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Influential Relationship between Green Manufacturing and Organizational Sustainability of Manufacturing Firms in Rivers State

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Abstract **Original Research Article**

The study examined the influential relationship between green manufacturing and organizational sustainability. The study adapted energy efficiency and green recyclability of waste as dimensions of green manufacturing while economic and social sustainability were adapted as measures of the organizational sustainability. The study took a cross-sectional survey design in its assessment of the relationship between the variables. The population of the study is made up of 53 production managers across 53 manufacturing firms in Rivers state. The study adopted the structured questionnaire in the collection of data for analysis. The spearman rank correlation, an inferential statistical tool was adopted in the analysis of the relationship between both variables. The results of the analysis indicate that there exists a significant relationship between the dimensions of green manufacturing (energy efficiency and waste recyclability) and the measures of organizational sustainability (economic and social sustainability). In line with this finding, we therefore conclude that green manufacturing predicts organizational sustainability hence we make the following recommendations: Organizations perform periodic energy audits to identify areas of waste, inefficiencies, and opportunities for savings. Organizations should replace outdated machinery with energy-efficient alternatives .Organizations should adopt the Use eco-friendly materials and prioritize suppliers that provide biodegradable or recyclable input. Organizations should establish green teams to champion sustainability initiatives.

Keywords: Green manufacturing, organizational sustainability, energy efficiency, social sustainability.

Background of the Study

Organizations are in recent times bedevilled with the challenges arising from globalization, talent wars, recessionary economies, advances in technology, knowledge-based environment and changes in workforce demography (Etukudo, 2019). Being teleological in nature, that is, goal oriented and purpose-driven, organizations are naturally expected to carry out their operations into the foreseeable future since most of their goals have long-term focus. And in this regard, the need for sustainable actions becomes imperative if these goals are to be achieved.

However, the current adverse trends have led to stiff market competition which has threatened sustainability of organizations especially the Nigerian Deposit Money Banks. Organizations are under pressure to demonstrate that they are adopting ethical and sustainable business practices. Organizational Sustainability according to Colbert & Kurucz (2007) is an act of keeping the business going. In the context of Organizational Sustainability, the "Triple Bottom Line" (Elkington, 1999) comes to light. It advocates that the traditional business model that considers only the economic factors in the appraisal of organizations be expanded to this new model by incorporating the organizations' environment and social performance. Organizations are therefore in the quest for those actions, practices and decisions that would give them competitive edge and ensure sustainability.

On the other hand, Green manufacturing refers to the integration of environmental considerations into manufacturing processes, product design, and supply chain decisions to reduce waste, minimize pollution, conserve energy and materials, and improve overall environmental performance. It encompasses strategies such as cleaner production techniques, energy-efficient technologies, lifecycle thinking, use of renewable resources, material substitution, recycling and remanufacturing, and eco-design. As global environmental pressures—climate change, resource depletion, and stricter environmental regulations—intensify, firms are increasingly expected to operate sustainably while maintaining competitiveness.

Understanding the effect of green manufacturing on organizational sustainability is important for three reasons. First, it helps managers weigh short-term costs of green investments against long-term benefits such as cost reduction, risk mitigation, and improved brand reputation. Second, policymakers require empirical evidence to design incentives and regulations that genuinely promote sustainable industrial transformation without imposing undue burdens on firms. Third, scholars need to clarify mechanisms—whether green manufacturing leads to improved environmental performance only, or whether it also enhances financial performance, employee well-being, and community relations (i.e., the three pillars of sustainability).

Sustainability, according to Fink (2010) implies the adherence to both environmental and social frameworks in a manner that is not detrimental to the economic goals and functionality of the organization. Sustainability is justified on not only ethical or moral grounds of "right and wrong" but also on the basis of the effect and implications of organizational actions on the lives and wellbeing of its stakeholders and environment. Dias (2003) opined that organizational sustainability is a growing concern for businesses and governments. While it denotes the propensity for behaviour that is eco-friendly and high on social values, it also assumes a positioning within the market justified by its processes, techniques and methods of service and product offerings defined by certain boundaries and frames that are acceptable. Glade (2008) suggested that organizational sustainability should not only be imposed as an external requirement, but should also feature as a fundamental precept and behavioural baseline for organizations.

Statement of the Problem

Manufacturing industries are major contributors to environmental degradation through high energy consumption, greenhouse gas emissions, hazardous waste, and unsustainable resource use. At the same time, organizations face growing pressure from regulators, customers, investors, and civil society to reduce environmental footprints. While green manufacturing promises both environmental and economic benefits, such as cost savings from energy efficiency and access to green markets, the extent to which adopting green manufacturing practices translates into measurable improvements in organizational sustainability (economic, social, and environmental dimensions) remains uneven across industries, regions, and firm sizes.

In recent years, achieving organizational sustainability has become a global priority, compelling manufacturing firms to adopt eco-friendly practices that minimize waste, reduce pollution, and optimize resource utilization. Despite this global shift, many manufacturing firms in Port Harcourt still face challenges in

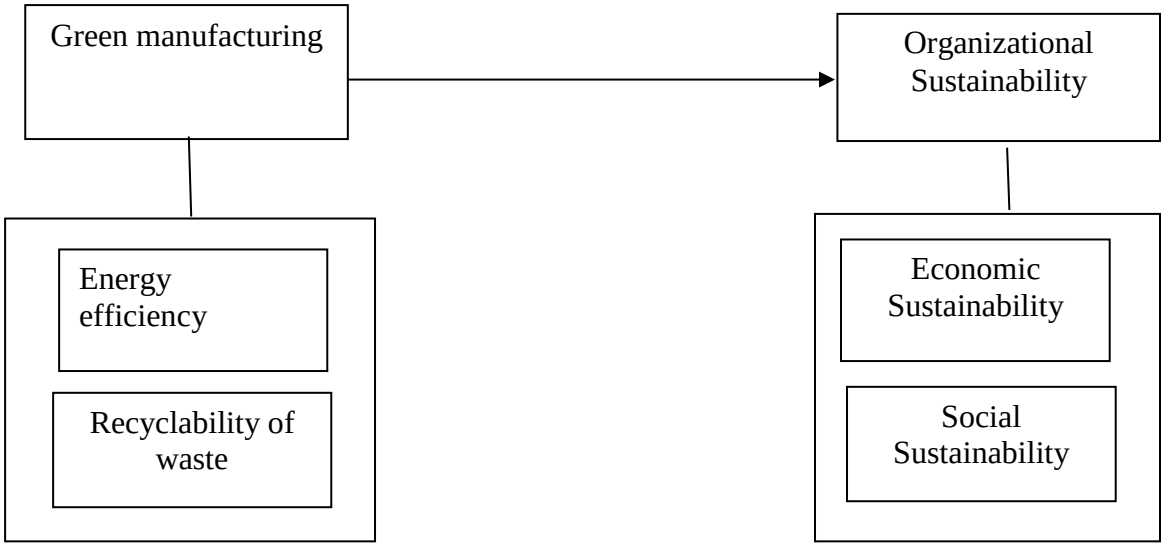
aligning their production processes with sustainable green manufacturing principles. Issues such as poor waste management, high energy consumption, inefficient resource utilization, and limited adoption of clean technologies persist, thereby undermining efforts toward sustainable industrial development.

While green manufacturing has been proven to enhance environmental performance, economic efficiency, and social responsibility, its adoption among firms in Port Harcourt appears limited due to factors such as inadequate awareness, lack of technological capacity, and insufficient regulatory enforcement. Consequently, many firms continue to operate under conventional manufacturing systems that contribute to environmental degradation, increased operational costs, and loss of competitiveness in a sustainability-driven global market.

Several recent studies from Rivers State / Port Harcourt focus on green supply chain practices and productivity of manufacturing firms in Port Harcourt (Onwuchekwa and Ayibalariomono 2024), Conceptual study on Green Manufacturing and Waste Management in Nigeria's Industrial Sector (Mohammed 2025). Broader Nigerian reviews and conceptual papers note green manufacturing is an *emerging* area in Nigeria, driven by resource pressures and weak enforcement; they highlight barriers such as cost, infrastructure and limited regulation. From the above its obvious that green manufacturing and organizational sustainability is an emerging area and so much knowledge and literature gap does exist, this study therefore raises critical concerns about how effectively sustainability can be achieved through green manufacturing practices in Port Harcourt's manufacturing sector. Therefore, there is a need to investigate the extent to which green manufacturing dimensions such as waste reduction, energy efficiency, pollution prevention, and eco-innovation contribute to achieving sustainability among manufacturing firms in Port Harcourt.

Conceptual Framework

The conceptual framework for this study addresses the relationship between two major variables: green manufacturing (independent variable), organizational sustainability (dependent variable)



Aims and Objectives of the Study:

The goal of this study is to examine the relationship between green manufacturing and organizational sustainability. The objectives are geared towards identifying the operational link between the dimensions of green manufacturing and organizational sustainability. Hence the objectives are as follows:

i. To ascertain the relationship between energy efficiency and economic sustainability of manufacturing firms in Port Harcourt, Rivers state.
ii. To examine the relationship between energy efficiency and social sustainability of manufacturing firms in Port Harcourt, Rivers state.
iii. To examine the relationship between recyclability of waste and economic sustainability of manufacturing firms in Port Harcourt, Rivers state.
iv. To determine the relationship between recyclability of waste and social sustainability of manufacturing firms in Port Harcourt, Rivers state.

Research Questions

The following research questions are further put forward as basis and guide for the study.

i. What is the relationship between energy efficiency and economic sustainability of manufacturing firms in Port Harcourt, Rivers state?
ii. What is the relationship between energy efficiency and social sustainability of manufacturing firms in Port Harcourt, Rivers state?
iii. What is the relationship between recyclability of waste and economic sustainability of manufacturing firms in Port Harcourt, Rivers state?
iv. What is the relationship between recyclability of waste and social sustainability of manufacturing firms in Port Harcourt, Rivers state.

Statement of the Hypotheses

HO_1: There is no significant relationship between energy efficiency and economic sustainability of manufacturing firms in Port Harcourt, Rivers State.

HO_2: There is no significant relationship between energy efficiency and social sustainability of manufacturing firms in Port Harcourt, Rivers State.

HO_3: There is no significant relationship between recyclability of waste and economic sustainability of manufacturing firms in Port Harcourt, Rivers State.

HO_4: There is no significant relationship between recyclability of waste and social sustainability of manufacturing firms in Port Harcourt, Rivers State.

Conceptual Review

This study has green manufacturing as our predictor variable and Organizational Sustainability as the criterion variable. The dimensions of green manufacturing as adapted in this study are: energy efficiency and recyclability of waste whereas the measures of Organizational Sustainability as adapted in this study are: Economic sustainability and Social sustainability.

Concept of Green manufacturing

Green manufacturing is a strategic, environmentally conscious production philosophy that aims to minimize negative ecological impacts while maintaining or improving organizational productivity and competitiveness. It integrates environmental considerations into all phases of manufacturing, including product design, material selection, process optimization, operations, and end-of-life management (Zeng et al., 2017). The core principle of green manufacturing is to achieve a balance between economic performance and ecological stewardship commonly expressed as "doing more with less" in terms of energy, materials, and emissions (Zhu & Sarkis, 2004).

At its foundation, green manufacturing emphasizes the reduction of waste, pollution prevention, and efficient resource consumption. This aligns with the broader sustainability paradigm, which stresses ecological efficiency and long-term environmental resilience (Gupta & Palsule-Desai, 2011). Through cleaner production technologies, eco-design, and process innovation, firms adopt green manufacturing not only to comply with environmental regulations but also to meet stakeholder expectations for responsible business practices (Deif, 2011). This approach enhances brand reputation, lowers operational

risk, and can reduce production costs via energy savings and waste minimization.

From a technological perspective, green manufacturing incorporates advanced tools such as automation, renewable energy systems, waste recyclability frameworks, and closed-loop production systems (Gao et al., 2018). These enable companies to redesign production chains to reduce greenhouse gas emissions, toxic outputs, and material depletion. Scholars note that improvements in energy efficiency, material circularity, and low-carbon technologies directly reinforce environmental performance, thereby strengthening the sustainability profile of manufacturing organizations (Jabbour et al., 2019).

Dimensions of Green manufacturing

Energy Efficiency

Energy is a very vital element needed for human existence, its demand has increased globally (Xu et al. 2023). . Energy efficiency refers to the ability to use less energy to provide the same level of output, service, or activity. It involves adopting technologies, practices, and systems that minimize energy waste while maintaining or improving performance (International Energy Agency, 2021). In simple terms, an energy-efficient system delivers higher output per unit of energy consumed.

Energy efficiency is considered one of the most cost-effective strategies for addressing growing global energy demand, reducing greenhouse gas emissions, and promoting sustainable development. According to the Intergovernmental Panel on Climate Change (IPCC, 2022), improving energy efficiency across sectors industry, transportation, buildings, and power generation—could significantly reduce global emissions and contribute to climate mitigation.

In the industrial sector, energy efficiency measures such as process optimization, waste heat recovery, and the use of high-efficiency motors can lower production costs and enhance competitiveness (UNIDO, 2020). Similarly, in the residential and commercial sectors, the use of efficient lighting technologies (e.g., LEDs), insulation, and energy-efficient appliances reduces energy bills and conserves resources (U.S. Department of Energy, 2023).

At the macroeconomic level, energy efficiency is linked to energy security, as it reduces dependence on imported fuels and improves the resilience of national energy systems (IEA, 2021). Governments often promote energy efficiency through standards, incentives, public awareness campaigns, and policy reforms.

Trianni et al. (2014) provided a framework of drivers that promote industrial energy efficiency, as well as knowledge on energy efficiency measures and comprehension of the elements limitating their adoption.

Recyclability of waste

Waste recyclability refers to the capacity of materials to be reprocessed into new products instead of being disposed of in landfills or incinerators. It is a core component of modern waste management and a strategic tool for promoting environmental sustainability by reducing resource depletion, minimizing pollution, and lowering carbon emissions (Singh & Ordoñez, 2016).

Recyclability contributes to the circular economy, which emphasizes keeping resources in use for as long as possible through recovery, reuse, and regeneration. By converting waste into valuable inputs, organizations and communities reduce dependence on virgin raw materials and enhance resource efficiency (Geissdoerfer et al., 2017). For instance, recyclable materials such as metals, plastics, paper, and glass can be continuously reprocessed, thereby decreasing the extraction of new resources and reducing environmental degradation (Zaman, 2015).

Moreover, waste recyclability plays a crucial role in reducing greenhouse gas emissions. Recycling processes often consume less energy than producing materials from raw resources. For example, recycling aluminum requires up to 95% less energy compared to primary production (EPA, 2020). This reduction in energy use significantly lowers carbon footprints, thereby contributing to climate change mitigation efforts (Murray et al., 2017).

From an economic standpoint, recyclability supports job creation, stimulates green industries, and reduces waste management costs. The recycling sector contributes to the development of sustainable business models and promotes innovation in waste processing and material recovery technologies (Kirchherr et al., 2017).

Effective recyclability depends heavily on infrastructure, consumer behavior, and product design. Many materials are technically recyclable but end up in landfills due to inadequate sorting systems, contamination, or poor recycling habits (Hopewell, Dvorak & Kosior, 2009). Therefore, enhancing recyclability requires investment in waste segregation, public awareness campaigns, and policies encouraging eco-design and extended producer responsibility (EPR) (Nnorom & Osibanjo, 2008).

Concept of Business Sustainability

Business sustainability refers to an organization's ability to operate in a manner that meets present needs while ensuring that future generations can also meet theirs. It involves integrating economic, environmental, and social considerations into business decision-making to achieve long-term value creation (Elkington, 1997).

At its core, business sustainability is grounded in the triple bottom line (TBL) approach, which emphasizes three performance dimensions: profit, people, and planet. The TBL argues that organizations must go beyond financial performance to also consider their social responsibilities and environmental footprints (Slaper & Hall, 2011). This means companies should ensure responsible resource use, reduce waste, and maintain ethical relationships with employees, customers, and communities.

Furthermore, sustainability helps businesses manage risks and respond to stakeholder expectations. Modern consumers, regulators, and investors increasingly demand environmentally conscious and socially responsible practices. As a result, companies that embrace sustainability tend to experience improved reputation, customer loyalty, and operational efficiency (Dyllick & Muff, 2016). For example, sustainable supply chain practices can reduce costs while enhancing compliance and quality.

Strategically, sustainability drives innovation. Firms often develop new technologies, products, and processes that minimize environmental harm or improve social well-being. This can create competitive advantages in markets where sustainability is valued (Hart & Milstein, 2003). Thus, business sustainability is not merely a moral obligation—it is a strategic imperative for long-term survival in a rapidly changing global environment.

Economic sustainability

Economic sustainability refers to an economic system's ability to support long-term growth, productivity, and development without degrading the resources (human, natural, financial, institutional) on which it depends. Economic sustainability focuses on creating value in a manner that is efficient, resilient, and socially inclusive. This means that economic progress should be stable, long-lasting, and supported by strong institutions and responsible use of resources (Barbier, 2011). Economies are considered sustainable when they can continue to provide employment, income, and productive opportunities without causing long-term imbalances or crises (Pearce & Barbier, 2000).

A central element of economic sustainability is the efficient allocation and management of resources. This involves producing goods and services using methods that minimize waste and maximize productivity (Goodland, 1995). Efficient use of resources ensures that economic activities remain viable and profitable over extended periods. Economic sustainability also involves resilience the ability of an economy to withstand shocks such as inflation, recessions, or global supply disruptions. Sustainable economies build strong institutions, diversify economic activities, and promote innovation to handle both expected and unexpected stresses (Elkington, 1997).

Although economic sustainability focuses on financial and productive capacity, it is closely linked with social and environmental sustainability. For instance, the long-term

stability of an economy depends on a healthy workforce and the preservation of natural ecosystems. This interdependence is often explained through the triple bottom line approach, which emphasizes the balance of economic, social, and environmental outcomes (Elkington, 1997). Sustainable economies prioritize inclusive growth, ensuring that opportunities and benefits are equitably distributed among all groups in society. Inclusive economic policies help reduce inequality and improve social cohesion, which in turn supports long-term economic stability (Stiglitz, 2012).

Social sustainability

This encompasses the management of the impact that the organizations cause on the social systems by its operational activities. The expectations of the different social groups relate to the organization are genuinely considered. In summary, it incorporates questions related to human development (education, training, occupational health, workplace safety and competence development), to equality (fair salaries and benefits, equal opportunities and absence of workplace discrimination) and to ethical considerations (human rights, cultural values, intergeneration and intra-generation justice). The social sustainability covers the following characteristics (Azapagic, 2003): fair pay, equal opportunities, good health and safety conditions, gratification system, securing ideas for the improvement of the Triple Bottom Line, competence development and training, career plans and ethical organizational behaviour.

Negative socio-cultural impacts are mainly concerned with banking services in developing countries where overcrowding, 'demonstration' effect, 'etc. are phenomena possibly leading to a certain irritation of the host community and socio-cultural problems (Mason, 2003). Nevertheless, also in developed countries the banking industry might have impacts on the socio-cultural conduct and behaviour of people. The question of authenticity in banking experiences arises when cultural traditions get modified and altered based on the changes and development originating from these financial institutions. Commoditization can lead to pseudo-events that are planned to be convenient for clients which might lead to a falsification of the traditional meaning of service (Mason, 2003). Consequently, cultural promotion through banking support and initiatives to promote and enhance appreciation for cultural and historic heritage are indicators and actions outlined by Roberts and Tribe (2008).

Theoretical Framework of the study

This study draws its theoretical grounding from ecological modernization theory. Sustainability science emphasizes the need to balance economic growth, environmental protection, and social equity through innovations that limit resource depletion (Khan & Terano, 2018). Sustainability science is an emerging trans disciplinary field that seeks to understand the dynamic interactions between human and environmental systems in order to support long-term human well-being and ecological integrity. The theory underpinning sustainability science emphasizes the integration of knowledge across disciplines, the co-production of solutions with stakeholders, and the pursuit of actionable insights that address complex socio-ecological challenges (Kates et al., 2001).

Methodology

The cross-sectional design is considered suitable and therefore adopted as the research design for this study. The population of this study consist of production managers drawn across 53 manufacturing firms in Rivers state, Since our population as stated above is small, we did census the entire 53 production managers of the manufacturing firms in Rivers state .The study adopted the structured questionnaire as instrument for data collection The study adopted the use of the spearman rank order correlation coefficient in testing the relationship between the variables.

Energy efficiency and measures of organizational sustainability

			Energy efficiency	Economic	Social
Spearman's rho	Energy efficiency	Correlation Coefficient	1.000	.200*	.126
		Sig. (2-tailed)	.	.036	.186
		N	53	53	53
	Economic	Correlation Coefficient	.200*	1.000	.393**
		Sig. (2-tailed)	.036	.	.000
		N	53	53	53
	Social	Correlation Coefficient	.126	.393**	1.000
		Sig. (2-tailed)	.186	.000	.
		N	53	53	53

The hypotheses on the correlation between energy efficiency and the measures of organizational sustainability is addressed in the table above. The result presents the outcome on the test for the hypotheses as follows:

i. Energy efficiency significantly correlates with economic sustainability of manufacturing firms in Rivers state. The result shows that where rho = 0.200 and P = 0.36; the relationship between the variables is significant, hence a rejection of the null hypotheses.

ii. Energy efficiency does not significantly correlate with social sustainability of manufacturing firms in Rivers state. The result shows that where rho = 0.126 and P = 0.186; the relationship between the variables is insignificant, hence an acceptance of the null hypotheses.

Waste recyclability and measures of organizational sustainability

			Waste recyclability	Economic	Social
Spearman's rho	Waste recyclability	Correlation Coefficient	1.000	.233*	.111
		Sig. (2-tailed)	.	.014	.245
		N	53	53	53
	Economic	Correlation Coefficient	.233*	1.000	.393**
		Sig. (2-tailed)	.014	.	.000
		N	53	53	53
	Social	Correlation Coefficient	.111	.393**	1.000
		Sig. (2-tailed)	.045	.000	.
		N	53	53	53

The hypotheses on the correlation between waste recyclability and the measures of organizational sustainability is addressed in table above. The result presents the outcome on the test for the hypotheses as follows:

i. Waste recyclability significantly correlates with economic sustainability of manufacturing firms in Rivers state. The result shows that where rho = 0.233 and P = 0.014; the relationship between

the variables is significant, hence a rejection of the null hypotheses.

ii. Waste recyclability significantly correlate with social sustainability of manufacturing firms in Rivers state. The result shows that where rho = 0.111 and P = 0.045; the relationship between the variables is significant, hence a rejection of the null hypotheses.

The result from the analysis show that energy efficiency and waste recyclability dimensions of green manufacturing advance significant impact on sustainability features of manufacturing firms. It is noted that relationship between energy efficiency and social sustainability to be weak The results suggest that green manufacturing plays an imperative role in enhancing the organizational sustainability of the of manufacturing firms .Based on this outcome the study affirms to the following evidence:

Statement of the Findings

This study in view of the evidence presented on the nature of the relationship between green manufacturing and organizational sustainability, as well as the noted role of organizational culture (hierarchical and market culture) on the relationship between the variables advances the following findings:

1. Energy efficiency significantly impacts on organizational sustainability, and as such enhances outcomes of economic and social sustainability of manufacturing firms in Rivers state
2. Waste recyclability significantly influences organizational sustainability, and as such enhances outcomes of economic and social sustainability of manufacturing firms in Rivers state

Discussion of findings

Energy efficiency and Organizational Sustainability

The relationship between energy efficiency and the economic as well as environmental sustainability of manufacturing firm is observed to be significant. The evidence shows that energy efficiency significantly influences outcomes of economic as well as environmental features of manufacturing firms in the sense of their profitability, market share and capacities for sustainable environmental practices. Previous scholars appear to share this position as they agree that, energy efficiency is very important source for improved sustainability, success and competitiveness (Vilani Sachitra & Siong-Choy, 2018; Garba Muddaha, Yeoh Khar Kheng & Yaty, 2018; Goh, Elliott & Quon, 2012).

Energy efficiency has emerged as a fundamental driver of organisational sustainability in the 21st century, as firms face increasing pressure to minimize environmental impact while maintaining competitiveness. Energy efficiency refers to the ability of an organization to deliver the same or improved products and services using less energy input (International Energy Agency [IEA], 2022). Organisational sustainability, on the other hand, encompasses economic viability, environmental stewardship, and social responsibility (Elkington, 1997). The relationship between the two concepts is both complementary and reinforcing, as energy efficiency initiatives directly contribute to environmental and economic sustainability outcomes.

According to Dangelico and Pujari (2010), energy efficiency serves as a critical pathway for achieving sustainable operations, as it reduces greenhouse gas emissions and operational costs simultaneously. By optimizing energy use, organizations not only conserve resources but also enhance their long-term viability. Similarly, Zhang and Wang (2020) emphasize that energy-efficient technologies improve process performance and resource utilization, leading to reduced waste and lower carbon footprints — essential dimensions of sustainability.

The economic benefits of energy efficiency further strengthen its relationship with sustainability. Studies such as Porter and van der Linde (1995) argue that environmental efficiency, including energy conservation, drives innovation and cost reduction, thereby improving overall competitiveness. This "innovation offset" concept suggests that organisations investing in energy-efficient processes can simultaneously enhance profitability and sustainability performance. Likewise, Hasanbeigi et al. (2019) found that

firms adopting energy management systems experienced reduced energy intensity and improved financial performance, confirming the economic-sustainability nexus.

Socially, energy efficiency contributes to sustainability by promoting corporate responsibility and stakeholder trust. Yadav and Sagar (2021) assert that organizations that adopt sustainable energy practices enhance their reputation and legitimacy in the eyes of stakeholders, including consumers, investors, and regulators. This social dimension reinforces the organisational commitment to sustainable development beyond economic or environmental concerns.

However, the literature also points to certain challenges in aligning energy efficiency with sustainability objectives. Boiral and Henri (2012) argue that despite evident benefits, organisational barriers such as inadequate capital, limited technical expertise, and resistance to change hinder the full realization of energy efficiency gains. Furthermore, Tan and Hashim **(2018)** note that in developing economies, the lack of policy support and energy auditing frameworks can limit the contribution of energy efficiency to overall sustainability performance.

Waste recyclability and Organizational Sustainability

The nature of the relationship between waste recyclability and the dimensions of organizational sustainability are all noted to be significant. Waste recyclability has emerged as a crucial component of organizational sustainability strategies in the modern industrial landscape. The growing environmental awareness and regulatory pressures have compelled organizations to adopt sustainable waste management practices, among which recyclability plays a central role (Ghisellini, Cialani & Ulgiati, 2016). Recyclability refers to the ability of waste materials to be reprocessed into new products, thereby reducing raw material consumption and mitigating environmental impact (Sariatli, 2017). Organizations that integrate waste recyclability into their operations demonstrate a commitment to sustainability through resource efficiency, pollution reduction, and circular economy principles (Kirchherr, Reike & Hekkert, 2017).

Research indicates that recyclable waste management significantly enhances organizational sustainability performance by fostering operational efficiency and reducing environmental footprints. For instance, Tseng et al. (2018) found that companies adopting recycling-oriented production systems achieved lower waste generation rates and improved ecological efficiency. Similarly, Govindan and Hasanagic (2018) emphasised that recycling contributes to sustainable supply chain practices by extending product lifecycles and reducing dependency on virgin materials. This aligns with the triple bottom line framework, which suggests that environmental, social, and economic outcomes are interrelated dimensions of sustainability (Elkington, 1998).

From an economic standpoint, waste recyclability reduces operational costs associated with waste disposal and raw material procurement (Zailani et al., 2012). By converting waste into valuable resources, firms can improve cost savings and competitive advantage (Masi, Day & Godsell, 2017). Moreover, recycling initiatives can create new business opportunities in secondary material markets, reinforcing the financial dimension of sustainability (Geissdoerfer et al., 2017). Socially, organizations that promote recyclability enhance their corporate reputation, stakeholder trust, and employee engagement through visible environmental responsibility (Dangelico & Vocalelli, 2017).

Conclusion

In conclusion, the position of this study is that green manufacturing drives and substantially enhances outcomes of organizational sustainability of manufacturing firms in Rivers state. The evidence on the relationship between the variables also demonstrates that there is an evident contribution and support from the hierarchical and market culture of the organization towards its actions and success with regards to sustainability.

Recommendations

The evidence presented in this study have established the relationship between green manufacturing and organizational sustainability. Drawing from the observations of the study, the following recommendations are put forward:

i. Organizations perform periodic energy audits to identify areas of waste, inefficiencies, and opportunities for savings.
ii. Organizations should replace outdated machinery with energy-efficient alternatives.
iii. Organizations should adopt the Use eco-friendly materials and prioritize suppliers that provide biodegradable or recyclable inputs
iv. Organizations should establish green teams to champion sustainability initiatives.

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