Green Manufacturing Practices as a Tool for Improving Competitiveness in the Light of Egypt's Vision 2030 "An Empirical Study on Egyptian Ceramic Industry"

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ABSTRACT

This paper aims to investigate the impact of green manufacturing practices on the competitiveness factors of ceramic manufacturing companies in the Arab Republic of Egypt.

Design / Methodology / Approach - A tentative list of green manufacturing and competitiveness factors has been developed based on a comprehensive and detailed analysis of the relevant literature. The survey questionnaire contained 27 items, which were developed based on the literature and interviews with three industry experts, specifically representatives of the supply chain, foreign production and sales department. 166 questionnaires were distributed to the sample under study, which is a group of 7 factories that obtained integrated environmental management certificates, and 166 questionnaires were returned. Using the data collected, a specific analysis was carried out via factor analysis to demonstrate reliability and validity.

Finding - The results showed that there is a positive impact of green production practices and increasing competitiveness factors represented in reducing (cost - reducing delivery time) and increasing (quality - flexibility) of products and services.

Originality / value - This paper presents an empirical investigation of green production practices and fills a gap in the literature related to green production practices to achieve competitiveness factors by applying to the ceramic industry in the Arab Republic of Egypt.

Key words - Green manufacturing - Competitiveness - Ceramics Industry - Egypt's vision 2030 .

INTRODUCTION

Egypt Vision 2030 seeks to maximize the competitive advantages of Egyptian products to penetrate global markets, especially the ceramic industry. Where the percentage of the local component is about 80%, and it is considered one of the large industrial sectors, where approximately 400 thousand workers (direct and indirect) work in it. It also contributes to the national income by about 20 billion dollars annually (Mabrouk, 2020). However, the problem is concentrated in the environmental burdens caused by this industry, which are concentrated during the industrialization stage (Zhu et all., 2019). This clearly conflicts with the desires of consumers, civil society organizations, and government legislation that advocate green products that do not harm the environment. Rather, it contradicts Egypt's vision 2030 itself because it seeks to pay attention to sustainable development, clean energy and environmental protection and believes that environmental health guarantees the health of individuals (Ministry of Planning and Administrative Development Egypt 2017). Therefore, financial penalties were adopted for those who did not comply with the environment. Thus, organizations have turned to green manufacturing policies as an essential and pivotal part of green supply chain practices. Green manufacturing could enhance the competitive advantage, improves quality and flexibility, reducing costs and delivery time. (Yehia, 2015) agreed that adopting green policies not only reduces costs but improves reputation, which creates customer loyalty and increases satisfaction rates.

From the above, this research is concerned with studying the impact of green manufacturing policies that enhance the competitiveness of ceramic manufacturing organizations in line with Egypt Vision 2030.

LITREATURE REVIEW

GREEN MANUFACTURING

(Gao et all., 2009) argued that green manufacturing is one of the most important steps in GSCM activities and basically means relying on activities that take into account levels of efficient use of energy and resources in a way that leads to the reduction of pollution and the use of hazardous materials during the process of converting inputs into outputs. To achieve this, manufacturers must design their processes in a way that ensures implementation of the 3RS concept, which means reuse, reduced energy use and later recycling. (Rao and Holt, 2005) tested the supply chain as an entire entity (inbound logistics - outbound logistics) and used structural equation modeling to discover whether greening the supply chain would lead to potential benefits such as (lowering cost - increasing market share and increasing profit margin). And they demonstrated that there is a positive relationship between them, and that the most important of these stages is green manufacturing. They also recommended that attention should be paid to increasing

research on the impact of green manufacturing on firm's competitiveness in Asia, Europe and North America. The first step begins with greening the manufacturing process for the products in a way that ensures their production, use, reuse and even disposal in a way that ensures sustainability and taking into account the environment. This means that the following must be noted:

- The production process consumes minimum energy and resources.
- Using recycled materials to reduce the burden of waste on the environment.
- Ensure that the product is durable, energy-saving, and easy to reuse and recycle.

(Kim et al., 2006) and (Rostamzadeh et al., 2015) mentioned that if green manufacturing policies are applied properly, we can gain benefits such as reducing manufacturing and operating costs as well as improving the corporate image of customers who prefer green products that do not affect them in the future. This positive image will improve the company's reputation, which increases the demand for products and increases its market share. Therefore, stakeholders should be encouraged to implement green manufacturing policies.

COMPETITIVENESS

(Porter, 1991) believed that competitiveness at the level of the firm means its ability to use its resources in a way that ensures the effective achievement of its goals, achieving product differentiation, cost differentiation, and creating value that outweighs competitors. (Goldsmith, 2013) believed that if the company obtains natural resources such as high quality environmentally friendly raw materials at a reasonable cost and also has human resources that can use modern technology, then it has a competitive advantage that enables it to outperform the competitors. (Mabrouk, 2020) confirmed that competitiveness is one of the components of the company's marketing strategy, and it means creating value for the products that are presented to the customer in a way that exceeds the competitors through the green supply chain, starting from the downstream point through the manufacturing process, which is considered the most important stage and ends with the final stage to achieve differentiation and distinction In cost, quality, delivery time and flexibility that help achieve sustainable market share and profitability. He also believes that the competitive advantage is not fixed and needs constant improvement and development to be close to technological, economic and social changes. (Rao and Holt 2005) We can measure competitiveness through the dimensions that differ in industrial enterprises from organizations that provide services, but there are common dimensions that fit both of them. As illustrated by (Al-Lami, 2008), the dimensions of the competitiveness are (cost - quality - delivery time - flexibility).

Accordingly, the main hypothesis of this research developed as follows:

H.1: There is a statistically significant impact of green manufacturing practices on firm's competitiveness.

COST

Cost is a very important competitive dimension that enables the company to withstand strongly against competitors, and that the company's lack of interest in reducing its costs may be an important reason for its decline and its withdrawal from the market. (Hussein, 2000) illustrated that if cost is considered as a competitive dimension, it is necessary to use modern environmentally friendly technology in production processes to effectively improve operations to spare the company penalties and fines as a result of environmental violations. We can also reduce costs through the efficient use of production capacity, in addition to continuous improvement of product quality, creativity in product design and the use of the latest information technology. (Melnyk et al., 2002) said that energy consumption during manufacturing processes in line with greening policies reduces processing fees and waste disposal and avoids the company environmental penalties, which leads to a positive economic performance that enables us to reduce costs and improve the company's position so that the company can take advantage of this price difference to excel over competitors. Thus, the sub hypothesis developed as the following:

H 1.1: There is a statistically significant impact of green manufacturing practices on cost.

QUALITY

Quality is an important competitive dimension because it refers to doing things right to provide products that meet customer needs. (Evans and Collier, 2007) mentioned that high-quality products contribute to customer satisfaction and improve company reputation, thus enhancing the company's competitiveness. (Salah Diab, 2014) affirmed that competitiveness is strongly achieved through the quality window when the company produces products and services in a way that meets the requirements of its customers. This requires that companies view quality as the key to customer satisfaction and not just a means to solve problems and reduce costs, and achieving the concept of quality guarantees The Company’s acquisition of a larger market share contributes to a significant increase in investment returns and ensuring survival in the competitive market. (Mabrouk, 2020) believed that quality is the dimension that reflects how companies focus on improving their internal processes and activities in a manner consistent with the environmental management of manufacturing processes in order to increase customer satisfaction with the level of quality and reliability of products and services. Thus, the sub hypothesis developed as the following:

H 1.2: There is a statistically significant impact of green manufacturing practices on quality.

DELIVERY TIME

(Evans and Collier, 2007) mentioned that most companies use delivery time as a weapon to maintain existing customers and attract new customers by offering better products faster than other companies. (Al-Lami, 2008) believed that the desire of customers to receive their products in a short time has made delivery time an important dimension of companies' competitiveness. (Salah, 2014) agreed with them that the delivery time is a very important competitive dimension, as speed of service and response to customer demand has become one of the factors that distinguish between organizations. (Bakri and Thamer, 2005) mentioned that if the organization is able to respond to the needs and requirements of the client quickly and in a shorter time, it will gain a large market share and will charge higher prices for its services. Thus, the sub hypothesis developed as the following:

H 1.3: There is a statistically significant impact of green manufacturing practices on delivery time.

FLEXIBILITY

(Russell and Roberts, 2000) illustrated that flexibility as a competitive dimension means the ability of the organization to provide multiple and different levels of products and services to the target market, the ability to keep pace with developments in technology services, design according to customer expectations and respond to changes in customer demand, whether increase or decrease. Flexibility plays an important role in achieving a competitive advantage for organizations, which leads to improve the company's reputation and its market position. (Seuring, 2004) described Flexibility as the management integration of information and material flows within the green supply chain with the purpose of meeting customer demands for products and services produced by the company in a manner that improves their satisfaction and creates their loyalty. Thus, the sub hypothesis developed as the following:

H1.4: There is a statistically significant impact of green manufacturing practices on flexibility.

THE RELATION BETWEEN GREEN MANUFACTURING & COMPETITIVENESS

(Zhu and Sarkis, 2004) indicated that green supply chain is an increasingly important environmental solution as it impacts the future of industrial processes and could be the difference between business survival and business failure in the coming days. However, implementation of green supply chain strategies faces hurdles across the world.

(Klassen and McLaughlin, 1996) indicated that environmental management includes various initiatives to reduce the environmental impact of manufacturing processes by

minimizing hazardous and non-hazardous wastes. Which leads to better use of resources, improved production efficiency, reduced risks of environmental non-compliance, which improves the environmental performance, the mental image of the company, this will increase economic performance again and reduce operating costs. (Rao et al., 2005) illustrated that greening the supply chain increases competitiveness and economic performance, especially in the Middle East, which strives to achieve competitiveness in its commercial activities at the local and global levels. It has a positive effect on saving costs, enhancing sales and market share, creating new opportunities that lead to high profit margins and increasing competitive advantage. (Ling et al., 2016) illustrated that green production practices include the 3RS concept which results in reduced direct and indirect costs thus reducing product cost, increasing market share and increasing competitiveness. For the purposes of the overall objective and the proposed hypotheses, the model shown in Figure 1 has been proposed to see the impact of green manufacturing practices on the competitive factors (cost, quality, delivery time, and flexibility).

Figure 1: Research model developed by the researchers

EGYPT VISION 2030

By the year 2030, Egypt will be based on justice and sustainable development, competitive diversified economy that depends on innovation and knowledge that exploits the genius of the place, the human being and improves the quality of life. The strategy focuses on four main axes:

The economic axis: aspires to a disciplined market economy that is characterized by stability and capable of achieving sustainable growth, characterized by competitiveness and diversity, capable of adapting to global changes, being a player in the global economy and adding value.

Energy axis: able to meet the requirements of sustainable development, able to adapt to global changes in the field of energy, innovation and leadership in the fields of renewable energy.

The axis of health: that Egyptians enjoy a healthy and safe life.

The environment axis: sustainable improvement of the quality of life for current and future generations, raising awareness about nature protection, limiting the impact of

climate change with the aim of providing a clean, safe and sustainable environment through the application of development policies characterized by the integration of the environmental component and achieving a balance between the priorities of economic growth and environmental elements to stop environmental degradation and preserve its balance and the transition to more sustainable consumption and production patterns that meet the global requirements and manage the waste system in a technical and environmental manner. (Ministry of Planning and Administrative Development Egypt 2017).

From the foregoing, the researchers see that green manufacturing policies are fundamentally linked to the vision of Egypt 2030 because they link the [economic axis in achieving economic and competitive growth for Egyptian products, the environmental axis in improving the quality of life for future generations, protecting nature and integrating the priorities of economic growth and environmental elements, the energy axis in meeting the requirements of sustainable development. The axis of health in preserving the health of the human resource, which is considered the most important resource of organizations]

METHODOLOGY

This study focuses on green manufacturing practices for ceramic factories in the Arab Republic of Egypt. Where a sample of 7 companies that implement environmental management systems and have a market share in the global markets was selected according to the data of the Egyptian Chamber of Ceramic and Building Materials Export 2019-2020.

Data were collected using a structured questionnaire consisting of 27 items. Items are rated using a Likert scale (1 corresponds to "Strongly disagree" and 5 correspond to "Strongly Agree"). Table 1 shows the elements used as well as the sources for these elements.

Table 1: The Questionnaire Items

N	Statement
Green manufacturing	▪ The company uses control systems to reduce toxins in the production process. ▪ The company has a system to reduce waste generated by the manufacturing process. ▪ The company uses systems to reduce pollution. ▪ We use the application of manufacturing techniques such as agile manufacturing. ▪ Manufacturing machines are subject to regular maintenance procedures. ▪ Firm cares about the quality of the final product. ▪ Employees possess the skills to apply green manufacturing.
cost	▪ The company plans to reduce the cost of raw materials. ▪ The company offers competitive prices for its products. ▪ The company focuses on reducing production costs. ▪ The company determines the size of the order to match the cost. ▪ The company's R&D policy seeks to reduce costs .
quality	▪ The company relies on quality in competition. ▪ The company's products correspond to the desires and needs of customers. ▪ Company concerns with customer's complaints especially those related to quality. ▪ Company uses appropriate means of transportation to keep its product's quality. ▪ Company directs customers towards proper storage conditions to maintain product quality.
delivery time	▪ The company receives the orders from the suppliers on the specified dates. ▪ The company provides services to customers on time. ▪ The company adheres to the deadlines for delivery of orders. ▪ The company has programs to quickly develop its products. ▪ The company is concerned with the delivery of emergency orders quickly.
flexibility	▪ The company has the ability to develop its products according to the wishes of customers. ▪ The company provides offers on products constantly. ▪ The company continues to update the means and methods of promoting its products. ▪ The company has the ability to supply production quantities of different sizes. ▪ The company has the ability to enter new markets .

The researchers conducted the validity and reliability test of the measuring instrument used in the field and selected companies that rely on the concept of "green supply chain practices". The sample size was 7 companies, as shown in the following table.

Table 2: Selected Sample Companies

N	Company name
1	Cleopatra
2	Royal
3	Al Jawhara
4	Art
5	Alfa
6	Lecico
7	Prima

Source: Central Agency for Mobilization and Statistics.

The researchers identified the departments within the companies that are related to the research variables, and found that they are (general managers, production and operations management, supply chain management, quality department, sorting department).

The researchers conducted that the number of workers in these departments within the seven companies are numbered (166) individuals, so they followed the comprehensive inventory method, the distribution of the sample was as shown in the following table.

Table 3: The distribution of the sample

N	**Department / Administration**	**Size Sample**	**%**
1	General managers	١٤	%٨,٥
2	production and operation management	٨١	%٤٨,٨
3	Supply Chain management	٢٦	%١٥,٧
4	quality department	٢٠	%١٢
5	Sorting department	٢٥	%١٥
Total		١٦٦	**100%**

Source: developed by the researchers

Validity and reliability of the study variables

To test the internal stability of the scale statistically, Cronbach's Alpha was used and the results as follow:

Table 4: The reliability of the dimension

Variable	The number of items	Factor Reliability Cronbach's Alpha
Green manufacturing	٧	٠,٧٩٥
Cost	٥	٠,٧١٧
Quality	٥	٠,٧٥٦
Delivery time	٥	٠,٧٧٥
Flexibility	٥	٠,٧٦٩

It is clear from the previous table that all values of the Cronbach's Alpha stability factor of the survey list variables were greater than 0.6. This means that the degree of consistency and sincerity of the content of the research variables is high.

Testing the main hypothesis:

This hypothesis states that "there is a statistically significant impact of green manufacturing practices on corporate competitiveness" and this hypothesis is divided into four sub- hypotheses:

- **The first sub-hypothesis**: there is a statistically significant impact of green manufacturing practices on cost.
- **The second sub-hypothesis**: there is a statistically significant impact of green manufacturing practices on quality.
- **The third sub-hypothesis**: there is a statistically significant impact of green manufacturing practices on delivery time.
- **The fourth sub-hypothesis**: there is a statistically significant impact of green manufacturing practices on flexibility.

Table 5: shows the Correlation coefficients between green manufacturing and corporate competitiveness dimensions.

Correlations					
		Cost	Quality	Delivery time	Flexibility
Green manufacturing	Pearson Correlation	.858	.823	.827	.854
	Sig. (2-tailed)	.000	.000	.000	.000
	N	166	166	166	166

Testing the first sub-hypothesis:

Table 6: Analysis the impact of green manufacturing practices on cost.

Coefficients					
Model	**Unstandardized Coefficients**		**Standardized Coefficients**	**T**	**Sig.**
	B	**Std. Error**	**Beta**		
(Constant)	.092	.117		.790	.430
Green manufacturing	.283	.058	.272	4.880	.000

The previous table shows a significant impact of (green manufacturing), on cost. For this variable, it reached 0,000 which was below the significance level of 0.05. Therefore, we accept the first sub-hypothesis.

Testing the second sub-hypothesis:

Table 7: Analysis the impact of green manufacturing practices on quality

Coefficients					
Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	.018	.125		.145	.885
Green manufacturing	.119	.062	.110	1.912	.058

The previous table shows the results that indicate a significant impact of (green manufacturing), on quality. Therefore, we accept the second sub-hypothesis.

Testing the third sub-hypothesis:

Table 8: Analysis the impact of green manufacturing practices on delivery time

Coefficients					
Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	-.055-	.122		-.451-	.653
Green manufacturing	.118	.061	.107	1.953	.050

The previous table shows the results which indicate a significant impact of (green manufacturing), on delivery time as a dependent variable. Therefore, we accept the third sub-hypothesis.

Testing the fourth sub-hypothesis:

Table 9: Analysis the impact of green manufacturing practices on flexibility

Coefficients					
Model	**Unstandardized Coefficients**		**Standardized Coefficients**	**T**	**Sig.**
	B	**Std. Error**	**Beta**		
(Constant)	-.143-	.115		-1.240-	.217
Green manufacturing	.193	.057	.176	3.367	.001

The previous table shows the results that indicate a significant impact of (green manufacturing) on flexibility with a value of 0.001, which was below the significance level of 0.05. Therefore, we accept the fourth sub-hypothesis.

RESULTS

The research results show that the ceramic industry sector in Egypt is not witnessing the optimal application of green supply chain management practices.

Therefore, the application of green manufacturing should be reviewed to enhance the sector's competitiveness where the ceramic industry represents an important sector in the Egyptian industry, which has a place in the global markets and contributes greatly to the composition of the promising Egyptian economy.

The results of testing the hypotheses showed that:

Main hypothesis: there is a statistically significant impact of green manufacturing practices on corporate competitiveness, and this hypothesis is divided into four sub- hypotheses:

- The first sub-hypothesis: there is a statistically significant impact of green manufacturing practices on cost.
- The second sub-hypothesis: there is a statistically significant impact of green manufacturing practices on quality.
- The third sub-hypothesis: there is a statistically significant impact of green manufacturing practices on delivery time.
- The fourth sub-hypothesis: there is a statistically significant impact of green manufacturing practices on flexibility.

HOW DO FIRMS UNDERSTAND THE NATURE OF THIEIR ACTIVITIES AND PRODUCTS TO START GREENING THEM?

(Zhu, et all., 2019) determined three questions that help to identify how and from where the firms can start to implement GSCM practices.

First Question: Where should organizations begin?,

Second Question: What should be done first?,

Third Question: What is the company's priority to successfully implement GSCM practices?

The answer to these questions is summarized in three steps:

First Step: Correct understanding of the company product life cycle (PLC),

Second Step: Know and understand where your company is located in relation to the environmental burden in the supply chain,

Third Step: Choose the appropriate practices for greening activities.

Thus:

- From the perspective of Product Life Cycle Analysis (PLC) Ceramics are included in the second type of products.
- Therefore, the greatest environmental burden falls during the production stage.
- Therefore, priority is given here in internal environmental management (IEM) processes to reduce energy consumption and greenhouse gas emissions using cleaner production techniques.

Responsibility of SC members	Suppliers - sub Suppliers	Producers	Wholesalers	Consumers
environmental Liability roles	ECO - DESIGN and supply of raw materials that take into account environmental dimensions	Green manufacturing Planning and Operations Management (IEM) efficiently	Green purchases of end-of-life products. And educate customers about the need for cooperation to make the series successful	Collaborate with chain parties to dispose of expired products to return them to the cycle.

The researchers developed an action plan clarifying the environmental burdens during the ceramic manufacturing stages. This action plan was presented to three industry experts

and reported on its effectiveness and the benefits that would happened from its implementation.

stage	Description of the stage	Environmental burden	Action	Objective	Responsibility	Time frame
Transporting, handling and storing R.materials, weight,sorting grinding and mixing	-Raw materials are stored in warehouses or in open spaces as piles. -Raw materials are domestic elements in addition to materials imported from abroad. -Water and clay are mixed with compounds such as (aluminum balls to add strength to the mixture, calcium carbonate and silicates). -The mixture is dried with air and mist in giant dryers and comes out as a fine dust powder with slight moisture (Environment 2000).	-Produces fine particles suspended in the air in the form of dust containing dangerous substances such as silica dust, feldspar and others. -Inhalation of this dust causes lung cancer, shortness of breath, pulmonary toxicity and pulmonary ossification.	-Buy environmentally friendly raw materials that contain less harmful materials according to European ceramic industry standards. -Separate storage areas for raw materials from operating areas. -Use wind protection methods. For example (using wind barriers or using thick-growing trees or shrubs if raw materials are stored in open spaces). -Use closed silos to store the ground materials. -Using closed systems to transport raw materials (conveyors and closed screw feeders). -Use of dust extraction equipment and bag filters, especially at dry material loading points, as well as in places of cutting, sharpening and polishing of products. -Use wet dust separators to treat emissions from the spray drying process. -Maintaining the negative pressure level in closed systems used in material handling and removing dust from the withdrawn air. -Using personal protection devices.	Reducing air pollution and dust emissions that affect work crews and lead to health risks, reducing waste in materials during transport, handling and sorting, as well as improving the quality of materials during the mixing process, which improves the durability of tiles	Members of procurement, transportation, raw material stores and production under the supervision of Supply Chain and Production Managers	

stage	Description of the stage	Environmental burden	Action	Objective	Responsibility	Time frame
Casting, cutting and glazing stage	-It is the stage of pouring the mixture, cutting it into the desired shapes and sizes. -spray with similar materials such as quartz, which is called silicates, to add a protective layer after melted on the surface of the slab after burning.	-Produces soot and carbon components and also includes suspended particles, acidic capacitors and minerals such as lead, cadmium, sulfate, and nitrate. -They are nanoparticles (less than 10 ppm) and cause severe respiratory damage identical to those previously mentioned (EPA 2002).	-Implementation of the glazing stage in well-ventilated areas with the installation of spray booths and avoid the use of low soluble glass coating materials. And that contains lead or other heavy metals. -Use of colored compounds and permanent dyes at elevated temperatures. -Use wet separators to treat emissions from spray drying, glazing, and cleaning gases from spray booths. -Use rapid burning cycles to reduce metal variability with these types of coatings.	-Reducing air pollution emissions that affect work crews and lead to health hazards. -Reducing waste in materials during spraying and glazing, as well as improving the final shape of the slab surface.	- Department of Production. - Maintenance department. - Procurement department.	**During the implementation of the process. Maintenance must be done periodically.**
Burning stage	The tiles are burned to give them color hardness and consistency.	-Sulfur dioxide is emitted from burning the level of sulfur in the atmosphere depends on the rate of fuel and the presence of some raw materials, as well as gypsum, byte and other sulfur compounds it is harmful to plants, animals and building materials.	-Use of low-sulfur fuel such as natural gas or liquefied gas. -using raw materials characterized by a low level of sulfur. -Improving fire control and combustion temperature by electronic control and use of rapid burning furnaces (Environment 2000).	-Reducing air pollution emissions that affect work crews and lead to health hazards. -Reducing waste in materials during burning, as well as improving the final shape of the slab surface and increase durability of tiles.	- Department of Production. - Maintenance department. - Procurement department.	**During implementation of process. Maintenance must be done periodically.**

Source: developed by the researchers.

RECOMMENDATIONS

Recommendations for Government Decision-makers

- Granting benefits to companies that implement sustainable development policies to encourage companies to implement them.
- Provide training and support programs to initially assist firms to implement green sourcing practices.
- Carrying out campaigns to educate customers about the importance of green products to increase pressure on companies to adopt these policies.
- The Ministry of Planning, in cooperation with the Ministry of Trade, Industry, Environment and Health, and the labor offices of the Ministry of Manpower, must develop a plan to protect the environment and workers from the wrong practices of factories and organizations.
- Looking at green products as part of the strategic development plan, especially with the Egyptian political leadership adopting Egypt Vision 2030.
- Reducing the price of natural gas to encourage firms to expand its use because of its environmental impacts that are less harmful than similar.

Recommendations for Decision-makers in Business Organizations

- Modernizing incineration and mixing systems in line with modern systems that consider the environment.
- Make green policies part of the company's culture.
- Supporting strong training programs to develop green leaders with support from senior management.
- Establishing a future plan for selecting environmentally friendly suppliers and evaluating them regularly.
- Take environmental measures to ensure the sustainability of the supply chain as a whole, and developing methods that include recycling used ceramics to reduce its harmful effects on the environment and making use of the Japanese experience in recycling ceramics and reintroducing them into the production process.
- Encouraging employees to present innovative ideas that serve green policies.

Recommendations for future research

- The relationship between GSCM practices and Total Quality Management.
- Study the application of GSCM practices in the petrochemical, marble, fertilizer, and energy-intensive industries that are believed to cause environmental burdens during their various stages.

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