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Environmental Quality Cost Management as an Approach to Achieving Sustainability in Healthcare Institutions

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Abstract. *.This study addresses the importance of environmental quality cost management as modern tool that contributes to supporting environmental sustainability practices in healthcare .a institutions. The increasing environmental challenges associated with medical waste and polluting emissions have prompted healthcare institutions to seek effective solutions to control environmental ,costs and comply with regulatory standards. The study reviewed concepts related to the environment cost management, environmental costs, and environmental quality costs, in addition to approaches to their accounting measurement and disclosure. The study concluded that integrating cost management and environmental trends improves operational efficiency, enhances compliance, and strengthens the organization's public image, bringing it closer to achieving the status of a "green The researcher adopted a descriptive and analytical approach, studying the ".healthcare institution reality of cost management and treatment technologies in the hospital and analyzing data such as quality costs, waste volume, environmental performance, and Their impact on achieving green health institutions. Among these indicators are the energy consumption index, the energy cost index , the water consumption index , and the water cost index, etc. Among the most important findings are a gradual increase in the costs of quality that add value (prevention and evaluation) and a decrease in the costs of internal failure. The analysis also revealed that the medical waste treatment unit accounted for the highest percentage of prevention costs, indicating its pivotal impact in supporting environmental sustainability and reducing health risks within the hospital, especially after the .introduction of new sorting and treatment technologies in 2023.*

Keywords*: Environmental quality؛ cost management؛ environmental costs؛ sustainability*

1. INTRODUCTION

Environmental quality costs (EQCs) are a necessary investment to ensure the continuity of healthcare institutions' operations, enhance their ability to excel, and achieve their sustainable goals. They form the basis of preventing environmental pollution from medical and hospital waste, as these wastes require sorting, transportation, storage, and treatment, in addition to high disposal costs. Environmental considerations for healthcare institutions require the adoption of modern medical waste disposal methods, contributing to the achievement of green healthcare institutions. This approach ensures effective and appropriate management of EQCs. EQCs play a pivotal role in the

optimal use of resources, which is essential for achieving sustainable development and environmental conservation. The efficient use of resources contributes to creating a healthy and safe environment while reducing waste and harmful emissions. EQCs represent an approach aimed at reducing environmental costs by rationalizing expenditures and reducing waste. They also focus on reducing internal and external failure costs by increasing spending on assessment and prevention costs, which supports operational efficiency and reduces negative environmental impact. Environmental quality cost management (EQC) refers to the process of identifying, analyzing, evaluating, and managing the costs associated with the environmental aspects of a healthcare organization by balancing the costs and benefits associated with implementing sustainable environmental practices. To achieve the research objectives, the research was organized into four chapters covering both theoretical and practical aspects. The first chapter, titled "Research Methodology and Previous Studies," consists of two sections: the first section, "Research Methodology," and the second section, "Previous Studies and Their Contributions to the Current Research." The second chapter, titled "Environmental Quality and Treatment Technologies Towards Green Healthcare Institutions," was devoted to the theoretical aspect. It was divided into three sections. The first section addressed the cognitive foundations of EQC management, while the second section addressed the cognitive foundations of medical waste treatment technologies. The third section addressed the cognitive foundations of green healthcare institutions. The third chapter, titled "Measuring Environmental Quality Costs and Medical Waste Treatment Technologies in Enhancing Green Performance in Healthcare Institutions," was devoted to the practical aspect. The first chapter discussed the description of the study sample, while the second chapter discussed measuring quality costs, and the third chapter discussed medical waste treatment techniques in enhancing the hospital's green performance, testing research hypotheses, and analyzing the results. The fourth chapter dealt with the conclusions and recommendations, which were divided into two separate chapters. The first chapter included the conclusions, while the second chapter included the recommendations.

2. Materials and Methods

2.1. theoretical materials

2.1.1. The problem of the study

With the increasing challenges facing healthcare institutions around the world, medical waste management has become a vital aspect of ensuring environmental and health sustainability. Managing the environmental quality costs of medical waste treatment is essential to achieving this sustainability, as it presents a range of challenges and opportunities that directly impact the efficiency of healthcare institutions and their impact on the surrounding environment.

The fundamental challenge lies in the delicate balance between ensuring compliance with stringent environmental standards and reducing the operational costs of medical waste treatment. This qualitative and quantitative challenge provides an opportunity to examine the impact of environmental cost management on healthcare organizations' ability to transition to green sustainability. Based on the above, the research problem can be summarized as follows: **“How do environmental quality cost management and medical waste treatment technologies contribute to achieving sustainability for Al-Furat Al-Awsat Teaching Hospital?”** Based on this question, several questions can be formulated:

1. How does environmental quality cost management contribute to enhancing the green performance of Al-Furat Al-Awsat Hospital?

2. How do medical waste treatment technologies contribute to enhancing the green performance of Al-Furat Al-Awsat Hospital?

2.1.2. Objectives of the study

This research aims to achieve the following:

1. Understanding the impact administration costs Quality Environmental.
2. Clarification relationship between administration costs Quality Environmental and technologies Modern To process waste Medical And its role in investigation performance Green To the hospital Euphrates Middle East.

2.1.3. Importance of the study

1. Highlighting the relationship between cost management and environmental quality, which helps achieve efficient use of resources.
2. Contributing to reducing the negative environmental impact of medical waste and improving the environmental performance of healthcare facilities.
3. Highlighting the importance of achieving sustainable development in healthcare institutions through responsible environmental practices.

2.1.4. Study hypothesis

The research attempts to verify the following hypotheses:

1. The application of environmental quality management enhances the level of green performance at Al-Furat Al-Awsat Hospital.
2. There is a significant impact of applying medical waste treatment technologies on the green performance level of Al-Furat Al-Awsat Teaching Hospital.

2.1.5. study Methodology

To achieve the research objectives and test its hypotheses, this research will rely on the inductive, deductive, and applied approaches. The inductive approach will be used to study the theoretical aspect by analyzing relevant Arab and foreign studies and research on this topic. As for the deductive approach, it will be applied in the practical aspect to study the role of environmental quality cost management and medical waste treatment technologies in achieving green healthcare institutions through their application in healthcare institutions represented by Al-Furat Hospital. This is to address the research problem and test its hypotheses. The researcher will also use the applied approach to apply environmental quality cost management tools to the research sample data to reach a solution to the study problems. The researcher relied on the financial data of Al-Furat Hospital located in Najaf Governorate. The time period during which the data was collected is (2021-2022-2023-2024).

2.1.6. study References:

A variety of studies were used, including the following:
1. Theoretical sources: These include books, articles, Arabic and foreign master's theses, and many Arabic and foreign academic dissertations related to the topic under study.
2. SPSS statistical analysis program were used to test the hypotheses.

2.1.7. Limitations of the study

Researchers often face many obstacles while writing academically, including the following:
1. Difficulty accessing reliable sources due to the novelty of the topic. The role of environmental quality cost management and medical waste treatment technologies in achieving green performance levels in healthcare institutions.
2. Time constraints, which represent a major challenge for the researcher during the writing process.
3. The researcher is committed to avoiding unauthorized quotations and ensuring the use of accurate scientific methods.

2.1.8. Previous studies

1.Arab related to quality costs studies

The details	Statement	Seq
, Hamdan and Shahada 2020	**the study**	**1**
The role of green supply chain activities in managing environmental quality costs: an applied study in a gas bottling .company	Study title	**A**
A gas filling company/public company was selected as a sample .for the research	Study sample	**for**
Research for an applied study in a gas filling company / published in the Journal of the City of Science College	Type of study	**T**
The study aimed to identify the activities of the green supply chain and to demonstrate their impact on managing environmental quality costs in a gas filling company in a way that helps reduce the costs of external and internal failure by giving importance to the costs of evaluation and prevention.	Study objective	**Th**
The 2016 data on the company's environmental conservation costs was used, which included a set of costs in the sample company, namely prevention costs (including research and ,development costs, maintenance of gas machines and equipment and employee training), evaluation costs (including engineering ,inspection costs, environmental equipment depreciation costs and laboratory testing costs), as well as internal failure costs including valve repair costs, employee treatment costs, raw) material damage costs, cylinder mishandling costs, cylinder	Measurement indicators	**C**

,storage costs, water pollution treatment costs, waste/stack costs and inventory damage costs), as well as external failure costs including remanufacturing costs, impurity costs, and poor) .(handling costs The percentage of the cost of each type of total environmental quality costs was shown, and a study was conducted of which .costs require more importance and attention		
:The most important conclusions of this study were as follows The economic unit's adoption of green supply chain activities -1 helps create a competitive advantage as well as achieve .appropriate environmental cost management After calculating the environmental quality costs for the -2 research sample unit, it became clear that the costs of failure, both external and internal, constituted 98% of the total costs at the .supply chain level	The most important conclusions	**H**

2 . Previous Arab studies related to green health institutions

Study details	Statement	Seq
Tayr ,and Oqoon 2024	**the study**	**1**
:The reality of applying green practices in health institutions a case study of health institutions in the city of Constantine	**Study title**	
The study community consists of health institutions in the state ,of Constantine. A non-random, intentional sample was selected .including 10 public health institutions	**Study sample**	
An applied study, research published in the Namaa Journal of Economics and Trade	**Type of study**	
To identify the level of green building application in health ;institutions in Constantine • Identifying the level of green purchasing application in health .institutions • Identify the level of application of energy management in .healthcare institutions • Identify the level of application of water management in health .institutions • To identify the level of application of green waste management ;in health institutions in Constantine	**Study objective**	

The descriptive analytical approach was adopted, where information related to the theoretical and applied aspects is described and analyzed. The statistical approach was used in the .applied aspect	**Measurement indicators**	
It is to enhance the influence on local government and policy makers about the importance of green practices, in addition to requesting interventions to support these initiatives. This requires a serious commitment from all parties, including health institutions, government, and society as a whole. The costs and benefits should also be considered in the long term, using a .model An economist shows how investing in green practices can help reduce operating costs; it also needs to focus on To build a positive culture that supports green practices by .motivating employees to commit practices, by With these providing training opportunities and continuing education. Finally, a continuous monitoring system must be ensured to evaluate the environmental performance of institutions, thus contributing to the effective and .sustainable preservation of the environment and human health	**The most important conclusions**	

2.2. Methods

2.2.1. The concept of the environment and its importance

The environment is an integrated biological system comprising diverse biotic and abiotic components that surround living organisms and provide them with the means to live and survive. This ecosystem has been passed down from generation to generation as a shared heritage, constituting an essential and indispensable element for any living being. However, the rapid industrial and technological developments witnessed by the world, accompanied by an unprecedented increase in the consumption of natural resources, have led to an exacerbation of environmental pollution, posing a major threat to environmental sustainability and the health of all living organisms [1].

2.2.2. Managing environmental quality costs

A. Cost concept

Cost management is one of the fundamental measures managers adopt to achieve customer satisfaction on the one hand, and to reduce and continuously monitor costs on the other. In order to invest the organization's resources efficiently, a vast amount of financial and non-financial information is required, which is generated through the accounting systems within the economic unit. The optimal investment of these resources contributes to achieving management objectives, and this

is achieved through the information provided by cost management, which is the primary task of the economic unit's accounting system [2].

b. Cost management concept

Cost is a fundamental concept in accounting. It represents the expenses incurred by an economic unit to produce goods or provide services for sale in markets. It is also defined as the flow of funds from an economic unit with the aim of generating a financial return when those goods or services are sold. The production of goods and services requires a variety of costs, which vary in nature and classification. These costs include several types, including: direct (or explicit) costs, indirect (or implicit) costs, in addition to fixed, variable, accounting, and economic costs, in addition to total, average, opportunity costs, and operating costs [3].

Cost is defined as the resource that is sacrificed or given up achieving a specific goal, and cost - such as the cost of labor or advertising - is often measured by the monetary amount that must be paid to obtain a good or service [4].

C. The concept of environmental quality

The technological revolution and the modern manufacturing environment have contributed to the development of cost accounting and the emergence of the concept of cost management and its techniques. These techniques have facilitated the use of advanced technologies, such as electronic mechanization and flexible and automated manufacturing systems. Recent research has focused on developing cost management methods to enhance competitiveness, but it has often been limited to the internal aspects of economic units without addressing the external collaborative dimensions. Cost management systems aim to determine the cost of products and services using methods that enable the study of the impact of management decisions on costs, while employing a combination of financial and non-financial information to improve performance, raise productivity, and enhance quality [5].

Horngren defines cost management as “a set of methods and activities within an economic unit that managers adopt to use resources to increase customer value and achieve the economic unit’s objectives” [6]. In another definition, he indicated that it is: “a set of actions taken by managers to control costs, reduce them, and achieve customer satisfaction” [7].

In this context, the primary goal of environmental quality cost management is to improve economic efficiency by reducing the environmental costs associated with production processes. Achieving this goal requires the application of advanced cost management practices, including environmental cost analysis and identifying sources of environmental loss [8]. "Identifying and estimating environmental costs enables organizations to identify sources of waste and analyze opportunities to improve operations and reduce associated costs." The concept of environmental costs: The idea of environmental costs emerged in the late twentieth century, coinciding with the consolidation of the concept of sustainable development, launched by the World Commission on Environment and Development in its 1987 report, "Our Common Future." This concept was further developed during the Stockholm Conference in 1974 and later at the Rio Summit, which addressed the issue of sustainable development and the environment more broadly [9]. Environmental costs are a result of economic activity, arising from the use and protection of natural resources, and are directly linked to efforts to reduce pollution and dispose of waste that harms the environment. Therefore, they represent necessary expenditures allocated to preserving the environment and reducing environmental problems such as pollution, which requires economic units to include them within their operational interests in line with the nature of their activities [10].

First: Direct environmental costs

These costs include expenditures on waste and polluted water treatment processes, which can be directly attributed to specific environmental activities. As [11]. point out , direct costs relate to the actual actions taken to manage waste and emissions.

These costs are defined as the expenses incurred by an economic unit to mitigate environmental damage, whether as a result of compliance with environmental laws and regulations or the implementation of internal environmental policies. These costs may also include multiple aspects, such as production costs related to environmental conservation, waste treatment costs, environmental risk costs, and the impact on the facility's environmental reputation [12].

It also includes costs related to treating and preventing emissions and waste, environmental management costs, in addition to the costs of unproduced materials and their treatment methods, as waste is considered an environmentally harmful output [13].

Second: Indirect environmental costs

Indirect costs are those that cannot be directly linked to a specific environmental activity, such as the costs of training employees in environmental practices and developing environmental management systems [14]. These costs are expenses associated with strengthening environmental capabilities within the organization. Environmental costs are part of social costs, which are divided into:

Direct social costs: These are the costs that the economic unit bears voluntarily to protect the environment from the negative effects of its activities, or those that are spent within programs that comply with environmental legislation and regulations [15].

Indirect social costs: These are costs borne indirectly by society as a result of the actions of individuals or organizations. These include environmental and health damages that are not reflected in the direct financial costs of those organizations [16]. They are defined as "costs that are not included in corporate expenditures but affect societal well-being, such as air pollution and its impact on public health and the environment.

2.2.3. Green Performance in Healthcare Institutions

1. Green healthcare concepts

Green healthcare facilities are defined as those that implement sustainable practices in design, construction, and operation to conserve natural resources and reduce pollution, according to the Federal Office of Environmental Management [17]. According to the Green Guide for Health [18]. these practices include careful site selection, water and energy efficiency, the use of renewable materials, waste reduction, and enhanced natural lighting. Studies indicate the need to adhere to environmental standards throughout a building's life cycle, from planning to operation [19]. ensuring the provision of high-quality healthcare services in an environmentally friendly environment.

2. The importance of achieving green healthcare institutions

Green healthcare organizations play an important role in protecting the environment by reducing emissions and waste and using natural resources efficiently [20]. They also contribute to promoting sustainability by reducing water and energy consumption [21]. and improving air and water quality within facilities [22]. These organizations reflect a clear social responsibility toward the community by providing environmentally friendly healthcare services.

3. Green performance indicators and their environmental sources

Environmental performance indicators are used to measure an organization's commitment to sustainable practices and include:

Energy and emissions indicators: such as energy intensity and renewable energy use [23].

Water and waste indicators: such as water use efficiency and recycling rates [24].

Environmental compliance indicators: such as the number of environmental violations and the percentage of recycled materials [25].

4. Goals of green healthcare institutions

These institutions aim to promote public health and environmental sustainability by:

These institutions aim to promote public health and environmental sustainability by:

1. Sustainable management of medical waste through environmentally friendly technologies [26].
2. Rationalizing resource consumption by using renewable materials and recycling systems [27].
3. Improving air and water quality using non-toxic materials and natural ventilation designs [28].
4. Commitment to environmental activities that support social and environmental responsibility [29].
5. Commitment to green building standards and obtaining international certificates [30].

4. Applied study

4.1. Environmental Quality Management and its Role in Improving Green Performance in the Hospital

A. The Role of Environmental Quality Management in Improving Green Performance in Healthcare Institutions: A Case Study of Al-Furat Al-Awsat Teaching Hospital (2022-2024)

This study analyzes the role of environmental quality management in enhancing green performance at Al-Furat Al-Awsat Teaching Hospital, by tracking quality cost components for the period from 2022 to 2024. It focuses on classifying these costs into four main categories: prevention costs, appraisal costs, internal failure costs, and external failure costs. It also takes into account the nature of healthcare services, which differ from manufacturing industries in terms of the intangible nature of services and the difficulty of measuring their quality or conforming to standards.

The importance of this study lies in revealing the impact of environmental quality management and its costs on reducing failure rates and improving the efficiency of healthcare service delivery, thus contributing to the realization of the concept of "green healthcare institutions" in Iraq. Healthcare services are more complex in terms of measuring their quality, as they cannot be restored, as is the case with industrial products, if they do not meet beneficiaries' expectations.

The study also highlights the difficulty of accurately defining quality cost categories due to the service-oriented nature of the health sector. In its applied aspect, the study presents the distribution of these costs according to the four categories, starting with the category of prevention costs.

A prominent example of prevention costs in hospitals is the medical waste treatment unit, which serves as a major center for infectious disease prevention, hospital contamination control, and health awareness. The costs of this unit are divided between prevention costs and assessment costs based on the nature of the activities it conducts, with half of the costs allocated fairly to each category. Details of these costs are provided in Table (1) of the study.

Table 1. Costs of the medical waste treatment unit (1)

Cost elements	2022	2023	2024	rate of change
Employee salaries	17,892,000	13,305,600	35,000,000	%196
Rental of transportation vehicles (waste (transport	16,500,000	14,400,000	12,420,000	%75

Purchase sharp waste containers	16,575,000	12,450,000	10,325,000	%62
Buy yellow bags	6,850,000	4,320,000	3,875,000	%57
cleaning materials	29,850,000	22,435,000	20,525,000	%69
Sterilizers	10,973,000	14,164,500	16,425,230	%150
Device maintenance	635,000	1,220,500	2,475,000	%390
Buying devices	685,000	2,675,500	3,465,200	%506
furniture	325,000	950,000	1,240,000	%382
Furniture	250,000	750,000	1,310,000	%524
stationery	125,000	175,000	185,000	%148
the total	100,025,000	86,846,100	107,247,454	%107

Source: Prepared by the researcher based on hospital records over the years of research

Table (1) showed a 196% increase in the employee salaries item, which can be explained by an increase in the number of employees, a raise in wages, or the creation of new units that required the appointment of additional staff. The transportation rental item witnessed a 75% decrease, likely a result of reduced reliance on taxis for transporting medical waste following the adoption of more efficient internal or alternative means of transportation.

Regarding the expenditure on purchasing sharp waste containers, it decreased by 62%, indicating improved waste management procedures, or perhaps the possibility of reusing some containers while adhering to sterilization and safety procedures. Expenses for purchasing yellow bags decreased by reflecting improved waste sorting at the source, which reduced the need for large quantities of ,%57 these bags.

,Regarding cleaning materials, despite a 69% decrease, spending levels remain relatively high indicating a continued focus on hygiene as an essential component of maintaining a safe and healthy environment. Sterilizers saw a 150% increase, an increase that can be explained by the tightening of health and infection control protocols, especially in the post-pandemic context. Equipment maintenance saw a sharp increase of 390%, indicating increased malfunctions or greater reliance on equipment for daily work, necessitating increased maintenance operations. Equipment purchase expenses increased by 506%, reflecting the expansion of operations departments and their equipping with new equipment such as modern sterilization machines (autoclaves). Furniture increased by .likely to improve the work environment or furnish new units within the healthcare facility ,%382 Furniture expenses increased by 524%, which may be linked to updating office equipment or enhancing the work environment to support administrative and operational functions. The increase in stationery costs reached 148%, a moderate increase that reflects the expansion of administrative activities and the increased need for paper documentation.

Looking at total costs, we find that they increased by 107%, indicating the organization's focus on essential investments in areas such as maintenance, equipment, and human resources. This trend can be considered a strategic step within the framework of preventive costs, which aims to enhance the environmental and health performance of the healthcare organization in a sustainable manner.

Table 2. Total report of quality cost categories in the hospital during the study years

The details	2022	2023	2024
Prevention costs	119,763,466	123,614,338	149,642,354

Prevention costs/total quality costs ratio	79%	84%	89%
Evaluation costs	5,171,870	9,839,300	8,474,166
Evaluation costs ratio / total quality costs	3%	7%	5%
Costs of internal failure	25,750,000	14,040,000	10,175,000
Internal failure costs/total quality costs ratio	17%	10%	6%
Total quality costs	150,685,336	147,493,638	168,291,520
Total health service costs	10,213,002,355	11,906,972,372	10,677,231,212
Quality costs/total health costs ratio	1%	1%	2%

Source: Prepared by the researcher

Table (2) shows that the quality costs during the research years were for the year 2022 in the amount of (150,685,336) dinars, while they decreased in the year 2023 to (147,493,638) dinars, to rise in the year 2024 and reach (168,291,520) dinars, as it is noted that they decreased in the year 2023 and rose again in the year 2024, and this is due to the increase in quality costs that add value from (prevention costs and evaluation costs) and interest in preventive measures and continuous examination processes to ensure the provision of a suitable health environment for patients, as it is noted from the results of the table above that the percentage of prevention and evaluation costs to the total quality costs was high and the percentage of internal failure costs was decreasing during the .study years, and these percentages are shown in Table (3)

Table 3. Ratio of quality cost categories/total quality costs for research years

costs	2022	2023	2024
Prevention costs	80%	83%	89%
Evaluation costs	3%	7%	5%
Costs of internal failure	17%	10%	6%
the total	1.00	1.00	1.00

Source: Prepared by the researcher

B. The role of medical waste treatment technologies in enhancing environmental performance in the hospital

Measuring environmental performance indicators in the hospital

Environmental performance indicators are effective tools for assessing hospitals' commitment to sustainable environmental practices. These indicators include:

1. Energy efficiency: Measuring the amount and cost of energy consumed, which contributes to reducing the carbon footprint and improving operational efficiency.
2. Water use efficiency: measuring the amount and costs of water consumed and recycled.
3. Medical waste management: Assessing the amount of solid medical waste produced and the costs of disposing of it safely.

4. Recycling practices: as an indicator of environmental commitment and achieving a balance between operation and environmental efficiency.
5. Green Building Design: By adopting sustainable engineering principles in the construction and operation of healthcare facilities, Al-Furat Al-Awsat Teaching Hospital adopted nine green performance indicators, based on available data, to form an effective framework for monitoring and improving environmental sustainability.

Table 4. Coding of green performance indicators used in the study

T	Indicators	The symbol	Unit of measurement
1.	Electricity consumption(kWh) per month	ELC	kilowatt
2.	Electricity cost (dinar)	CEL	Dinar
3.	Fuel quantity (liters)	Ful	liter
4.	Fuel cost (dinar)	CFUL	Dinar
5.	Quantity of water consumed (m^3)	WQU	m^3
6.	Water cost (dinar)	WAC	Dinar
7.	Reused water (m^3)	RCW	m^3
8.	Waste volume (kg)	WAS	kg
9.	Waste disposal cost (dinar)	CWD	Dinar

Components of the hypothetical model:
Medical Waste Treatment Technologies (MWP) Independent Variable
Dependent variables:

Electricity Consumption (ELC)
Cost of Electricity (CEL)
Fuel Quantity (FUL)
Fuel Cost (CFUL)
Water consumption (WQU)
Water Cost (WAC)
Recycled Water Quantity (RCW)
Waste volume (WAS)
Cost of waste disposal (CWD)

The following provides details of the measurement of the main green performance indicators in the research sample hospital for the period from 2021 to 2024, on a monthly basis, as well as the totals for each indicator for the years covered by the current study, as follows:

1. Measuring electricity consumption

Table (5) below shows the results of measuring the monthly electrical energy consumption index for Al-Furat Al-Awsat Teaching Hospital during the study period 2021-2024

Table 5. Measurement of the hospital's monthly electrical energy consumption index (kilowatts)

The most famous	2021	2022	2023	2024
January	143,000	130,000	127,235	121,176
February	137,500	125,000	127,235	121,176

March	154,000	140,000	141,372	134,640
April	159,500	145,000	141,372	134,640
May	176,000	48,000	141,372	134,640
June	187,000	170,000	169,646	161,568
July	192,500	175,000	169,646	161,568
dad	198,000	180,000	169,646	161,568
September	176,000	48,000	141,372	134,640
October	165,000	150,000	141,372	134,640
November	154,000	140,000	141,372	134,640
December	148,500	135,000	127,235	121,176
the total	1,991,000	1,810,000	1,738,876	1,656,072

Source: Prepared by the researcher based on hospital records.

Table (5) shows the monthly electrical energy consumption at Al-Furat Al-Awsat Teaching Hospital during the period from 2021 to 2024. The data shows a gradual and noticeable decrease in the annual electrical energy consumption, reflecting the impact of the implementation of medical waste treatment technologies starting in 2023, which contributed to improving operational efficiency. Total annual consumption before the implementation of the technology in 2021 amounted to approximately 1,991,000 kilowatt-hours, and decreased in 2022 to 1,810,000 kilowatt-hours, a decrease of **9.1%** . After the introduction of the treatment technology, consumption in 2023 amounted to 1,738,876 kilowatt-hours, followed by a further decrease in 2024 to 1,656,072 kilowatt-hours, representing an overall decrease of approximately**16.8%.** .During the study period

Thus, these results confirm that the implementation of medical waste treatment technologies not only achieves environmental benefits by reducing waste-related damage, but also positively impacts the hospital's financial efficiency by reducing electricity consumption and associated costs. This reinforces the hospital's drive to adopt sustainability standards and transform into a green healthcare institution.

2. Measuring the cost of electricity consumed

the monthly electricity consumption cost index for Table (6) below shows the results of measuring Al-Furat Al-Awsat Teaching Hospital during the study period 2021-2024

Table 6. Measurement of the monthly consumed electrical energy cost index (dinars)

The most famous	2021	2022	2023	2024
January	4,290,000	3,900,000	3,817,044	3,635,280
February	4,125,000	3,750,000	3,817,044	3,635,280
March	4,620,000	4,200,000	4,241,48	4,039,200
April	4,785,000	4,350,000	4,241,48	4,039,200
May	5,280,000	4,800,000	4,241,48	4,039,200
June	5,610,000	5,100,000	5,088,342	4,846,040
July	5,775,000	5,250,000	5,088,342	4,846,040
dad	5,940,000	5,400,000	5,088,342	4,846,040
September	5,280,000	4,800,000	4,241,48	4,039,200
October	4,950,000	4,500,000	4,241,48	4,039,200
November	4,620,000	4,200,000	4,241,48	4,039,200
December	4,455,000	4,050,000	3,817,044	3,635,280
the total	59,730,000	54,300,000	52,163,118	49,679,48

.Source: Prepared by the researcher based on hospital records.

Table (6) shows that the total cost of electricity consumed (CEL) in the hospital in the years 2021 and 2022, which are the years preceding the application of medical waste treatment technology, amounted to (59,730,000) and (54,300,000) dinars , respectively, while the total cost of electricity consumed (CEL) in the hospital in the years 2023 and 2024 amounted to Which followed the implementation of waste treatment technology (52,163,118) and (49,679,48) dinars, respectively . There has been a gradual decrease in the cost since 2021. After the introduction of the technology in 2023, the cost decreased by approximately -7.7%. Between 2022 and 2024. As for the savings achieved, approximately 4,620,520 dinars between 2022 and 2024. This is due to technology contributing to improved efficiency and reduced energy consumption of appliances.

3. Impact analysis

The second main hypothesis(H2) examines the impact of applying medical waste treatment technologies on the green performance of Al-Furat Al-Awsat Teaching Hospital. The following :are the results of testing this hypothesis .

The second main hypothesis(H2) There is a significant impact of applying It states that **medical waste treatment technologies on the green performance level of Al-Furat Al-Awsat Teaching Hospital.**

.The following are the results of testing the sub-hypotheses of the second main hypothesis

Tables(7) show the results of testing the third main hypothesis (H2) :

Table (7) Summary of the regression analysis model for the third main hypothesis (H3)

Model Summary				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
ELC	0.431	0.186	0.168	18069.642
CEL	0.432	0.186	0.169	7458249.585
FUL	0.222	0.050	0.029	7458249.585
CFUL	0.144	0.021	0.000	7458249.585
WQU	0.433	0.188	0.170	7458249.585
WAC	0.433	0.188	0.170	7458249.585
RCW	0.116	0.013	0.000	2903.500
WAS	0.958	0.918	0.916	7458249.585
CWD	0.165	0.027	0.000	131072.008
a. Predictors: (Constant), CWD, CFUL, Ful, WAS, RCW, ELC, WQU ,CEL, WAC				

General trend R

Most of the variables have a medium to strong positive relationship with MWP, especially WAS, ELC and WQU, which means that the application of MWP technique is accompanied by a clear change in these indicators.

Explanatory power R^2

The model explains a good proportion of the variance in some variables such as waste volume (91.8%), while it explains a weak proportion in variables such as the cost of fuel or reused water.

R^2 rate

It confirms that models that achieved an R^2 higher than 0.15 are considered to have acceptable statistical validity within a realistic research sample.

Standard deviation of the estimate

Some variables Like ELC and RCW, they showed a large standard error which reduces the accuracy of prediction and indicates the presence of large unexplained variance.

Table 8. Analytical indicators of the test results for the third main hypothesis (H3)

ANOVA [a]						
Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	11,632	7	1.662	180,564	.000 [b]
	Residual	.368	40	.009		
	Total	12,000	47			
a. Indeendent Variable: MWP b. Predictors: (Constant), CWD, CFUL, Ful, WAS, RCW, ELC, WQU ,CEL ,WAC						

Interpretation of Table (8) shows the results of the analysis of variance (ANOVA) for the statistical regression model that studies the effect of applying waste treatment technologies(MWP) as an such as) independent variable on a group of dependent environmental indicators: Ful ,CFUL ,WAS (.etc ,.

1. **Independent variable(MWP)** : represents the introduction of waste treatment technology in the health facility, which is the factor whose impact is to be measured.
2. **Dependent variables**: are environmental performance indicators that are supposed to be affected by the introduction of technology (such as reducing fuel consumption, improving water (.quality, reducing waste, etc.
3. **Regression SS = 11.632** represents the amount of variance in the environmental indicators that can be explained by the independent variable (i.e., the application of the technique explains about of the total variance 11.632) .
4. **Residual SS** = 0.368 It is the remaining variance in the data that is not explained by the independent variable (i.e. there are other minor factors that influence the indicators).
5. **Total SS = 12.000** is the sum of the total variance in the dependent environmentalindicators.
6. : **F = 180.564** This statistical value means that the model explains the variance strongly, and the larger it is, the better the model is.
7. : **Sig. = 0.000** It is a significant value that indicates that the effect of applying the technology on environmental indicators is real and not random (because the value is much less than 0.05).

Conclusion The results indicate that the introduction of waste treatment technology(MWP) has a significant and clear impact on improving environmental indicators, and explains the majority of the variance in these indicators.

Summary of results and transaction table

Table (9) shows a summary of the most important results for each dependent variable, including the value of**B** and**Beta.** Standard, probability value**(Sig.)** with a brief explanation of the relationship ,

Table 9. Regression model coefficients for the third hypothesis (H2)

Dependent Variable	Variable	B	Std. Error	Beta	T	Sig.
ELC	(Constant)	158,375,000	3688.450		42,938	.000
ELC	MWP	-16918.850	5216.256	-.431	-3.243	.002
CEL	(Constant)	4,751,250,000	110616.898		42,952	.000
CEL	MWP	-507821.750	156435.918	-.432	-3.246	.002
Ful	(Constant)	17,546	.289		60,756	.000
Ful	MWP	-.632	.408	-.222	-1.548	.129
CFUL	(Constant)	7722.839	121,615		63,502	.000
CFUL	MWP	-169.205	171,989	-144	-.984	.330
WQU	(Constant)	17,500,000	460,668		37,988	.000
WQU	MWP	-2125,000	651,482	-.433	-3.262	.002
WAC	(Constant)	2,625,000,000	69100.146		37,988	.000
WAC	MWP	-318,750,000	97722.363	-.433	-3.262	.002
RCW	(Constant)	15955.385	220,811		72,258	.000
RCW	MWP	-247,669	312,274	-.116	-.793	.432
WAS	(Constant)	3064.688	23,836		128,571	.000
WAS	MWP	-765.271	33,710	-.958	-22,702	.000
CWD	(Constant)	1057377.590	15415.299		68,593	.000
CWD	MWP	-24721.293	21800.525	-165	-1.134	.263

4. Detailed analysis of each dependent variable

1. consumption (ELC) The regression coefficient B came for consumption Electricity (ELC) worth -16918.850 It is negative, indicating that the relationship between (MWP) application of treatment technologies and ELC is a relationship Inverse, i.e., an increase in MWP contributes to a decrease in ELC. P-value (Sig.) = 0.002 It is less than 0.05, which means that this relationship is statistically significant. The value of Beta shows Standard -0.431 The strength of the relationship is moderate and negative. The t-statistic value is -3.243. This effect is significant (at a significance level of 0.05), confirming the negative and significant effect of MWP on ELC.

2.Cost of Electricity Consumption (CEL) Regarding the cost of electricity consumption (CEL) , we find that the coefficient B = -507821.750 is negative, indicating an inverse relationship between (MWP) of the application of treatment techniques and (CEL) , i.e., an increase in (MWP) is associated with a decrease in (CEL). The value of Sig. = 0.002 The relationship is statistically significant at a significance level of 0.05. Also, Beta Standard = -0.432 It indicates a moderately strong negative relationship between the two variables. This is reinforced by the value t = -3.246. which falls within the range of statistically significant values ($p < 0.01$), confirming the negative and significant effect of MWP on CEL.

3.Fuel quantity Ful)) For fuel quantity (Ful), value B = -0.632 It is negative, indicating a (weak) inverse relationship between (MWP) of treatment technology application and fuel quantity (Ful); that is, an increase in MWP may lead to a slight decrease in Ful. But Sig. = 0.129 It is greater than 0.05, which means that the relationship is not statistically significant (does not reach the level required to prove significance). Beta value Standard = -0.222 relatively low, suggesting that the strength of the relationship is weak. Similarly, the value of t = -1.548 Not statistically significant, which is consistent with the high Sig. value. It indicates that there is no clear significant effect of MWP on Ful.

4.Fuel cost (CFUL) For (CFUL) fuel cost, factor B = -169.205 (negative), indicating a very weak negative relationship between the MWP of waste treatment technology application and the cost of Fuel (CFUL) Higher MWP is associated with a slight decrease in CFUL. However, Sig. = 0.330 (>

0.05) indicates that this association is not statistically significant. Also, Beta Standard = -0.144 It indicates that the effect of MWP on CFUL is very weak in magnitude. The value of t = -0.984 corresponds to with this result, it is also not statistically significant, meaning that there is no significant effect of MWP on CFUL.

5.Quantity of water consumed (WQU)) Regarding the (WQU) quantity of water consumed , the B coefficient shows: Negative with a value of -2125.000 , which means that there is an inverse relationship between the application of treatment technologies (MWP) and the quantity of water consumed (WQU) , i.e., an increase in MWP leads to a decrease in WQU. Sig. = 0.002 This indicates a high statistical significance for this relationship. Also, Beta Standard = -0.433 It reflects a relationship of medium strength and in the negative direction. The t - test confirms that t = (-3.262) This relationship is statistically significant, as it falls within the range of critical values that indicate a significant effect of MWP on WQU.

6.Cost of water consumed WAC In the case of (WAC) , we find that the coefficient B = -318750.000 (negative), indicating a negative relationship between Application of treatment technologies (MWP) and (WAC) The cost of consumed water, i.e., an increase in (MWP) is associated with a decrease in (WAC) Sig. = 0.002 Indicates that this effect is statistically significant at the 0.05 level. The Beta coefficient shows: Standard of -0.433 The relationship has a medium strength and is in a negative direction (like what was observed with (WQU). Also, the value of t = -3.262 It was statistically significant. (Also similar to the case of (WQU), which reinforces the presence of a significant effect of MWP on WAC.

7.reused water RCW): For RCW, the B factor was negative by -247.669 Indicating a very weak negative relationship between MWP and application of treatment techniques. and Reused Water (RCW) That is, a higher MWP may be associated with a slight decrease in RCW. However, a Sig. value of 0.432 (>0.05) indicates that this association is not statistically significant. Also, Beta Standard = -0.116 This means that the effect of MWP on RCW is very weak in magnitude. The t-statistic came out to be -0.793. Not statistically significant, confirming the absence of a significant effect of MWP on RCW.

8.Waste volume WAS) The B coefficient appears. For WAS valued at -765.271 It is negative, indicating a clear inverse relationship between Application of treatment technologies (MWP) and waste volume (WAS) (i.e., a higher MWP leads to a lower WAS). A Sig. value = 0.000 (< 0.05) means that the relationship is statistically significant at a very high level of confidence. Also, Beta Standard = -0.958 This is an absolute high value (close to -1), indicating that the relationship is very strong and negative in direction. This indicates that the effect of MWP on WAS is the largest among all the dependent variables in this study. In addition, the t value = -22.702 It is considered statistically significant. ($p \approx 0.000$), which confirms that the effect of MWP on WAS is undoubtedly a strong and statistically significant negative effect.

9.waste disposal cost CWD): Finally, for (CWD), the coefficient B = -24721.293 (Negative) meaning there is a negative (inverse) relationship trend between (MWP) The application of treatment technologies and (CWD) waste disposal cost, but the value of Sig. = 0.263 (> 0.05) indicates that this trend is not statistically significant. Also, Beta Standard = -0.165 It reflects a weak relationship in terms of strength. The value of t = -1.134 Statistically not significant, consistent with the lack of statistical significance of the relationship and insufficient evidence of a significant effect of MWP on CWD.

The second hypothesis aims to test the impact of medical waste treatment (MWP) technologies on reducing environmental indicators within healthcare facilities. The results of the

regression analysis revealed a statistically significant inverse relationship between the application of MWP technologies and a number of dependent variables, supporting the validity of the hypothesis.

The results showed a statistically significant negative impact of MWP on electricity consumption (ELC), electricity cost (CEL), water quantity consumed (WQU), and water cost (WAC), as well as a very strong impact on waste volume (WAS). The standardized Beta value for this variable reached -0.958, the highest among all variables, indicating that waste treatment technologies contribute significantly to reducing the amount of waste produced. In contrast, the results did not demonstrate a statistically significant impact of MWP on the variables of fuel quantity (Ful), fuel cost (CFUL), reused water quantity (RCW), and waste disposal cost (CWD). The probability values (Sig .) were higher than 0.05, indicating a weak or non-existent impact on these aspects.

Accordingly, it can be concluded that medical waste treatment technologies contribute to improving the efficiency of environmental resource use in healthcare institutions, by reducing electricity and water consumption and reducing the volume of waste, thus supporting the move towards green performance for the hospital.

Based on the above, it can be said that the third main hypothesis of the study is accepted, which states that (there is a significant effect of applying medical waste treatment technologies on the level of green performance of Al-Furat Al-Awsat Teaching Hospital).

5. RESULTS AND DISCUSSION

5.1. Conclusions

1. Gradual increase in the costs of quality (prevention and evaluation): The study results indicate a growing trend by hospital management toward focusing on preventive measures and evaluation processes, reflected in a significant increase in prevention and evaluation costs during 2024. This demonstrates management's awareness of the importance of proactive quality in reducing errors and minimizing breakdowns.
2. Reduction in internal costs: The data showed a gradual decrease in internal breakdown costs over the study period, which is a positive indicator of the efficiency of the implemented environmental quality system and reinforces the hypothesis that investing in good quality contributes to reducing subsequent treatment and correction costs.
3. Total Quality Costs to Rise in 2024: Despite a slight decline in total quality costs in 2023, they will witness a significant increase in 2024 as a result of the expansion of preventive health services and the increase in specialized staff, reflecting a strategic shift towards improving the hospital’s environmental and health performance.
4. The role of the medical waste treatment unit as a focal point for prevention: The analysis revealed that the medical waste treatment unit accounted for the highest percentage of prevention costs, demonstrating its pivotal role in supporting environmental sustainability and reducing health risks within the hospital, especially after the introduction of new sorting and treatment technologies in 2023.
5. The impact of investment in prevention on green performance: The results of the tables confirm that adopting preventive measures and enhancing the efficiency of quality support units contributed to improving the hospital's green performance by reducing sources of pollution and improving the quality of services provided, which is in line with the goals of green healthcare institutions.

5.2. Recommendations

1. Expanding the scope of application of medical waste treatment technologies: Extending shredding and microbiological diagnosis technology to other hospital units. Studying the introduction of modern technologies (such as autoclaves and dry heat) to increase efficiency.
2. Strengthening preventive measures and allocating costs: Increasing reliance on prevention and assessment costs, and reducing the percentage of breakdown costs through regular training programs. Preparing an annual budget allocated to the maintenance and upgrade of sorting and processing equipment.
3. Improve energy management: Install energy-efficient lighting and electrical systems (such as LED lights and smart controls). Regularly monitor electricity consumption and upgrade air conditioning and refrigeration equipment to increase their efficiency.
4. Rationalize water consumption and encourage its reuse: Implement wastewater treatment systems for reuse in non-medical processes (such as irrigation and cleaning). Install smart meters to monitor leaks and control network pressure.
5. Reduce fuel consumption and emissions: Use backup power units powered by gas or environmentally friendly solar energy. Regulate generator operating hours to reduce operating hours and rely on the national grid as much as possible.
6. Solid waste reduction and management: Promote waste separation at the source (colored containers) and train workers on accurate sorting.

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