

Integrating Input/Output Analysis and Green Technological Innovation to Enhance Sustainable Performance in Economic Units



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ABSTRACT: The research aimed to improve the level of sustainable performance in the economic units, especially the industrial ones. This is done by studying and analyzing the theoretical foundations and knowledge foundations for each of the input / output analysis and green technological innovation and evaluating the level of application of the Iraqi industrial economic units for them by choosing the Al-Zawraa General Company in Baghdad as a place for research. That company is one of the subsidiaries of the Iraqi Ministry of Industry and Minerals. An applied study was conducted on the company for the period (2020-2021). The extent of its use of green technology in its production and operational processes was evaluated by relying on sustainable performance indicators. The efficiency of natural and human resources, waste, air emissions, and water pollution were analyzed and diagnosed for solar photovoltaic energy systems, cost accounting by (IOA), and fault handling and sustainable performance improvement by (GTI). The research reached a set of conclusions, the most important of which was the suffering of the company under study from the lack of central government support for it and the failure to provide sufficient financial allocations for the application of green technology innovations. There are also no current or future visions for dealing with the waste and emissions caused by solar energy systems after the end of their lifespan. The application of (IOA) and (CTI) enables the economic unit in question to achieve many sustainable advantages, including: saving natural resources and improving the efficiency of their use, reducing costs, increasing market share and maximizing its profits, providing environmentally friendly products and services of high quality and efficiency, creating A supportive environment for creative ideas, supporting the process of sustainable decision-making, enhancing sustainable competitive advantages, contributing to preparing sustainable reports by diagnosing environmental, creative and other sustainable costs, and then improving its level of sustainable performance.

KEYWORDS: input/output analysis, green technological innovation, sustainable performance.

I. INTRODUCTION

Contemporary economic units have to meet all needs and expectations of internal and external stakeholders. Economic units are often encouraged to improve their level of sustainable performance to keep pace with rapid developments in changing business environments and to take into account all aspects of economic, environmental and social sustainability. In order for these economic units to achieve this, they must develop green creative strategies and adopt sustainable technologies. Among the most important of these techniques and strategies are input/output analysis and green technological innovation. The (IOA) and (GTI) focus on the economic, environmental and social aspects by providing and improving the use of natural resources, reducing costs, reducing emissions and waste, providing high-efficiency products, enhancing competitive advantages and other sustainable advantages.

The first chapter focused on the methodological framework through two parts. The first section was devoted to the research methodology, while the second section was devoted to presenting some previous studies related to the subject of the research. While the second chapter dealt with a theoretical study of the concept of (IOA) and (GTI) and their role in improving sustainable performance. While the third chapter was devoted to the applied side of the research, as the role of (IOA) and (GTI) and its importance in improving sustainable performance was applied in Al-Zawra State Company / Electronic and Laboratory Units Factory. As for the fourth and final chapter, it focused on the conclusions and recommendations reached in two sections, the

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first was devoted to the conclusions related to the theoretical and practical aspects, while the second section was devoted to the recommendations made by the authors.

II. PROBLEM STATEMENT

There is a clear weakness on the part of Iraqi economic units in general and industrial ones in particular in relying on sustainable strategies and technologies and creating creative environments capable of generating sustainable ideas. In order to save natural resources, improve production and operational efficiency, analyze and treat emissions, recycle waste and reduce costs, as well as enhance sustainable competitive advantages in order to survive in changing business environments. At a time when the process of developing green technology applications has become one of the most important pillars of international efforts to achieve long-term sustainable development that reflects positively on all stakeholders.

III. OBJECTIVES OF THIS PAPER

The research mainly aims at studying and analyzing the theoretical foundations and knowledge foundations of each of the input/output analysis and green technological innovation and their effective role in improving the sustainable performance of the Iraqi economic units. In addition to the main objective of the research, the researchers seek to study the level of application of the Iraqi economic units for (IOA) and (GTI) technologies and its importance in improving their sustainable performance.

IV. PAPER'S SIGNIFICANCE

The importance of the research comes from the importance of the subject (input / output analysis) and (green technological innovation), as they represent a basic pillar on which the global economic units depend on providing and improving the efficiency of using natural resources, improving green technologies and processes, dealing with emissions, recycling waste, and providing environmentally friendly green products. In addition to presenting a theoretical and practical methodology that helps the economic unit in question to understand how to apply (IOA) and (GTI) in order to improve its level of sustainable performance. The research also derives its importance from the scientific aspect, as (IOA) and (GTI) have been applied in the economic unit in question, as this will help improve the aspects of sustainability (economic, environmental, and social) and work to modify the traditional elements of competitive advantages.

V. HYPOTHESIS OF THIS PAPER

1. The economic unit in question suffers from a lack of interest in applying modern strategies, technologies and systems in order to provide new products and services or new business models that have a positive impact on the environment and society.
2. The possibility of adopting input/output analysis and green technological innovation to improve sustainable performance in the economic unit under study.

VI. RESEARCH AREAS

1. Spatial: Al-Zawraa State Company affiliated to the Iraqi Ministry of Industry and Minerals was chosen as the place of application, specifically the electronic and laboratory units factory located in Baghdad / Al-Zafaraniya Governorate.
2. Temporal: The data and reports of Al-Zawra State Company for the year (2020-2021) were relied upon, and it is the most recent reports and data obtained.

VII. PREVIOUS STUDIES

A Study by Bouslami (2022) titled "The Impact of Technological Innovation on the Overall Performance of the Economic Institution- A Case Study of the Casablanca Unit of the Sidal Pharmaceutical Production Complex"

The study aimed to identify the impact of technological innovation on the overall performance in its three dimensions (economic, environmental, and social) in the Casablanca drug production unit of the Sidal complex. The results showed a statistically significant relationship between technological innovation and the economic dimension of comprehensive performance in the economic unit under study, as well as a statistically significant relationship between technological innovation and the social dimension of comprehensive performance. The results of the study also confirmed that there is no statistically significant relationship between technological innovation and the environmental dimension of the overall performance of the economic unit under study.

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Another paper by Tsai et al. (2016) titled "Input-Output Analysis for Sustainability by Using DEA Method: Comparison Study between European and Asian Countries"

The study aimed at the need for policy makers to show the causal relationship between energy consumption, labor force, government expenditures, carbon dioxide emissions and gross domestic product in order to build policy decisions and reduce concerns about the negative effects of carbon reduction and economic energy efficiency. Developing countries must establish climate change governance and policies on the one hand. On the other hand, developed economies must seek to reduce carbon emissions. It is also necessary to emphasize that energy policies play a pivotal role in improving energy efficiency and reducing carbon emissions. In addition to the need to formulate environmental policies and introduce new production techniques, treatment methods and measures to prevent pollution. As well as improving the effectiveness of energy policies by learning from the success of developed countries and the need to propose building long-term independent management institutions by governments to enhance cooperation and exchange in natural resources.

VIII. INTRODUCTION TO THE CONCEPT OF SUSTAINABLE PERFORMANCE

The concept of sustainable performance

Since sustainability is related to building a society that achieves a balance between economic, environmental and social goals, economic units seek to achieve integration between sustainability on the one hand and their business models on the other hand. By restructuring its organizational strategies in the light of the efficient use of material and energy consumption, reducing emissions, paying attention to its social responsibilities, as well as achieving its economic goals in order to improve its sustainable performance (SP). In addition, the evaluation of the sustainable performance of economic units must include non-financial indicators rather than focusing on economic indicators only. In addition, the sustainable performance of economic units must take into account intangible assets such as relationships with employees, customers and other actors.

(Yusliza et al., 2019: 7-8), (Baumann & Genoulaz, 2020: 3) see that the concept of sustainable performance (SP) is derived from the concept of sustainable development, that is, it defines the sustainable performance of any practice as a combination of its economic, environmental and social performance Hence, this coherent integration between the three dimensions enhances the competitiveness of the economic units. On the other hand, Zhao & Huang (2022: 2) believes that sustainable performance is achieved when the economic units perform their activities without causing any harm to the quality of the environment and society, that is, taking into account The quality of natural resources and taking into account the welfare of the community in the area in which it operates. In addition, an economic unit can reach sustainable performance when managers are aware of the environmental and social requirements of all stakeholders.

On the other hand, sustainable performance can be evaluated by evaluating the performance of three basic pillars, which are the economic, environmental, and social factors, on an equal footing (Mousa & Othman, 2019: 13), and (Yusliza et al.) believes that there are three dimensions of sustainable performance, which are The following (Yusliza et al., 2019: 18):

1. Economic performance: It is the ability of the economic unit to reduce costs associated with purchased materials and energy consumption, reduce waste treatment and disposal fees, and reduce fines for environmental accidents.
2. Environmental performance: It is the ability of the economic unit to reduce energy consumption, used materials and hazardous materials, reduce air emissions, as well as comply with environmental standards.
3. Social performance: It is the ability of the economic unit to improve the welfare of stakeholders and improve the safety of employees, as well as reduce environmental impacts and risks on the general community. Accordingly, social performance is divided into two sub-criteria (Labuschagne et al., 2005:382):
 - a. Social/Economic Performance: This criterion shows the external economic impacts of the economic unit's business initiatives, economic welfare (such as contribution to GDP, taxes, etc.), trade opportunities (such as contribution to foreign currency savings, etc.).
 - B. Social/environmental performance: This criterion indicates the need for operational initiatives to contribute to improving the environment at all societal, local and regional levels. This criterion also includes expanding the community's capabilities in the field of environmental control and strengthening and implementing legislation.

(Yusliza et al., 2019: 3) sustainable performance is defined as a concept that obliges economic units to implement their responsibilities related to the environment and society as well as their focus on achieving their economic goals, i.e. focusing on achieving their economic, environmental and social performance together. (Stainskis & Arbaciauskas, 2009: 43) indicated that sustainable performance is the final result of managing the economic, environmental and social aspects, by adopting financial and non-financial indicators that improve the effectiveness of managing the economic unit and then improve its sustainable

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performance. Whereas (Seelos & Mair, 2005: 241) see the integration between economic growth, social development and the natural environment in order to achieve justice between generations to ensure their survival and well-being. The researchers believe that sustainable performance is a comprehensive performance that provides a current and future overview that enables the economic unit to deal with potential determinants and risks that stand in the way of achieving its goals on the one hand, and on the other hand, focusing on all economic, environmental and social dimensions of all sustainability drivers. In addition, achieving and improving the sustainable performance of the economic unit requires the adoption of sustainability in the plans, culture, strategy and business models of the economic unit.

IX. SUSTAINABLE PERFORMANCE MEASUREMENT

Performance measurement is a fundamental principle of management. It is not possible to manage what cannot be controlled and it is not possible to control what cannot be measured. Performance measurement is important because it defines the difference between the current performance and the required performance of the economic unit (Weber & Thomas, 2005: 3).

Therefore (Varisco et al.) believes that performance measurement is a system consisting of a set of procedures and indicators that measure the performance of the activities and operations of the economic unit accurately and continuously to compare the current performance with the required performance and take the necessary measures for the success and continuity of its business (Varisco et al., 2018: 2)

(Taouab & Issor, 2019: 103) confirms that performance measurement is very important for effective management. Because it is considered as the main provider of perceptual and organizational capabilities in the economic unit. As performance requires a measurement to determine and study the management strategy in order to set goals, predict future internal and external conditions, and make decisions at the necessary times, then good performance contributes to achieving high and long-term profits for the economic unit that works to enhance employee returns, provide new job opportunities, bring high-quality products, and this process cannot be possible without benchmarking. Hence, the process of measuring performance within economic units includes several steps, as follows (Wheelen et al., 2018: 362):

1. The process or area to be examined is selected. Activities that have the potential to determine competitive advantage must be measured within the economic unit.
2. Appropriate measures for each activity are obtained by searching for behavioral and output measures.
3. Performance is measured on the basis of identifying a group of competitors and economic units that provide similar activities, with the aim of measuring performance on its basis.
4. The difference between the performance measures of the economic unit is calculated and the best and most appropriate measure is selected.
5. Developing tactical programs to bridge performance gaps.
6. Work on implementing programs in order to compare the new standards with those of the best economic units.

The aim of this benchmarking of performance measures is to achieve the best results in economic units that are well managed, in addition to that this comparison leads to an increase in sales.

Hence, performance measurement is the language of the process that gives guidance to economic units in order to achieve their goals, through a decision based on information on all financial, environmental and social aspects, i.e. focusing on all financial and non-financial measures to improve their level of performance (Amos et al., 2021: 1).

X. INDICATORS OF SUSTAINABLE PERFORMANCE (ECONOMIC, ENVIRONMENTAL, AND SOCIAL)

The Organization for Economic Co-operation and Development (OECD) defines an indicator as “a parameter or value derived from parameters, which describes and provides information about the state of a phenomenon, environment, or area, with an emphasis on the extension directly related to the value of the parameter” (Castellani, 2010: 9). Highlighting in this paragraph the indicators of sustainable performance as follows:

Key Performance Indicators

Key Performance Indicators (KPIs) are critical measures for the success of economic units and for evaluating their performance, because key performance indicators (KPIs) can be very important for assessing the current position of an economic unit on the one hand and making the decision to adopt new and sustainable strategies to achieve current and future goals on the other. The correct use of key performance indicators enables the economic unit to achieve its objectives in a sustainable manner. That is, the development of (KPI) reflects the critical success factors in economic units. It is classified into financial and non-financial indicators. Where financial performance indicators deal with information that is measured in monetary values and

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reflects the main financial positions and results of operations such as sales growth, return on equity, revenues, and others. Whereas, non-financial performance indicators deal with information that cannot be measured by monetary values, such as environmental and social issues, customer satisfaction activities, compliance, ethics, and others (Brockett & Rezaee, 2012: 16). The International Organization for Standardization (ISO) issued the (ISO 22400) standard for key performance indicators (KPI) with the aim of improving the management of manufacturing operations of economic units, as (KPI) is the core of the performance management system that provides data to monitor the past and future performance of economic units. and strengthen its strategies. The KPI allows managers to determine the progress of critical activities of the economic unit, support the setting of new goals, and assist in decision-making in order to reach sustainable performance and address any gap between actual and desired performance (Varisco et al., 2018: 1). Accordingly, (KPI) was defined by (ISO 2240) as quantitative and strategic measures that reflect the critical success factors for the sustainability of the business of economic units (Kikolski, 2022: 92), as (KPI) are basic indicators in measuring and improving performance because they provide information about performance in various fields such as raw materials and energy, planning and scheduling, and others (Lindberg et al., 2015: 1785). Hence, KPIs are the business measures used by economic units in order to evaluate their sustainable performance in terms of critical success factors or strategic and operational goals. (Turban et al, 2015: 5).

XI. INDICATORS OF SUSTAINABLE PERFORMANCE

Sustainability Performance Indicators (SPIs) are a promising tool that assesses and addresses the short- and long-term effects of strategies developed on the basis of the participation of all internal and external stakeholders. In addition, addressing and defining action lines for local development in order to contribute to achieving sustainability at the local and global levels because it is a useful tool for decision makers to evaluate the effectiveness of policies within economic units (Castellani, 2010: 94). Indicators of sustainable performance are often divided into three dimensions, economic, environmental and social, in order to measure the progress of the economic unit towards achieving sustainability.

It is noted that (SPI) includes economic, environmental and social indicators that cover all aspects of sustainability. The economic indicator covers the financial and non-financial economic unit capacity with the aim of improving efficiency and effectiveness. While the environmental indicator is concerned with measuring environmental aspects. The social indicator focuses on stakeholder satisfaction and community health and safety. Hence enabling the economic unit to improve its sustainable performance.

XII. COMPLEMENTARITIES BETWEEN (IOA) AND (GTI) AND ITS IMPORTANCE IN IMPROVING SUSTAINABLE PERFORMANCE

Input-Output Analysis (IOA) is one of the most important indicators for evaluating environmental performance as well as economic and social performance (Szekely & Kinrsch, 2005: 632).

(Warhurst, 2002: 47-48) explained that the (IOA) is an important indicator for measuring and improving the sustainable performance of an economic unit. It gives specific progress towards the objectives that can be set by the economic unit in its environmental policies by evaluating the resources allocated to environmental management and the integrity of the existing systems for evaluating environmental performance on the basis of which compliance with the environmental requirements and legal challenges of the economic unit is made.

(Kinney & Raiborn, 2011: 705) indicated that (IOA) has become one of the techniques on which economic units rely to measure activities traditionally classified as non-core discretionary activities such as (research and development, employee training, etc.) that have now become necessary for survival. in world class environments. In the long run, these activities produce sustainable, high-quality products and services that contribute to improving the level of sustainable performance of economic units. Therefore, before spending money on these activities, managers must determine the real benefit from them by adopting alternative non-monetary measures. Comparing input costs and output outcomes then helps to determine whether there is a true cost-benefit relationship from these activities.

(Paul, 1999: 3) indicated that evaluating actual and expected productive and economic performance requires evaluating basic production, technical progress in the cost structure, or changes in inputs and outputs through which productivity growth is determined, measured and evaluated. As productivity growth measures are based mainly on the idea of net production growth, that is, production at the lowest cost, and then an increase in efficiency indicates an increase in productive performance. The indicators of productivity that depend on (IOA) are the most common measures used by economic units to represent economic performance (Paul, 1999: 3).

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(Marion et al., 2012: 400) emphasized that economic units must identify sustainable performance indicators and integrate them with stakeholders, as this type of indicator consists of four categories: total, cost, quality, service and time, as each of these four indicators depends on the analysis (IOA) to reach the goals to be achieved. The overall indicators depend on the inputs of the service process provided to customers, the outputs produced and the material resources used.

While cost indicators depend on a single unit measurement of inputs and outputs, while quality indicators depend on measuring the ability of process inputs and outputs to conform to expected performance, while the service and time indicators depend on customer-oriented procedures (inputs), response time, flexibility, and adherence to ideal orders (outputs).

On the other hand, the Green Technology Innovation (GTI) strategy, in integration with the Input/Output Analysis (IOA) technology, enables economic units to achieve and improve their sustainable performance, as (Shahzed et al.) believes that advanced technologies have been integrated in order to reduce the use of Resources, pollution prevention, waste recycling and environmental management.

Green technology innovations have a significant and positive role in achieving the sustainable performance of economic units, as the (GTI) is a basic strategy through which economic units seek to reduce the negative and harmful effects of production and manufacturing processes, because progress in technologies and strategies helps in preserving the environment, as the adoption of Environmentally friendly strategies and technologies have two benefits for economic units, especially industrial ones (Shahzed et al., 2020: 9):

1. Business advantages by manufacturing environmentally friendly products.
2. Economic benefits that improve competitive advantages.

(Zizka & Rydvalova, 2021: 68) indicated that performance is linked to creativity in particular, meaning that the increase and improvement of the performance of economic units is due to the innovation of products, processes, equipment models, systems, and others.

As the quantity and quality of creative ideas and the efficiency and effectiveness of implementing those ideas have the greatest role in achieving sustainable creative performance through the successful conversion of inputs into outputs, and it was mentioned (Wheelen et al., 2018: 354) that economic units that used traditional financial measures such as return on Investment, return on property rights, and other measures that are used to evaluate the general performance of economic units have come to an end, as most economic units tend to increase the use of sustainable measures to evaluate their performance. As the writers and researchers pointed out that economic units that adopt strategies based on creativity to develop new and environmentally friendly products tend to prefer non-financial measures over financial measures, it is noted that the economic unit's dependence in its production and operational processes on the complementary relationship between (IOA) technology and (GTI) strategy enable it to improve its sustainable performance as follows:

1- Preparing sustainable reports: (IOA) enables the economic unit to prepare sustainable reports by tracking all tangible and intangible resource flows, from inputs to outputs, in addition to tracking and processing all emissions and wastes, and this will enable the preparation of sustainable reports covering all environmental, economic and social aspects of the economic unit, and therefore these reports focus on all important and fundamental issues for the stakeholders, in contrast to the financial reports that focus primarily on the interest of the shareholders.

2-Supporting sustainable decision-making: (IOA) contributes to processing all data and converting it into useful information that supports the decision-making process in the economic unit. Likewise, (GTI) contributes to supporting the decision-making process within the economic unit by developing processes and products and generating new ideas that enable it to choose the best. The available alternatives to work according to and take the optimal decisions that support all dimensions of sustainability for the economic unit.

3- Sustainable efficiency: (IOA) has an important role in cost management and improving production efficiency by reducing costs, reducing consumption of materials and energy, and addressing emissions and waste. Improving the use and allocation of resources, and then developing energy-saving products that are harmless to the environment and society, while at the same time enhancing the financial performance of the economic unit.

4- Sustainable quality: (GTI) has the greatest and fundamental role in providing high-quality products that are able to control the increasing environmental impacts and do not pose a threat to the health of society and take into account all aspects of sustainability in the economic unit. Likewise, (IOA) contributes to achieving quality for the economic unit by specifying the inputs and outputs of all processes and products.

5- Sustainable competitive advantage: (IOA) enhances the competitive advantage of the economic unit as it is a technology that applies to all dimensions of sustainability, as it works to reduce costs and detect and treat environmental impacts harmful to the

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environment and society, and (GTI) positively affects the competitive advantage by providing new products and services that enable The economic unit is to attract new customers, retain existing customers, secure new and pioneering positions in the market, and then ensure its continuity in its changing environments.

XIII. APPLICATION OF INTEGRATION (IOA) AND (GTI) IN AL-ZAWRAA STATE COMPANY FOR PRODUCERS OF SOLAR PHOTOVOLTAIC ENERGY SYSTEMS AND LIGHT-EMITTING DIODE (LED)

Within this part, the two researchers will apply the integration of input/output analysis and green technological innovation with the aim of demonstrating their role in improving sustainable performance in the economic unit in question represented by the Al-Zawraa State Company. As the producers of solar photovoltaic systems and Light-emitting diode (LED) were selected from the products of Al-Zawraa General Company, specifically the electronic and laboratory units factory, for the purpose of implementing this integration as follows:

Costs of inputs needed to produce photovoltaic solar energy systems and smart LED lighting installations

In this paragraph, all production inputs that enter into the work of solar photovoltaic systems and Light-emitting diode (LED) are identified. The production capacity of solar energy systems ranges from 4 megawatts to 10 megawatts annually, while the production capacity of smart lighting installations reaches (LED) 20,000 lamps annually, and all production costs for the year (2021) will be calculated from raw materials and direct labor wages as well as indirect industrial costs. Table (1) shows the actual costs that have been calculated for the product of solar photovoltaic systems, while table (2) The actual costs of the Light-emitting diode (LED).

Table (1) Total actual cost inputs for solar energy systems production lines

Solar Energy Systems (ID)					
	Details	10MW	8MW	6MW	4MW
1	Raw material costs	4,940,779,000	3,952,622,674	2,964,467,000	1,976,311,337
2	direct labor costs	504,000,000	449,040,000	401,280,000	157,920,000
3	indirect manufacturing costs	1,632,000,000	1,392,000,000	1,152,000,000	912,000,000
4	Administrative and marketing costs	110,600,000	96,080,000	81,560,000	67,040,000
	Total	7,187,379,000	5,889,742,674	4,599,307,000	3,113,271,337

Source: The table was prepared by the two researchers based on the company's data

Table (2) Total actual cost inputs for the smart lighting product (LED) (20000 light bulb annually)

Light-emitting diode (LED)		
	Details	Amount (ID)
1	Raw material costs	3,829,090,000
2	direct labor costs	167,280,000
3	indirect manufacturing costs	200,500,000
4	Administrative and marketing costs	50,000,000
	Total	4,246,870,000

Source: The table was prepared by the two researchers based on the company's data

Application of (IOA) technology in the research company

Rapid changes in business environments and facing local and international competitors require the adoption of sustainable strategies and technologies that take into account environmental, economic and social aspects when developing products, processes and activities. The improvement of sustainable performance depends mainly on improving the efficient use of natural resources and human resources. Therefore, the cash inflows and outflows of producers of photovoltaic solar energy systems and Light-emitting diode (LED) for all dimensions of sustainable performance will be analyzed and diagnosed as follows:

XIV. ANALYZING AND DIAGNOSING THE EFFICIENCY OF NATURAL RESOURCES AND ACCOUNTING FOR THEIR COSTS (ECONOMIC PERFORMANCE)

Natural resources (materials, energy, water) are issues of wide concern to economic units and society as a whole. This is due to the scarcity of resources and the difficulty of obtaining them, as there are large quantities of these resources that are wasted

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during production processes. Because most of the traditional techniques and systems do not help in preserving natural resources. Therefore, the adoption of accounting techniques that focus on sustainability enables the economic unit in question to improve its production efficiency and enhance its competitive advantages. On the other hand, measuring and improving productivity sheds light on the specific input-output relationship that contributes to cost leadership. As the input-output relationship shows the amount of units produced with fewer materials, less effort, and lower costs, which improves its level of sustainable performance and enhances its competitive advantages compared to other competing companies. Hence, it is possible to measure the partial and total productivity of the 10MW solar photovoltaic systems, knowing that the sales value amounted to 9,180,000,000 dinars. In addition to measuring the partial productivity of Light-emitting diode (LED), bearing in mind that the number of manufactured units is 20,000 lamps annually, and that the sales value with connecting poles and lamps amounted to 8,250,000,000 dinars, through the equations below, and Table (3) explains this:

Partial Productivity = (Output Sales Value or Manufactured Units) / (One Resource Input Cost or Number of Units)

Total Productivity = (Outputs Sales Value or Manufactured Units) / (Inputs Resources for All Total Cost)

Table (3). Measuring the production efficiency of producers of photovoltaic solar energy systems and Light-emitting diode (LED)

Details	Equations	ID/Unit
Photovoltaic solar energy systems		
Partial production of direct materials	$\%100 * \frac{ID\ 9,180,000,000}{ID\ 4,940,779,000}$	1.86
Partial direct labor productivity	$100 * \frac{ID\ 9,180,000,000}{ID\ 504,000,000}$	18.21
Partial productivity of industrial indirect costs	$100 * \frac{ID\ 9,180,000,000}{ID\ 1,632,000,000}$	5.63
Partial productivity of administrative and marketing costs	$100 * \frac{ID\ 9,180,000,000}{ID\ 110,600,000}$	83.00
total productivity	$100 * \frac{ID\ 9,180,000,000}{ID\ 7,187,379,000}$	1.28
Light-emitting diode (LED)		
Partial production of direct materials	$\frac{\text{light bulb } 20000}{ID\ 3,829,090,000}$	5.2232
Partial direct labor productivity	$\frac{\text{light bulb } 20000}{ID\ 167,280,000}$	0.0001
Partial productivity of industrial indirect costs	$\frac{\text{light bulb } 20000}{ID\ 200,500,000}$	9.9751
Partial productivity of administrative and marketing costs	$\frac{\text{light bulb } 20000}{ID\ 50,000,000}$	0.0004
total productivity	$\frac{\text{light bulb } 20000}{ID\ 4,246,870,000}$	4.7094

Source: The table was prepared by the two researchers based on the company's data

Through table (3), it is noted that these ratios indicate a high productivity efficiency of the economic unit under study for the producers of photovoltaic solar energy systems and Light-emitting diode (LED) due to the high sales value compared to the costs of material and human resources and other costs. Hence, the measure of production efficiency is the most important indicator for evaluating the performance of economic units because it helps them discover strengths and weaknesses, develop their production lines, and then continue production, enhance their competitive position and increase their profits. In addition, the increase in production efficiency, which depends mainly on the innovations of green technology, is considered an important matter for the environment and society, because it enables economic units to improve the efficiency of workers, save resources, reduce costs, and provide environmentally friendly products, which improves their level of sustainable performance and contributes to achieving sustainable development.

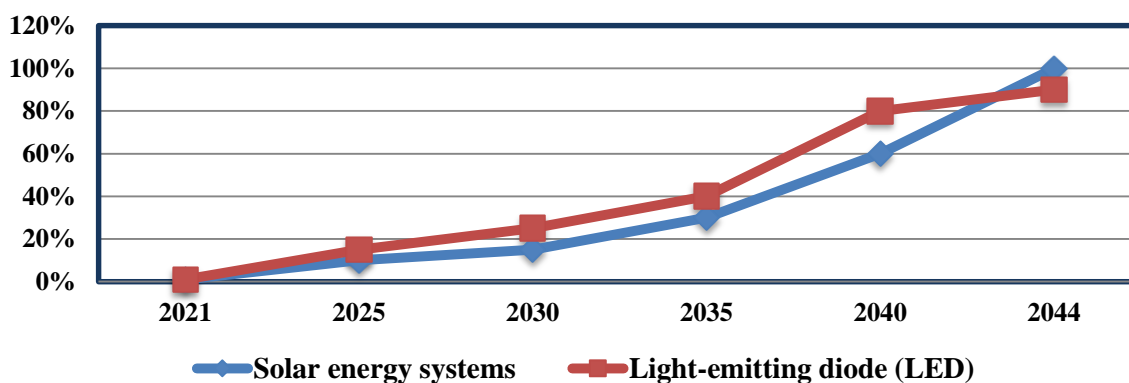
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XV. ANALYSIS AND DIAGNOSIS OF WASTE, AIR EMISSIONS AND WATER POLLUTION, AND ACCOUNTING FOR THEIR COSTS (ENVIRONMENTAL PERFORMANCE)

Waste, emissions and water pollutants indicate inefficient production. Therefore, economic units, especially industrial ones, seek to take into account environmental impacts related to sustainability, including waste, emissions and water use. Therefore, the environmental performance of Al-Zawra State Company will be discussed according to the following:

1. Waste management and calculating their costs

Most of the Iraqi industrial economic units suffer from problems arising from waste management and how they can be reduced or reduced. Although Al-Zawraa State Company seeks to provide environmentally friendly products and services based on clean, sustainable energy at the lowest possible cost, it lacks current and future plans and visions. To treat the waste caused by the panels of solar photovoltaic systems and Light-emitting diode (LED) during the production and assembly processes, as well as after the end of its operational efficiency or its useful life.



Source: made by authors

Figure (3). Expected waste volume for producers of photovoltaic solar energy systems and Light-emitting diode (LED)

From the above figure, it is concluded that the waste problem for producers of solar energy systems and Light-emitting diode (LED) will continue to escalate with the end of their operational efficiency or their lifespan during the coming years. Therefore, Al-Zawra State Company must develop green creative strategies and adopt sustainable technologies by relying on more sustainable inputs and less environmental damage, as well as work to recycle this waste to reduce its environmental and health effects.

2. Controlling air emissions and calculating their costs

After field experience and communication with employees and listening to their opinions, it became clear that Al-Zawra General Company uses many materials, machines, machines and equipment in its production operations, and it also owns means of transport that transport materials and products to and from the company. This is what leads to the emission of many harmful gases, and the factory of electronic and laboratory units must find appropriate solutions to reduce these emissions, by adopting sustainable green strategies and technologies that work on analyzing, diagnosing and treating these emissions. On the other hand, the commitment of the unit in question to the internationally permitted rates in accordance with the Kyoto Protocol avoids the cost of the imposed fine, as it exceeds the permissible normal rates.

3. Reducing water pollution and preserving the safety of its flows

Water pollution is one of the environmental challenges that threaten the lives of future generations and make it difficult to preserve natural resources. The economic units, especially the industrial ones, leave significant impacts on the water as a result of the discharged liquid waste and other pollutants that come out with the water. Therefore, the management of the economic unit in question must harness its capabilities in order to preserve the safety of the incoming and outgoing water by examining and analyzing it and establishing treatment units in order to reduce the harm to working individuals, the environment and society, by taking the necessary measures to rectify and treat the water to save it the amount of fines imposed. due to contamination of the outgoing water. As the factory must think of radical and creative solutions to this problem by improving and developing the testing and treatment units for the incoming and outgoing water, as well as recycling the traditional water inside the factory.

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Evaluate and improve the efficiency of human resource performance (social performance)

Evaluation of social performance is one of the important processes practiced by human resources management in economic units and for all internal and external stakeholders, especially workers at all levels, starting from senior management and ending with lower management. By improving the welfare of stakeholders and improving the safety of employees. Table (5) shows the analysis and diagnosis of the active and inactive workforce, as follows:

Table (4) Analyzing and diagnosing active and inactive workforce

Inactive Labor Ratio	Inactive Labor	Active Labor Ratio	Active Employment	The Total Number Of Employees
63%	765	37%	449	1214

Source: made by the authors based on the company's business plan for the year 2022

From the above table, it is clear that the number of workers in the Al-Zawra State Company has increased, and this is what causes great financial burdens by paying their salaries in full. In addition, the number of workers for the production of electric power systems with a capacity of 10MW is (57) workers, while the number of workers for the production of Light-emitting diode (LED) is (22), with one working shift during (240) days a year. This leads to higher costs due to the higher number of workers compared to the planned production capacity, i.e. the inputs are greater than the outputs in terms of employment.

XVI. APPLYING (GTI) TO IMPROVE SUSTAINABLE PERFORMANCE IN THE ECONOMIC UNIT UNDER STUDY

Green technological creativity is a basic strategy for creating a supportive environment for generating ideas and improving production efficiency by providing resources and reducing environmental pollution (for workers and society as a whole) in order to achieve long-term sustainable development in the economic unit in question based on new business models that enable it to achieve progress in the field of sustainability Natural resources, environment protection and society. The stages of GTI implementation are as follows:

Phase One: Promoting Research and Development (R&D)

This stage is considered an essential step in the application of green technological innovation in the economic unit in question. As this requires them to allocate part of their revenues and profits in order to improve their production efficiency, that is to allocate a separate part of their budgets in order to find sustainable solutions to all economic, social and environmental problems that have been analyzed and diagnosed. Accordingly, Al-Zawra State Company must allocate part of its budgets to support and improve research and development activities in order to achieve the following:

1. Creating a creative environment supportive of ideas that contributes to the development of current and future sustainable strategies.
2. The use of green technology that works to reduce the consumption of natural resources and reduce or reduce emissions and waste.
3. Providing new environmentally friendly products and services with high efficiency and quality that enhance competitive advantages.
4. Increasing the market share of Al-Zawra State Company, which contributes to achieving long-term sustainable development through increasing economic growth and protecting the environment and society.
5. The possibility of choosing among the available alternatives and then supporting sustainable decision-making that improves the level of economic, environmental and social performance.

The second stage: realization and implementation of green technology innovation

At this stage, creative ideas are transformed into green strategies, technologies, decisions, products and services based on economic, social and environmental impacts, primarily the depletion of natural resources and their high costs, as well as the increase in environmental risks. At this stage, the focus will be on the cost elements of the producers of electric power systems and Light-emitting diode (LED), as follows:

First: Reducing the costs of natural resources (materials, energy, and water): Reducing the costs of raw materials for producers of solar photovoltaic systems and Light-emitting diode (LED) lies in purchasing materials from their origins instead of purchasing from local markets, in addition to reducing the waste of raw materials from Through the recycling of products after the end of their operational efficiency or their productive life, and this is not limited to that, but the company must go further by increasing environmental awareness of customers and repurchasing these products after the end of their life and relying on solar energy

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systems to provide electricity in all departments of the company. In addition, plants for filtering and desalinating the incoming water should be established, as well as treating and recycling the water coming out of the company, with the aim of preserving water from pollution and waste. Accordingly, green technological innovation is sufficient to reduce the costs of natural resources and achieve economic development, as it saves costs by 26%, according to the opinions of specialists (engineers and technicians). For production inputs between reducing resource consumption, reducing pollutants and harmful effects, and adhering to environmental regulations and standards, the equivalent of 2,280,165,940 dinars.

Second: Reducing Labor Costs: It is possible to reduce labor costs for producers of solar energy systems and Light-emitting diode (LED) by reducing the number of workers, and this lies in modern technology based on creativity by relying on modern robots in all stages of the production process because of its efficiency And high quality in performance, speed and accuracy in work and other features. In addition, the use of green machines, machines, and equipment in the production process works to reduce the amount of emissions and energy use, and this in turn leads to a reduction in the number of technicians, and thus reducing labor costs by (37%) of the total direct labor costs, which is equivalent to 248,373,600 dinars.

The third stage: marketing green products

It is the stage in which the economic unit in question puts its green innovation achievements in the market in order to produce and increase economic benefits and gain more competitive advantages. As determining the current demand for producers of electric power systems and LED lighting fixtures at the present time is not at the required level, in addition to that, there are similar products from several origins (Chinese, Korean, American, and Turkish) competing in the local markets. Therefore, Al-Zawraa General Company must compare the prices and specifications of competing products in order to take the necessary measures to ensure its continuity in its changing environments. On the other hand, there is a possibility to reduce the indirect industrial costs by (5%), which is equivalent to 91,625,000 dinars of the total indirect industrial costs, through the adoption of the best technologies and sustainable strategies to allocate and reduce them. In addition to the possibility of reducing administrative and marketing costs by (10%) of the total administrative and marketing costs through the adoption of green strategies that support sustainable decision-making processes and improve the efficiency of administrative performance as well as providing environmentally friendly products that enjoy the interest and preferences of the customer, which is equivalent to 16,060,000 dinars and table (34) shows it.

Table (5). Reducing costs for producers of solar energy systems and Light-emitting diode (LED) according to creative proposals

Details	Amount (Id)	Creative Proposal
Direct Materials	2,280,165,940	<ul style="list-style-type: none"> ●Develop Current And Future Sustainable Strategies ●Reducing Material Waste Through Recycling After The End Of Its Life Span Or Production Efficiency ●The Possibility Of Choosing The Best Available Alternatives
Direct Action	248,373,600	<ul style="list-style-type: none"> ●Reducing The Number Of Workers ●Use Of Green Technology ●Adoption Of Modern Robots
Indirect Manufacturing Costs	91,625000	<ul style="list-style-type: none"> ●Adopt Sustainable Methods
Administrative And Marketing Costs	16,060,000	<ul style="list-style-type: none"> ●Improve The Efficiency Of Administrative Performance ●Supporting Decision-Making Processes ●Provide Products That Capture The Interest And Preferences Of The Customer
Total	2,636,224,540	

Source: made by authors

From the foregoing, the aspects that can be upgraded and improved by relying on the complementary relationship between (IOA) and (GTI) for Al-Zawra State Company become clear. And that each of these aspects was addressed through the complementary relationship between (IOA) and (GTI) for specific indicators of the dimensions of sustainability (economic, social, and environmental). This, in turn, leads to sustainable cost management, maximization of profits and revenues, and enhanced competitive advantages.

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XVII. CONCLUSIONS AND RECOMMENDATIONS

Conclusions

- 1- There are no features of the application of input/output analysis and green technological innovation in the economic unit in question represented by the Al-Zawraa State Company.
- 2- There are no current visions and future plans to treat the waste caused by the products of the company in question after the end of its operational efficiency or its useful life.
- 3- The existence of a close complementary relationship between input/output analysis and green technological innovation, and this integration enables economic units to improve their sustainable performance, as each of the input/output analysis and green technological innovation seeks to focus on the main aspects of sustainability (environmental, economic, and social) and achieve them. at the same time.
- 4- The economic unit in question can improve sustainable performance indicators (economic, environmental, and social) if the complementary relationship between input/output analysis and green technological innovation is relied upon.
- 5- The possibility of applying the integration of input/output analysis and green technological innovation in the economic unit in question, and disclosing the amount of positive returns and reduced costs as a result of its application, as the application of the integration of (IOA) and (GTI) in Al-Zawraa State Company proved to achieve economic returns for the company amounting to 2,636,224,540 dinars annually, in addition to the environmental and social benefits achieved as a result of the implementation of that integration.

Recommendations

In light of the conclusions reached, the researchers recommend the following:

- 1- Improving the performance and efficiency of workers and developing their creative skills, as well as educating them on the application and adoption of input/output analysis technology and green technological innovation in the company's production and operational activities and operations in order to improve the level of sustainable performance and then achieve long-term sustainable development.
- 2- Increasing government support in order to reduce the costs of adopting green technology and increasing financial allocations for environmental activities, as well as increasing environmental and social awareness of companies affiliated with their public sectors.
- 3- Addressing the problems that Al-Zawraa State Company suffers from, specifically the factory of electronic and laboratory units, represented by poor waste management that causes great damage to the environment and society, through the implementation of comprehensive environmental programs to reduce and reduce the risk of this waste.
- 4- Expanding the production of sustainable products such as solar energy systems and Light-emitting diode (LED) because of their importance in providing electric energy and reducing emissions harmful to the environment, in addition to their long useful life and recyclability.
- 5- Al-Zawraa State Company seeks to adopt the integration of input/output analysis and green technological innovation, in order to improve and upgrade aspects of sustainability.

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