of the above, the nature of the factory and the accounting system used in the National Company for Chemical and Plastic Industries in calculating the costs of the quantity of waste and emissions were identified. Also, the cost per ton for sponge, agricultural covers, bags, pallets, and containers and the production and service departments in the factory were identified. After identifying the nature of the company's work and visiting the relevant departments to calculate the costs, the researcher observed that there is a disclosure and measurement of environmental costs and the possibility of controlling them by applying cleaner production through the financial data published in the Iraq Stock Exchange. The environmental efficiency of the National Company for Chemical and Plastic Industries is 2%, indicating a low level of environmental efficiency. This occurs due to an increase in both waste and product output while inputs remain constant. Reducing waste means minimizing the waste of raw materials and converting as much of them as possible into finished products. Therefore, the amount of waste generated during the production stages should be reduced. Once the waste has been identified, a study and treatment process will commence. The National Company for Chemical and Plastic Industries recorded its highest rate in 2021 due to a decrease in waste and emissions, while the lowest rate (0.2%) was recorded in 2020 due to an increase in waste and emissions.

Identifying waste with an environmental impact helps the economic unit control it. To achieve this, it is essential to determine the quantities of input materials at each stage of production of sponge, agricultural covers, bags, pallets, and containers, as well as the quantities of outputs produced at each stage.

Table (3) Efficiency Effectiveness = Achieved Goals / Planned Goals for the National Company for Chemical and Plastic Industries (2018-2022)

Year	Achieved Targets	Planned Targets	Implementation Rate
2018	1190	4470	27%
2019	1144	3820	30%
2020	9079	1350	673%
2021	12628	3450	366%
2022	1846	3400	54%
Mean	5177.4	3298	230%

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Maximum	12628	4470	673%
Minimum	1190	1350	27%

Reference: The researcher based on financial reports published in the Iraq Stock Exchange for the period (2018-2022).

The table above illustrates the achieved and planned targets for the production process of sponge, agricultural covers, bags, pallets, and packaging at the National Company for Chemical and Plastic Industries. The effectiveness of efficiency can be determined by the difference between the achieved and planned targets, which indicates the degree of efficiency. The company recorded its highest achieved target of (12,628) in 2021 and its lowest target of (1,190) in 2018. Conversely, the company's highest planned target of (4,470) was recorded in 2018 and its lowest target of (1,350) in 2020. The highest implementation rate was recorded in 2020 at (673%) due to the high number of achieved targets, while the lowest implementation rate was recorded in 2018 at (27%) due to the high number of planned targets.

Table (4) Productivity = Outputs / Inputs for the National Company for Chemical and Plastic Industries (2018-2022)

Year	Outputs	Inputs	Percentage
2018	2701063	3135704	86%
2019	3840984	3384862	113%
2020	4897126	3780278	130%
2021	4275255	3449555	124%
2022	3912310	3660618	107%
Mean	3925347.6	3482203.4	112%
Maximum	4897126	3780278	130%
Minimum	2701063	3135704	86%

Reference: The researcher based on financial reports published in the Iraq Stock Exchange for the period (2018-2022).

The table illustrates the input and output costs and quantities for the production process of sponge, agricultural covers, bags, pallets, and packaging at the National Company for Chemical and Plastic Industries. Environmental costs are determined by the difference between production inputs and outputs, which reflects the amount

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of waste and spoilage resulting from production processes. This waste takes the form of deposits, gases, or damaged materials. If it is left untreated, it causes environmental damage. The highest percentage (130%) was recorded in 2020 due to increased output (revenue) from the company's industrial processes. The lowest percentage (86%) was recorded in 2018 due to increased input costs, which led to higher company expenses such as salaries, wages, goods and services, raw material purchases, and other processing costs.

7. Conclusions and Recommendations

7.1 Conclusions

1. When clean production is adopted, the volume of pollution gradually decreases. This is due to compliance with environmental standards imposed by government entities, such as fines and penalties for pollution, and improved relationships with environmental agencies and the community. Consequently, it increases the profitability and competitiveness of the economic unit. These resulting benefits outweigh the costs of waste management.
2. Commercial units show little interest in measuring environmental quality costs, which are crucial for preserving the environment and sustaining its resources. Furthermore, they lack interest in disclosing these environmental quality costs in their financial reports.
3. The company in the research sample shows little interest in measuring the environmental costs related to the damage it causes to surrounding areas, including pollution and diseases. This represents a significant environmental cost. Additionally, the Ministry of Industry shows little interest in reducing the pollution caused by the company in the research sample.
4. Economic support for resources used as inputs in the factory becomes an important factor for clean production. For example, if the government subsidizes the prices of polluting fuels, it will reduce the financial benefits of cleaner production.
5. Cleaner production, characterized by environmental and economic efficiency, can be implemented to reduce environmental costs through the optimal use of natural resources and energy conservation, thereby achieving a sustainable competitive advantage.
6. Clean production, achieved by using clean energy and raw materials, advanced technology and equipment, improved management and integrated utilization, pollution reduction at the source, and improved resource utilization, eliminates harm to human health and the environment.

7.2 Recommendations

1. Commercial units shall measure environmental quality costs by separating and distinguishing them from other costs to inform decision-making that serves the environment in which they operate.
2. Environmental quality costs shall be disclosed through dedicated reports presented and organized logically and clearly to facilitate understanding by users.
3. The company under study should adopt high-level training programs and courses that explain environmental quality costs and how to categorize them into environmental prevention costs, environmental assessment costs, and environmental failures, whether internal or external.

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4. The company under study should intensify its efforts in measuring and disclosing environmental quality costs in an easily understandable manner, providing crucial information that helps improve its environmental performance by directing spending appropriately towards prevention and assessment costs to minimize failure costs.
5. Implementing environmental efficiency measures at the National Company for Chemical and Plastic Industries contributes to increasing the environmental efficiency ratio, reducing pollution and gaseous emissions, and consequently improving product quality.
6. It is essential to encourage academics, professionals, and economic entities to conduct further studies and research in the field of measuring and disclosing environmental quality costs to improve environmental performance, contribute to the sustainability of their resources, and enhance product quality.

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