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The role of sustainable manufacturing in improving corporate competitiveness: A field study in northern refineries

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Abstract
This study aims to study the character of maintainable manufacturing in improving the lowness of companies by converging on the post-research stage as a practical model. It speeches the impact of sustainability on the standing and appeal of investors and clienteles. The descriptive analytical approach was used, and the study relied on a questionnaire directed to a sample of 100 individuals working in refineries. The results showed that sustainable manufacturing increases production efficiency and product quality, and energy technology contributes to improving the reputation of companies and attracting investors despite the challenges in applying renewable energy.

Keywords: Sustainable manufacturing, competitive advantage**,** refineries, sustainability, sustainable competitive advantage

Introduction
In light of the environmental and economic challenges facing the world today, sustainable manufacturing has become one of the most important strategies adopted by industrial companies to improve their performance and increase their competitiveness. Sustainable manufacturing, which means producing goods using resources more efficiently and reducing negative impacts on the environment while maintaining the economic capacity of companies and achieving long-term profitability, has become an inevitable response to global trends towards reducing carbon emissions, preserving natural resources and dealing with climate change. This type of manufacturing also contributes to building a positive image for companies in front of consumers and investors. This field study focuses on evaluating the benefits that can be achieved by adopting sustainable practices in manufacturing processes. These practices include improving energy efficiency, reducing waste, enhancing innovation in production processes and relying on renewable energy sources. It is expected that this will appear in reducing operating costs, improving the environmental performance of refineries and increasing their ability to compete in global markets. In addition, sustainable manufacturing will improve the image of refineries in front of stakeholders, including In investors, customers and local communities

Study problem
The research problem is to study the relationship between sustainable manufacturing and enhancing competitiveness in companies, focusing on the northern refineries as the field case, as oil refineries are considered vital industries that face major challenges related to environmental and social sustainability, and their activity is linked to the high consumption of natural resources such as water and energy and the increase in polluting emissions. In this context, the research problem is motivated by the economic and environmental need at the same time to ensure their continuity and ability to compete in a market where interest in sustainability is increasing. In addition, they face the coincidence of competitors who have already begun to practice sustainable production technology, which puts the northern refineries in a position that requires them to shift towards sustainable manufacturing to maintain their share. The problem is how to effectively apply the principles of sustainable manufacturing in the northern refineries to ensure the achievement of dual benefits and enhance the company's competitiveness by reducing costs and increasing efficiency while

improving its image in front of customers and investors who prefer environmentally responsible companies.

Study objectives

This study aims to achieve a set of main objectives related to understanding the relationship between sustainable manufacturing and improving companies' competitiveness, focusing on the Northern Refineries as an applied example.

1. The first objective is to analyze how sustainable manufacturing practices can improve resource efficiency and reduce industrial impacts by studying this relationship. The research aims to identify opportunities through which refineries can achieve a balance between economic guarantee and environmental conservation.
2. The second objective is to identify effective strategies that Northern Refineries can adopt to implement sustainable manufacturing, taking into account the environmental and technological challenges facing refineries, including exploring new renewable energy technologies, managing resources efficiently, and improving production processes to reduce waste and harmful emissions.
3. The third objective is to study the impact of sustainable manufacturing on the company's reputation and attractiveness to investors and customers, with the increasing global interest in sustainability and social responsibility. The research seeks to measure how sustainable manufacturing practices can positively affect the company's image in the market, attract new investors, and enhance customer loyalty.

Significance of Study

The importance of this research is highlighted in light of the environmental and economic challenges facing industrial companies, especially oil refineries, as global pressures are increasing towards adopting sustainable practices in the context of northern refineries. The research comes to provide a comprehensive vision on how to achieve sustainable manufacturing as a motive for improving competitiveness through the application of sustainable manufacturing practices and how refineries can improve resource utilization efficiencies and reduce the environmental impact, which contributes to reducing operating costs and increasing profitability in the long term and increasing or environmentally responsible practices. Therefore, the research is important because it helps companies understand the strategic role that sustainable photography plays in enhancing their image, which enhances their ability to compete in local and international markets.

Study Concepts

- Sustainable manufacturing: is another term for the manufacture of manufactured goods using a number of financially viable methods that reduce adverse effects on the environment, save natural resources, and ensure the safety of employees, communities, and consumers. Green product design, green technology, green production, and green procurement are all components of sustainable manufacturing (Fatoki, 2019) [11].
- Competitive advantage: The ability of a business to develop and put into action plans that provide it an advantage over other businesses engaged in the same activity is referred to as its competitive advantage. A company can gain a competitive advantage by making the best use of its technical, material, financial, and organisational resources in addition to its other assets, competencies, and knowledge that allow it to develop and carry out its competitive strategies. Two fundamental factors are associated with gaining a competitive edge: the customer's perception of the company's value and its capacity for excellence. (Abu Bakr, 2007) [1].
- Sustainable competitive advantage: (Barney's., 1991) [8] defined as the application of a value-creating strategy that has not been imitated in the past and that cannot be imitated in the future by any current or potential competitors, and when other organisations are unable to replicate the benefits of this strategy, is regarded as one of the most significant definitions of sustainable competitive advantage. In other words, it is the distinct position that the company strives for.

Previous studies

Study (Hussain Jahanzaib., 2018) [14]. About Sustainable manufacturing–An overview and a conceptual framework for continuous transformation and competitiveness

This research provides a comprehensive overview of sustainable manufacturing, focusing on three elements: "ideal," "strategy," and "architecture." The ideal is a context for exploration and selection, synthesis of stakeholders' desires, and systematic discovery of opportunities. The strategy element focuses on matching and transformation, enhancing a company's ability to adapt to changing contexts and achieve goals. Architecture is a functional and operational context, bringing together capabilities, organization, operational structure, and value-creating processes. This research proposes a systematic approach to integrate sustainability into the core of manufacturing businesses, guided by contextual questioning and multi-faceted research on sustainable manufacturing, circular economy, capabilities, strategy, transformation, and systems thinking. The proposed framework is expected to meet the essential needs of enterprises in sustainable manufacturing, ensuring transformation and competitiveness in a fast-paced environment.

Study (Afum *et al*., 2020) [2]. About Exploring the link between green manufacturing, operational competitiveness, firm reputation and sustainable performance dimensions: a mediated approach

This study investigates the relationship between green manufacturing practices, operational competitiveness, firm reputation, and sustainable performance dimensions. Data was collected from 158 manufacturing firms across various industries using a structured questionnaire. The findings demonstrate the beneficial effects of green manufacturing on environmental, social, and economic outcomes. However, there is no evidence that operational competitiveness or corporate reputation have a major impact on economic performance. Additionally, no mediation function was discovered by the mediation analysis between economic performance and green manufacturing. The relationship between green manufacturing and economic performance is mediated by social performance. The data was primarily gathered in Ghana, a developing nation, and moderator variables were not taken into account in this study. The results indicate that in order to increase

sustainable performance characteristics, boost operational competitiveness, and improve enterprises' reputation, managers should proactively apply and invest in green manufacturing methods. This study is one of the few that looks into this connection, especially from a mediation analysis approach, and it makes a substantial contribution to the body of knowledge on green manufacturing

-Study (Sivakumar *et al*., 2020) [21] About Analysing organisational competitiveness through sustainable manufacturing using a hierarchical approach.

A framework for assessing the organisational competitiveness obtained through sustainable manufacturing is proposed in this study. To evaluate organisational competitiveness, an analytical hierarchal process assessment model has been implemented. In order to comprehend the relationships between seven sustainable manufacturing practices and five organisational competitiveness with 14 intermediate-level sustainable manufacturing outcomes, a conceptual model is built. By calculating the worldwide priority scores of sustainable manufacturing practices and outputs, the achievement of six organisational competitiveness metrics is assessed. The key contribution of this work is the linkage matrix that was created between the practices and the output of sustainable manufacturing and the output and organisational competitiveness. This matrix can be used by researchers and practicing managers to better understand the various interactions and, ultimately, advance the field of sustainable manufacturing research.

-Study (May *et al*., 2017) [15] About the significance of organizational change management for sustainable competitiveness in manufacturing: exploring the firm archetypes.

Research and practice are very interested in the successful development and implementation of appropriate sustainable manufacturing techniques, which are still unresolved difficulties. Motivated by this specific difficulty, we examine the role that organisational change management plays in maintaining manufacturing's competitiveness over the long term. Using six case studies from the Lombardia region of Italy, we identify four archetypes of companies that show an increasing formalism and persistence in organisational change along with an increasing sustainable competitiveness. Our research is based on the theoretical constructs of organisational change and competitive aggressiveness. Our findings indicate that implementation gaps prevent businesses from reaching their full potential and that change management techniques are a necessary presumption for obtaining a sustainable competitive advantage. In addition to giving stakeholders insight on how better planning and leadership practices might effect sustainable performance, the study also offers advise on how change management measures may potentially affect firm performance in the manufacturing sector.

Literature Review

The concept of sustainable manufacturing has been developed over a short period of time and has been called under different names such as environmentally friendly manufacturing, as a sub-concept of pollution prevention, and it can be considered a manufacturing strategy that integrates environmental and social considerations in addition to technical and economic considerations (Despeisse *et al*., 2012, 9) [10]. It is defined as a manufacturing process through which goods and services are provided to meet the needs of customers in society and works to increase economic growth and delay or slow down the negative impact on the environment. (Al-Hamdani and Al-Saray., 2017) [3] see that sustainable manufacturing is a means of improving and developing life through an optimal combination of activities in the production and consumption process and working. to improve the efficiency of using raw materials and energy and using available resources effectively to achieve sustainable performance in the organization. (Al-Sabaawe *et al*., 2024: 243) [5] Sustainable manufacturing is an approach that aims to reduce environmental impacts to the lowest possible level, and works to conserve energy, enhance the safety of workers, consumers and society, and enhance the economic capacity of organizations. (Thirupathi *et al*., 2012) [22] defined sustainable manufacturing as a set of transformational activities in operations and trade to produce products in a way that achieves prosperity for society, preserves resources on the planet, ensures profitability for organizations, and contributes to achieving the well-being of stakeholders from workers, consumers and society in general. The researchers see from the above that sustainable manufacturing is a philosophy based on a set of systems and technologies through which organizations seek to fulfill their moral responsibility towards the environment through the efficiency of using all types of resources and energy, thus ac hieving social and economic goals. (Despeisse *et al*., 2012) [10].

The importance of sustainable manufacturing

Sustainable manufacturing contributes to:

a) Preserving the environment by reducing activities that harm it.
b) Addressing social problems such as reducing poverty and achieving maximum value from products that are manufactured sustainably.
c) Saving costs as a result of reducing energy and minimizing waste to the minimum possible The importance of sustainable manufacturing lies in reducing energy consumption, reducing waste, and improving the quality and durability of the product.
d) Reducing environmental and health impacts, and developing renewable energy resources. (Rebaz *et al*., 2022) [19].

Dimensions of sustainable manufacturing

Sustainable manufacturing differs from the concept of regular manufacturing in that it takes into account the triple bottom line (TBL) standards, which simultaneously take into account the environmental, economic and social dimensions. (Sadeghi *et al*., 2024: 107) [20]

(Qureshi *et al*., 2020) [18] agree that the dimensions of sustainable manufacturing the environmental dimension, the economic dimension, and the social dimension. These dimensions are consistent with the type of the current study. The following is an explanation of each dimension of sustainable manufacturing

The environmental dimension is the organization's interest in important environmental issues such as the depletion and exhaustion of natural resources. Therefore, organizations, when producing goods and services, try to diagnose the areas of waste in them and use them efficiently (Al-Samman and Al-Dabbagh, 2020) [7] is to evaluate the environmental life cycle of the product in order to enhance its

sustainability, achieve environmental benefits, and obtain environmental certificates and labels through several procedures such as using healthy and recyclable packaging materials.

The implementation of the manufacturing strategy for sustainable production is achieved through An integrated environmental protection system where the focus is on preventing pollution from its sources instead of treating industrial waste and waste (Al-Hamm, 2012) [6]. B. The economic dimension is the organization's long-term survival in the market by producing environmentally friendly products as there is an increasing demand from consumers for these products due to their increased environmental awareness and this responsible behavior helps organizations achieve sustainability.

It is achieving growth and reaching sustainable success from an economic point of view, where organizations work to adhere to environmental standards in their operational processes, and it is the organizations following steps such as producing environmentally friendly products, in order to enhance and improve their brand image as it drives consumer intention to purchase these products (Al-Sabaawe *et al*., 2021, 1459) [5].

T. Social dimension: It is the organization building better social relations by demonstrating a responsible and proactive approach in dealing with the local environment and local residents, improving employee morale and retention, and improving organizational relations with shareholders and stakeholders in order to enhance the organization's reputation. It is the inclusion of social responsibility indicators to achieve agility and greenness, which are among the best applications that improve organizational performance in industrial organizations (Al-Samman and Al-Dabbagh 2020) [7] It is following a set of procedures and making them part of the organization's strategies and not just a reaction after work-related problems occur, such as providing a safety guide, providing various safety tools that can be used in the workplace, appropriate training programs, comprehensive and written standard operating principles for machines, preventive maintenance procedures, and continuous monitoring and follow-up As mentioned, it leads to providing a more sustainable work environment for individuals working in industrial organizations and reducing work-related health risks (Parmar *et al*., 2021) [17].

Sustainable Competitive Advantage

Under the international green management trends, competition in global industries has become more complex and uncertain. Most product and technology developments are moving towards a green structure, and this has led to accounting for environmental impacts in business strategies to major changes in the social system and the competitive arena. (Al-Maadhedee &Al-Sabaawe, 20218: 89) [4] The concept of sustainable competitive advantage was introduced in 1984 and its focus was on strategies for maintaining it. The term sustainable competitive advantage was further developed in 1985 by Porter with a variety of competitive strategies (cost leadership, differentiation, and focus), however, he did not provide a formal definition of sustainable competitive advantage. (Barney, 1991) [8] provided the closest definition of sustainable competitive advantage by applying unique value creation strategies that competitors cannot imitate (Hakkak & Ghodsi, 2015) [12] by finding new advantages that keep them ahead of competitors, and looking for ways to differentiate themselves from competitors for the sake of "green", companies are trying to find several ways and practices to deal with environmental issues, one of the ways is innovations that can have positive environmental impacts. The idea of sustainable competitive advantage has become one of the most important principles that guide our thinking about our long-term relationship with the environment. The competitive advantage of businesses is managed by external and internal factors, and is a clear manifestation of the implementation of innovations in products, processes, and businesses in companies. Therefore, the degree of competitiveness of new green products and processes should be evaluated. Sustainability requires innovation performance, including the implementation of a new or improved product, process, new marketing method, production methods, or a new organizational method in business practices, or workplace organization, which contributes to environmental innovation efforts towards sustainability in enhancing sustainable competitiveness (Park *et al*. 2017) [16].

Writers and researchers differed in defining the concept of sustainable competitive advantage, each according to his approach and the angle from which he looks. The following are some concepts about it. Yahyaoui defined it as the distinctive position, status, or benefit resulting from the company's course of action compared to its competitors, in addition to maintaining it for the longest possible period. Coyne Kevin indicated that in order to create a sustainable competitive advantage, customers need to recognize the differences between the company's products and those of competitors. These differences must be created in the company's resources that cannot be accessed by its competitors. (Basir Khalaf *et al*., 2019) [9].

Resources should have four characteristics: scarcity, value, imitation, and substitution. Focusing on some competitive priorities or priorities, capabilities, or practices on key decision areas and their internal consistency can be the basis for achieving sustainable advantage. (Hong & Jian 2013) [13] suggested that companies prefer to make the strategic choice of green innovation in order to obtain sustainable competitive advantage. There are different views on how to obtain competitive advantage for companies, and this topic has become an important research area in strategic management. Recent research shows that the source of sustainable competitive advantage develops from several aspects, such as own core competence, resources, knowledge, and innovation. To measure the competitive advantage of companies, there are several items: (1) The company has a low-cost competitive advantage compared to other competitors, (2) The quality of the products or services provided by the company is better than the products or services of other competitors, (3) The company is more capable of research, development and innovation than other competitors, (4) The company has better management capacity than other competitors, (5) The company's profitability is better, (6) The company's growth exceeds the number of its other competitors, (7) The company is the first mover in some important areas and occupies an important position (Basir Khalaf *et al*., 2019) [9].

Methodology

This revision used a descriptive logical approach to analyze

the association between sustainable manufacturing performs and enhancing firms' competitiveness, concentrating on northern plants as a case study. Data were collected from a sample of 100 refinery workers from various sections and positions to provide a complete representation of views on sustainable manufacturing do. As the main means of data collection, we used a survey questionnaire, where we measured the extent of implementation of sustainable production practices and their impact on production efficiency, reduction of environmental impacts, improvement of the company's image on the market, and attractiveness of investors and customers. We analyzed the data using appropriate statistical methods in order to provide conclusions and recommendations regarding improving competitiveness through sustainable production.

Results

Table 1: Efficient use of resources and reducing environmental impacts

Phrase	Mean	Stander Deviation
Sustainable manufacturing practices contribute to improving the efficiency of energy use in refineries.	3.66	1.35
Sustainable manufacturing practices contribute to reducing the consumption of raw materials.	4.12	1.02
Refineries rely on modern technologies to recycle resources used in production processes.	4.31	0.93
Sustainable manufacturing practices contribute to reducing harmful emissions.	3.80	1.07
Refineries work to achieve a balance between economic production and environmental conservation.	4.24	0.90

Examination of the “Resource competence and environmental influence reduction” axis shows that maintainable industrial practices donate significantly to refining resource use and plummeting environmental impacts. The declaration “Refineries rely on contemporary technologies to reprocess resources used in manufacture processes” logged the highest mean (4.31) with the lowermost standard deviation (0.93), representative strong agreement among members on the efficiency of these practices. The declaration “Refineries work to attain a balance amid economic production and ecological conservation” also showed a high grade of contract with a mean (4.24) and a low standard deviation (0.90), strengthening the importance of these does in achieving the obligatory balance. In contrast, the declaration “Sustainable manufacturing performs contribute to refining energy efficiency in plants” had the lowermost mean (3.66) and a advanced standard deviation (1.35), representative that members’ sentiments on the efficiency of these aspects diverse.

Table 2: Resource Management and Environmental and Technological Challenges

Phrase	Mean	Stander Deviation
Refineries have effective strategies to manage resources sustainably.	4.68	0.60
Refineries face major challenges in applying renewable energy technologies.	4.48	0.83
Production processes are continuously improved to reduce waste.	4.10	1.02
Refineries overcome environmental challenges by adopting sustainable technologies.	4.01	0.83
Refineries seek to benefit from technological developments to enhance sustainability.	4.04	1.00

The analysis of the “Resource Management, Environmental and Technological Challenges” axis shows that refineries follow effective strategies for sustainable resource management, as the phrase “Refineries have effective strategies for sustainable resource management” indicates strong opinions about the effectiveness of these strategies among participants that we were . Refineries also face significant challenges in implementing renewable energy technologies, as the phrase “Refineries have significant challenges in implementing non-renewable energy technologies” received a high average (4.48), reflecting the difficulties in overcoming these challenges and showing the relative variance in opinions related to taking advantage of technological developments to enhance sustainability, indicating that there are some challenges associated with the full implementation of these developments

Table 3: The Impact of Sustainable Manufacturing on Reputation and Investment Attraction

Phrase	Mean	Stander Deviation
Improving sustainability in manufacturing enhances the reputation of refineries locally and globally.	3.88	1.06
Refineries are increasingly attractive to investors thanks to their commitment to sustainable manufacturing practices.	3.68	1.21
Sustainable manufacturing helps attract new customers and improve the loyalty of existing customers.	3.34	1.31
There is increasing interest in refineries that apply sustainability standards in their operations.	3.62	1.19
Sustainable manufacturing practices help enhance the social responsibility of refineries.	3.69	1.10

The analysis of the axis "The impact of sustainable manufacturing on reputation and investment attraction" indicates that sustainable manufacturing significantly enhances the reputation of refineries locally and globally, as the phrase "Improving sustainability in manufacturing enhances the reputation of refineries locally and globally" recorded a mean of (3.88) with a standard deviation of (1.06), indicating relative agreement. However, commitment to sustainable practices resulted in a relatively low mean of (3.68) for attracting investors, indicating that the impact of sustainability in attracting investment may be limited or may face some challenges (.34). On the other hand, opinions on the effectiveness of sustainable manufacturing need to enhance refineries' interest in applying sustainability standards (mean of 3.62) and improving social responsibility practices (mean of 3.69) to attract customers and investors

Table 4: The Impact of Sustainable Manufacturing on Productivity and Quality

Phrase	Mean	Stander Deviation
Sustainable manufacturing improves production efficiency in refineries.	3.66	1.35
Improving sustainability in operations contributes to reducing operating costs.	4.12	1.02
Sustainable manufacturing practices contribute to improving the quality of final products.	4.31	0.93
Sustainable technologies are applied to increase the flexibility of production processes.	3.80	1.07
Sustainable manufacturing contributes to enhancing innovation and improving products.	4.24	0.90

The analysis of the axis "Impact of sustainable manufacturing on productivity and quality" shows that sustainable manufacturing contributes positively to improving the quality and productivity of final products, as the statement "Sustainable manufacturing practices contribute to improving the quality of final products" recorded the highest mean (4.31) with a low standard deviation (0.93), reflecting a strong consensus among participants about the impact. Sustainability contributes to innovation and growth in products, as evidenced by the data (4.24). On the other hand, the impact on production efficiency was less clear, as the statement "Sustainable construction improves production efficiency in refineries" had an arithmetic mean (3.66) and a higher standard deviation (1.35), indicating heterogeneity in participants' opinions on the extent to which these practices affect production efficiency. In addition, improving sustainability contributes to reducing operating costs (mean 4.12), reflecting a tangible impact on reducing costs, while the flexibility of production processes came in at an average (3.80), indicating that the full benefits of this aspect of harvesting may need further improvement.

Conclusion

In conclusion, this research shows that sustainable manufacturing plays an important role in increasing the competitiveness of companies, especially in the finishing sector. The results showed that adopting sustainable construction practices improves resource efficiency, reduces operating costs, and limits harmful environmental impacts. Sustainable manufacturing also improves the quality of final products, contributes to encouraging innovation, and improves the image of companies locally and globally. Refineries face some challenges in expanding. Sustainability of production processes Therefore, companies continue to adopt new strategies and modern technologies to enhance their sustainability and achieve a balance between economic performance and environmental protection. The continued focus on sustainable manufacturing can enhance companies' resilience and ability to face future challenges, and achieve long-term sustainability that contributes to improving global competitiveness.

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