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Green Warehousing Practices and Their Impact on the Overall Business Performance

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Abstract

Warehouses contribute significantly to increasing greenhouse gas emissions in the supply chain. It is therefore not surprising that academic research on environmentally friendly and sustainable storage has increased in recent years. This attention has led to an increase in the number of publications in this field. Therefore, this study proposes a literature review on the topic of green warehousing. This study provides a comprehensive overview and classification of existing research on green warehousing, summarizes, and synthesizes available knowledge on the subject, and identifies key trends. Promising ideas for future research are suggested based on the literature review. This result indicates a growing interest in sustainability issues in the warehouse-related literature, with energy conservation being the most studied goal, followed by the environmental impact of warehouse buildings and green warehouses. However, the literature on green warehouses lacks case studies and empirical data. The main contribution of this study is to comprehensively present the current state of knowledge on green warehousing in terms of the macro-issues addressed, the specific issues considered, and the methodological approaches, including a comprehensive taxonomy of the relevant literature, is summarized. An overview of management guidelines for environmentally friendly resource management and proposals for future research ideas will contribute to further developing this emerging research area.

Index Terms–Green, Warehouse, Practices, Business, Performance, Emissions, Energy Consumption

INTRODUCTION

Nowadays green practices have become a global political issue for all types of organizations. Because of the expectations of society to protect the environment, sustainability is now sought after in all sorts of businesses. This business includes the field of logistics services, where the goal of adopting green practices is to reduce the harmful environmental impacts of its operations, and it is also necessary for sustainable business initiatives that link the social dimensions, the economy, and the environment (Castillo et al., 2022). Green warehousing is one of the processes that constitute green logistics services, and its practice achieves, in the long term, a significant reduction in operating costs and economic savings while ethically providing environmental protection. As a result, improving warehouse procedures to be more environmentally friendly may help a company become more productive and competitive (Xin et al., 2019). Warehouses have several purposes in addition to storing and distributing products. After

development over the decades, warehouses have become a place to provide manufacturing, assembly, and other value-added services. A key component of sustainable supply chain operations is green warehousing, known as a warehouse, that integrates environmental protection with its organizational, social, economic, and technological purposes (Castillo et al., 2022).

The warehousing factor, a critical component of logistics and supply chain, has received less academic attention in competitive logistics despite its importance from a global perspective as it embodies a core business philosophy of maximizing revenue and market share while minimizing adverse environmental impacts. Although little research has been done, green warehouse practices have an enormous amount of promise for sustainable development and for companies to be able to compete in a world that is becoming more socially responsible. However, it is still seen as a relatively new greening strategy and there are not many case studies or empirical research in the literature. This research



aims to bridge this gap. A key component of sustainable supply chain operations is green warehousing. Economically implementing green warehouse practices is difficult because it must maintain a balance between different concerns from social, economic, and environmental aspects (Castillo et al., 2022). This paper aims to address issues related to green warehouse practices and their impacts on overall business performance.

LITERATURE REVIEW

Green Practices

According to (Lee et al., 2013), green practices include adherence to various sound practices that help reduce the impacts that negatively affect the environment by reducing solid waste, saving water, and saving energy. Green practices have been categorized into two categories, including those that focus on comprehensive building, such as saving energy by using special lighting. The other category focuses on customers in terms of their exposure to them periodically, such as existing sustainability, environmentally friendly packaging, cleaning materials, equipment that saves both water and energy, recycling, and others.

Another definition of green practices was analyzed by (Kim et al., 2017) as commercial activities aimed at reducing negative impacts on the environment. However, there is a contradiction about that, as the authors stated that green practices are not limited to environmental support and that the commercial side has an interest in that. The characteristics of green practices have been expanded into three main areas, including that when the necessary conditions are met in the regulatory field, then commercially driven actions are taken, that is "green practices". The second area is that even when all requirements are met, green practices are unlikely to be adopted unless the company believes it will benefit them. The third area shows that green practices have benefits in the operational field of marketing and financing, and they need continuous improvement over time to meet the expectations required by stakeholders. At the end of the divisions, a definition of green practices was proposed as a business strategy that brings added value due to the benefit of companies, with an emphasis on participating in initiatives related to environmental protection.

The word green practices are being used a lot these days and most of them are business related. Green practices have a positive impact on environmental performance, as it results in an increase in market size, return on investment, net profit margin, sales, lower commodity prices, and lower operating costs. Moreover, there is a link between environmental performance and improving financial performance, as with a decrease in the percentage of waste and environmental pollution, the percentage of profits will increase, and that, of course, by following strategies for green practices. Almost all countries of the world have had their governments respond to the problem of pollution resulting from industries by setting laws and regulations enshrining the necessity of adhering to green practices. Among them, most organizations have studied the issue of greening to finally make it part of their

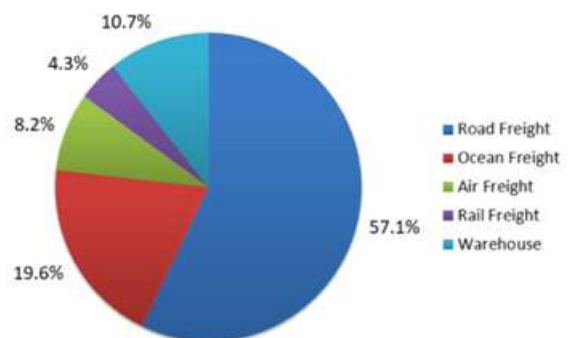
goals to achieve sustainable development, rather it was to respond to the requirements of stakeholder engagement after discovering the importance and necessity of green practices in gaining a competitive advantage.

Green Warehousing Practices (GWP)

Warehouses are one of the important activities of logistics services in the supply chain. Of the total logistics costs, it represents approximately 20%. It provides integrated services in storing and handling goods upon request. In warehouses, it includes major operations, including storage and protection of goods, transportation, classification, processing, financing, and risk-taking. Warehouses were defined by (Baker & Halim, 2007) as a place where goods are stored in large quantities temporarily for sale or distribution.

According to (Abushaikha, 2018) many operations are related to warehouses, so they can be a source of non-value-added activities. Since warehousing activities generate a large amount of waste throughout the supply chain, it is necessary to implement waste reduction strategies and policies in order to reduce its harmful effects on the environment and human life. One of the studies that were conducted on the supply chain to discover the percentage of carbon dioxide that is produced annually documented that the logistics and transportation sector let out approximately 2,800 megatons of carbon dioxide (Doherty & Hoyle, 2009). About 300 (10.7%) megatons of total emissions from logistics resulted from warehousing activities as shown in the figure (1). Other than the waste produced by warehouses, many other problems were not considered an obstacle to business. There are activities that are done in the warehouse as part of the job such as excessive use of paper unnecessarily, more packages than needed, and oversized boxes. In addition, there are problems in terms of high energy costs, operating costs, and inefficient use of storage space (Lin & Sheu, 2012).

Figure (1): CO2 emissions in logistics (Doherty & Hoyle, 2009).



Compared to traditional warehouses, it has been observed that companies that follow green practices in their warehouses have discovered that storage facilities can produce more pollution. Comparative analyzes have shown that forklifts and loading docks produce pollutants including hydrocarbons, nitrogen oxides, and carbon dioxide. Another controversial problem is the proliferation of toxic mold in areas with high humidity, poorly ventilated sections, and facilities, and this

happens if a strategy is not followed that suits the type of warehouse that may be affected by the geographical location and climate. All these concerns about harmful emissions are because they can affect the employees in the warehouse.

Many companies have recognized the importance of taking appropriate actions to reduce pollutants from warehouses and excess operations through green warehouse practices. Based on (Akandere, 2016) green warehouse practices are defined as a set of solutions specifically designed for storage places in order to produce lower costs and reduce the impact on the environment in terms of financial productivity and social standards. The scientists realized the importance of applying green practices in warehouses and suggested the use of warehouse management techniques to deal with energy-saving, including environmentally friendly strategies and sources.

Influential Benefits of Green Warehousing Practices

Green warehouse practices help improve efficiency and save costs. For warehouses to be effectively managed, green practices provide companies with an opportunity to be highly productive with the least possible number of resources and expenses by reducing energy and water consumption. The results of the research extracted by (Oloruntobi et al., 2023) indicate that warehouses often distribute their energy ineffectively, due to their needs for ventilation and heating, equipment, cooling, and lighting energy. According to research, warehouses that are not refrigerated and use old lighting can cut their electricity expenditures by up to 75% by switching to LED (Lighting Emitting Diodes) and implementing heating measures. In energy management, the focus is on the interior design of the warehouse, its area, and its height, as it has a direct impact on cost reduction. Companies benefit from green warehouse practices in that they reduce energy costs over time.

The study confirmed by (Chin et al., 2015) that poor performance of companies in terms of environmental achievement leads to financial losses, especially in the decline in stock prices. Companies that practice green warehouse practices and those that do not practice them have a significant direct relationship, where companies that are environmentally friendly and contribute to the development of their green management strategy in their warehouses have very high share prices compared to companies with harmful behavior, whose share prices are low. Therefore, it was concluded that companies that are sensitive to environmental footprints have an advantage in the market and are able to attract resources from pro-social and environmental investors. Studies have also confirmed that green warehouse practices provide a quick return on investment.

Green warehouse practices contribute to enhancing the company's reputation. (Wahab et al., 2018) stated that one of the most distinguished and innovative methods nowadays for companies to be known is to apply green practices in warehouses, as it contributes to attracting customers who care

about the environment. Some studies showed that about 36% of people tend to buy products with sustainable packaging, including paper packaging such as flexible paper by 14% and paper cartons by 16%. There are many people in this community whose concern is focused on the environment and its safety, and by exploiting this, companies gain a global level of reputation and trust from business partners, suppliers, and investors. Furthermore, industrial competition is described as a friendly competition between competitors who operate in comparable markets and share similar resources such as DHL and Amazon who compete against each other strictly in green warehouse practices. Organizations have also been inspired to self-regulate and take preventative measures due to an increase in environmental pressure. Thus, organizations can meet current and ever-evolving environmental challenges by applying a proactive approach to green practices.

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The application of green warehouse practices benefits companies in terms of facilitating entry into new target markets. There are many recognized international standards and certifications focusing on the environment such as the ISO 14000 certification for environmental management. Companies that possess this certificate have a great competitive advantage, and the difference appears when they develop their plans and expand their work. According to (Lotfi et al., 2018) the value of the supply chain improves with the market penetration of foreign and domestic enterprises. This is achieved through technological innovation, geographic expansion, product diversification, and green practices. Companies must take into account the strategy to be followed in order to succeed in opening businesses in other countries and their survival in the market, with the development taking place in society in terms of concern for the environment, and this has become one of the basics of competition in the market. In recent years, there has

been a direct focus on the environment, which has an impact on business lifestyles due to changes in demands. This led to the emergence of the concept of the green market, which produced increasing pressure on companies thinking of expanding their business or staying in the world of business. Therefore, green practices are a global issue in which the necessary measures must be taken, as customers' demands for environmentally friendly products and services change. To enter the green market, there is a gradual approach followed, which is an opportunity for entrepreneurs.

Effective Adoption of Green Warehousing Practices

Based on (Marchant & Baker, 2010), the warehouse sustainability framework consists of three stages, as shown in Figure (2). The first phase includes an energy-saving structure with minimum requirements and is considered one of the simplest level green warehouses. Mechanical handling equipment, air changes, heating and lighting, and green warehouse interiors are the main focus of this implementation. The Energy Efficient Warehouse also includes metering technology to calculate and control a building's energy use. In the next phase, the focus is on building a warehouse that is low in emissions and has green energy. During warehouse operations, green practices are practiced, and energy consumption is measured, while constantly trying to make improvements. In order to reduce carbon emissions, the building is also expected to use green and renewable energy sources. In the third phase, the focus is on how a sustainable warehouse can perform better than expected and exceed environmental requirements in the more advanced phase of green implementation. Warehouse managers pay close attention to total lifetime emissions in relation to the overall level of the environment. The warehouse is able to produce its electricity using sustainable resources including biomass, wind turbines, and solar panels.

Figure (2): The three stages of implementing green warehouse practices towards sustainability (Marchant & Baker, 2010)



Energy Efficiency in Warehouses

The first step to implementing green practices in warehouses is to focus on the energy used to run the daily operations of the warehouses. Companies can save up to 20% on energy costs with the proper installation of energy management systems and minimal capital investment. Heating and lighting systems consume most of the energy used in warehouses and there is the potential for energy-saving technologies and high-performance machinery to significantly reduce this huge

consumption. It is possible to increase energy efficiency in warehouses in the following way (Luu, 2016):

- **Warehousing Temperature:**

According to (Ries et al., 2017) each warehouse has distinct temperature requirements that must be maintained depending on the internal activities, design, local weather, storage, and functions of the warehouse. Gas, fuel energy, and electricity are the main energy sources for warehouse heating and cooling systems in real life. The author mentioned his observations about one of the results that help in the significant decrease in energy use is to reduce the temperature inside the warehouses; For example, lowering the temperature by 1°C will reduce energy use by 10%. To reduce monthly energy costs, warehouse managers must carefully consider the ideal temperature for each part of the warehouse. Also, all areas of the warehouse must contain different temperatures according to the activities that are carried out, as shown in the table (1).

Table (1): Different areas in warehouses and the appropriate temperature for them

Warehouse Zone	Temperature
Picking Areas and Inspection Sites	19° C
Loading and Unloading Gates	13° C
Bulk Storage Areas	10° C

Warehouse temperature control also takes ventilation into account. To maintain a comfortable working and storage environment, ventilation in the warehouse is necessary. Indoor air must be replaced by outdoor air. Using ventilation systems facilitates energy efficiency, and the following shows several methods that can be followed:

1. Using automated tracking and management systems.
2. Choice of good zones in the warehouse for picking and dispatch for their need for high cold.
3. Do not open the doors except when needed and use a special type of fast-acting doors, especially for the loading and unloading doors.

Build doors with a smart design that matches the shape of the warehouse, such as the U-Shape design that preserves the temperature (Figure 3).

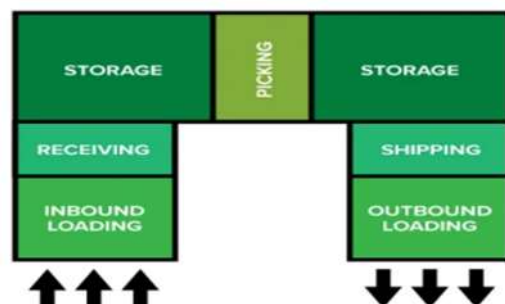


Figure (3): U-Shaped Warehouse (Webstaurant Store, 2021).

• **Warehouse lighting systems**

It is not difficult to maintain proper lighting levels in the warehouse to reduce costs and save energy. Engineers should be consulted to determine the number of lights required in specific locations. In order to increase energy efficiency, specialists must choose appropriate and effective lighting equipment, as shown in the examples given in Table (2).

Table (2): Types of lamps suitable according to the areas.

Areas	External Areas	The Factory	Offices
Suitable Lamp Types	- Metal halide	- Emergency directional LED	- Low-voltage tungsten halogen
	- High-pressure sodium	- Inductive	- Compact fluorescent
		- Metal halide	-
		- High-pressure sodium	- Triphosphorous tubular fluorescent
		- Triphosphorous tubular fluorescent	

Using suggested types of lamps for different areas in the warehouse as shown in Table (2) is an easy and effective way to conserve energy. These suggestions are based on the possibility of operating all the lights and determining the degree of lighting required in each warehouse location. The author mentioned that recently it has been noticed that there has been an increase in the use of LED lights in buildings and warehouses, and this type of lamp saves about 65-85% of energy while also offering a longer product life. Adding to that, the following tips can be followed to save energy:

1. Open the glass skylights.
2. Keep the lights clean.
3. Turn on the lights only when needed.
4. Control lighting systems by installing an automatic sensor or a timer.

▪ **Mechanical Handling Equipment**

According to (Richards, 2017), paying attention to the selection of mechanical handling equipment for warehouses is extremely important for those trying to implement green practices. One of the most popular choices for forklifts nowadays is the counterbalance forklift, which is electrically powered and provides an environmentally friendly approach to warehouse handling equipment. Electric forklifts improve indoor air quality without directly generating carbon dioxide. Introduced by Toyota are diesel-electric hybrid forklifts that reduce costs and consume 45% less fuel (Toyota, 2023).

Potential Challenges to Green Warehousing Practices

The built environment affects every aspect of human activity, so the construction sector of medium and small businesses needs to adapt quickly to the environmental and social agenda. It will take a lot of work from many different sides to do business improvement, especially to overcome any obstacles presented by resources, money, and technology. The transition from a traditional approach to a sustainable approach takes time, as there are requirements in terms of adaptability from the industrial level to the individual organizational level to the industrial level.

According to (Hasan & Zhang, 2016), time is one of the challenges companies face when adopting green warehouse practices. Schedule is an important criterion for performing huge projects and most stakeholders focus on it. Stakeholders and the company's reputation suffer when construction costs increase for green practices and with delays. The author mentioned that the reason for the delay is often a good review of the problems that can be caused by the other components that are focused on when the green practice process such as security, safety, and sustainable technologies.

The supply chain for green materials is a barrier to adopting green warehouse practices. The cost of materials for building an environmentally friendly warehouse is high, so the lack of a prior agreement by the stakeholders leads to the failure of the task before it begins. Also, there is no standard distribution network for green materials, so the supply of materials is not flexible or reliable. The lack of information taken about extensions due to the lack of a standard system reduces the possibility of evaluating the performance of green construction. Furthermore, Construction and post-construction insurance liabilities are two aspects of sustainable construction. Since 12% of the total energy involved is used for maintenance, this cost must be considered. In some states, it is standard practice to include professionals after a building is completed to ensure that it functions as expected and this is known as the soft-landing practice. As a result, the project encounters complications and contract management encounters difficulties. This resulted in ensuring that green building assurance had more commitments. Thus, it is necessary to find solutions to the conundrums of contracting and liability.

According to (Powmya& Abidin, 2018) green warehouse practices that focus on technology are often related to reducing energy consumption, using green materials, saving water, internal cooling, and so on. However, adopting green practices requires technical expertise and there is little competition, as most technologies are produced abroad and are seen as too expensive. There will be a problem with marketing because construction is expensive and developing this technology at the lowest cost is not possible. In addition, decarbonizing industrial warehouse buildings is challenging due to several factors, such as lack of incentives, supply chain constraints, tenant expectations, regulatory barriers, lack of knowledge and experience, inadequate or outdated

infrastructure, and high costs of capital investment. These barriers may impede the adoption of energy-saving technologies for green energy practices and the shift to renewable energy sources. Also, the capacity of building operators can be limited by supply chain constraints and tenant demands, thus affecting tenant operations for not implementing carbon removal strategies.

Figure (3): Barriers to implementing green warehouse practices (Powmya& Abidin, 2018).



There are barriers to the success of adopting green warehouse practices, as mentioned in a study conducted to assess potential challenges for companies considering greening their businesses. As shown in Figure (3), a large percentage of those believe that the application of green practices is not that important, and this is a cause for concern, because this explains the lack of knowledge of the positives that come with the implementation of the idea. Also, there are few specialists in greening, as this field is considered new, and there is not enough education in all countries and there is a weakness in promoting sustainable projects. With the lack of culture about greening comes resistance to change and the reception of a new idea. When there is no significant support from higher authorities such as the government and demand from the community, it is difficult for entrepreneurs, investors, and stakeholders to accept the success of the greening application (Wang et al., 2023). In addition, the lack of demand leads to a shortage of green products produced locally, and importing from abroad is a little difficult due to the different standards used due to the different climates. Some countries, such as the United States of America, it has a green evaluation system such as (LEED), which helped it accelerate green progress. In the Gulf countries, a local green certificate is not provided, and some believe that this is an obstacle for companies that supply the application of green practices.

Research Methodology

In this paper, we conducted a narrative literature review with the goals of summarizing the existing body of literature and identifying essential research gaps. To consider recent developments, we also included “grey” literature in our study. Furthermore, we used EBSCO Business Source Premier, Scopus, IEEE Xplore, Science Direct, and Google Scholar as our primary sources, but also screened numerous conferences proceedings and references (snowballing) of published papers

to find additional and related materials. We used the following search terms: (“Green warehousing” or “Green Practices”) and (“Business” or “Performance”) and (“supply chain*” or “logistics”). The paper collection and analysis took place between February and April 2023. The authors screened each paper for relevance, and the core topics were briefly summarized. Subsequently, we combined all topics and derived research questions by creating a map in which we listed the potential impacts of green warehousing practices on the overall business performance.

CONCLUSION

These studies, which were extracted through the efforts of researchers, identified the advantages and benefits of practicing green warehouses in the hope of improving business efficiency and reducing costs by following the correct steps. This research will be of interest to every reader interested in the subject of green practices and to companies that want to apply or that have implemented the idea in their operations or rather in their warehouses. There is a need to increase research related to the practices of green warehouses, as there are many entrepreneurs and academic scientists who are interested in the environment and the success of their businesses. There is difficulty in finding academic studies related to green warehouse practices, and if they exist, they include a gap, and the information was not sufficient. This field of study is shallow so valuable results can be obtained for future research on green warehouse practices and are easy to apply by companies. Given that the research topic is relatively new, it is possible to create integrated research that clarifies the idea in all aspects, including benefits and challenges.

Managerial Insights

With scientific development today, concern for the environment has become one of the main factors for business. For organizations to be prominent in this cultured society, they always find distinctive ways to meet customer demand and document their existence. Therefore, the study helps to reach the desired goals at the end of the research by presenting a literature review. The literature review consists of gathering and selling information from the sources of previous studies on the same topic as the research objectives. This literature review contains key information on green warehouse practices. Give an explanation about green practices and delve deeper into identifying the potential benefits and challenges facing companies that want to apply these practices in their warehouses. These articles emphasized the importance of the study for entrepreneurs, logistics company owners, academic researchers, and environmental scientists. According to the literature examined, the topics to be addressed in the research project revolve around how to make people more environmentally conscious and have an idea of how to apply the mentioned technologies in their work without influencing barriers. The reviews have reached the direction of the current research and it has been confirmed that the proposed objectives will assist the study users with

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what has been generated from the necessary information on green warehouse practices.

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