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تحديات صناعة الالواح الخشبية من مخلفات النخيل

The challenges of producing wooden Boards from palm Waste

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Abstract

Palm cultivation in Egypt dates back thousands of years, Egypt is one of the world's largest producers of palm trees, with these trees densely distributed in both desert and agricultural areas. Palm trees produce large quantities of palm waste, a byproduct of seasonal pruning., and palm waste has traditionally been used in basketry and household tool production. With the advancement of technology and the growing need for sustainable and environmentally friendly building materials, some initiatives have begun to explore the use of palm waste in the production of wooden boards. This emerging industry is an important step towards reducing reliance on imported traditional timber and reducing pollution from unsustainable disposal of palm waste. However, the use of palm waste in the production of wooden boards still faces several challenges that make it difficult to utilize them fully. The research problem is reflected in clarify **the main challenges facing the local palm reeds board industry, to promote the use of this sustainable material .**The research aims to: Monitor the stages of manufacturing wooden boards from palm waste to identify the most important technical, economic, and environmental problems of using palm waste in the production of wooden boards. The study was conducted using the descriptive-analytical method using literature references. To provide technical and economic solutions to overcome these challenges. Proving the feasibility of manufacturing palm waste boards as a sustainable alternative to traditional wooden boards.

Keywords:

Palm By-products, Renewable local material, Wood Boards Manufacturing, Wood Alternative.

1. Introduction

Egypt, with its rich history of palm cultivation dating back thousands of years, is one of the largest producers of palm trees in the world, which produce large quantities of waste as a byproduct of seasonal pruning. Traditionally, this palm waste has been used in the production of baskets, mats, and other household items. However, with the growing emphasis on sustainability and the need to utilize environmentally friendly materials for the ability to meet present needs without compromising the ability of future generations to meet their own needs. It involves the responsible use of resources, minimizing environmental impact, and promoting economic and social well-being. The idea of converting palm waste into wooden boards aligns with the principles of sustainability by providing a renewable and locally available resource that can reduce reliance on traditional timber, which is often imported and associated with deforestation and environmental degradation[10 P280].

despite its potential as a sustainable alternative the production of wooden boards from palm waste faces significant challenges that hinder

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its widespread adoption, that way promoting the use of palm waste as a viable and sustainable alternative in the wooden board industry in Egypt. Where waste materials are repurposed and reintegrated into the wooden board production cycle, thereby reducing environmental impact and promoting resource efficiency.

One of the primary challenges is the variability in the physical properties of palm waste, such as density and strength, which complicates its processing and adaptation to meet the standards required for wooden board manufacturing. Additionally, the industry is confronted with technical difficulties related to the machinery and technology needed to efficiently process palm waste into high-quality boards. Economic challenges also arise, particularly due to the high costs associated with the necessary additives and specialized treatments required to enhance the quality and durability of the boards. Furthermore, environmental challenges emerge from the management of secondary waste produced during the manufacturing process, which may contribute to environmental burdens if not properly managed. The aim to comprehensively analyze the challenges associated with the production of wooden boards from palm waste in Egypt, with a focus on identifying the key technical, economic, and environmental barriers. By understanding these challenges, the researchers can find practical solutions that can facilitate the development of palm wood board industry, therefore the capability of promoting the use of palm waste as a viable and sustainable alternative in the wooden board industry in Egypt[10 P111-126].

2. Stages of Development Date Palm Boards Industry in Egypt:

The wooden boards industry in Egypt has witnessed significant transformation over the years, particularly with the innovative use of palm waste as a raw material[20 P10].

The development of this industry can be broadly categorized into several stages, each reflecting advancements in technology, sustainability practices, economic incentives, and market demand. This development has been driven by the need to manage agricultural waste sustainably and to create value-added products that can meet the demands of both local and international markets. These historical stages illustrate the attempts that this industry went through.

2.1 Initial Exploration and Research (1970s-1980s)

The initial stage of development in the wooden boards industry in Egypt using palm waste began with exploratory research into alternative materials for wood-based products. During this period, researchers investigate the potential of agricultural residues, such as palm waste, as a viable raw material for composite boards. Studies focused on the physical and mechanical properties of palm fibers, assessing their suitability for producing particleboards and other wood-based products[17 P20].

Figure (1) Low-density chipboard, manufactured from date palm waste

2.2 Experimental Production and Prototyping (1990s)

In the 1990s, the research transitioned into experimental production and prototyping. This stage involved the development of small-scale manufacturing processes to produce composite boards from palm waste. During this stage,

Researchers experimented with various combinations of palm fibers and resins, seeking to optimize the balance between cost, performance, and environmental impact significant technological advancements were made. The development of new machinery and processing techniques enabled the efficient conversion of palm waste into usable board materials. Innovations included improved methods for drying, grinding, and pressing palm fibers, which enhanced the durability and strength of the boards produced. The results demonstrated that palm waste could be effectively used to produce MDF boards with properties that make it suitable for use and application for some wood products[3 P34-45].

Figure (2) Date palm medium density fiber board DPMDF

2.3 Commercialization and Market Entry (2000s)

The early 2000s marked the beginning of the commercialization phase. With the success of pilot projects, the industry moved towards commercialization. Companies began to invest in larger-scale production facilities, and the market for wooden boards made from palm waste started to grow. The commercialization phase was marked by increased awareness of the environmental benefits of using agricultural waste in manufacturing, which resonated with both consumers and policymakers.

The Egyptian government played a crucial role during this stage by providing incentives for businesses to adopt sustainable practices. These included tax breaks, subsidies, and support for research and development. Additionally, the government promoted the use of palm waste in various sectors, including construction and furniture manufacturing, thereby expanding the market for wooden boards[14 P23-36].

Figure (3) Blockboards from palm midribs.

Figure (4) Palm Midribs as a Core Material in Blockboards

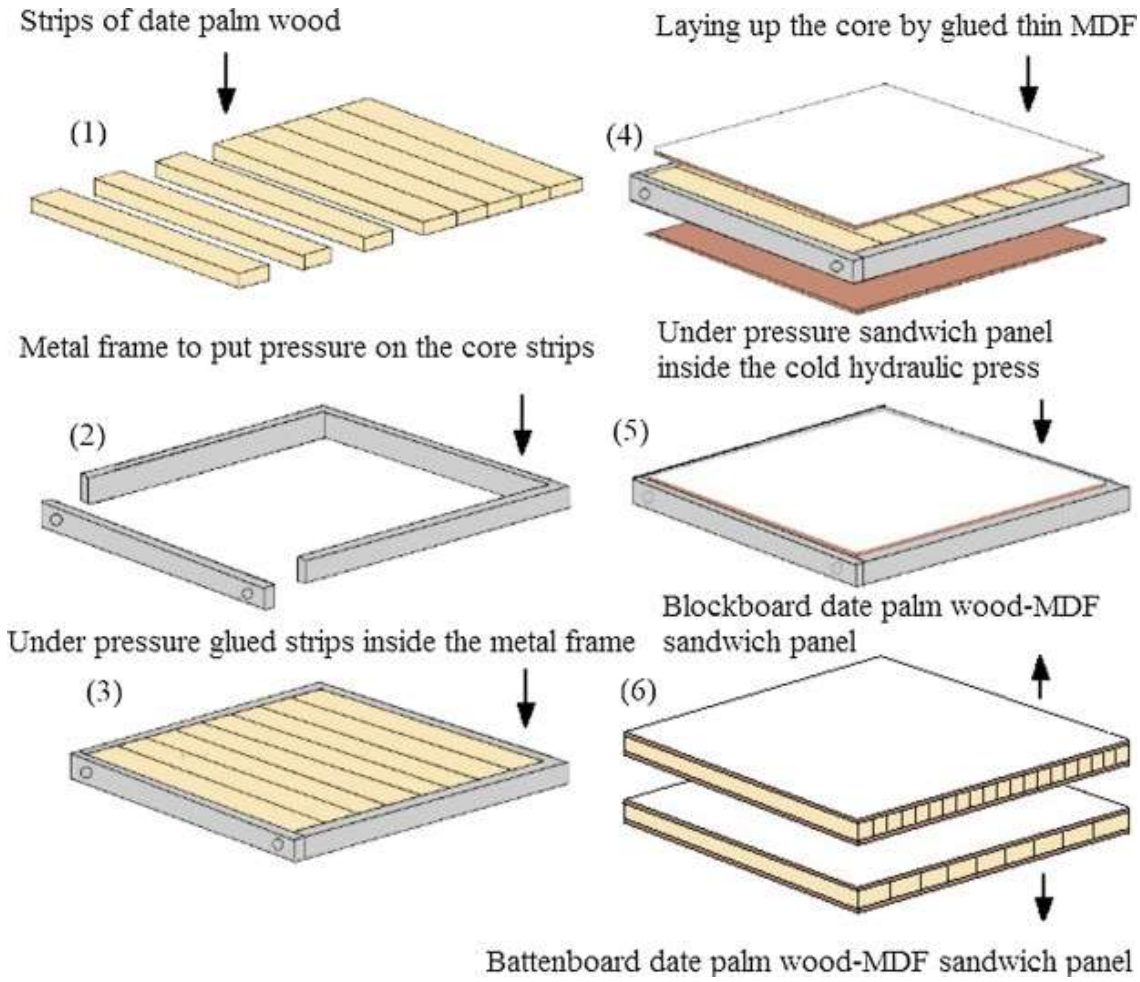

Figure (5) production technique of blockboard from date palm waste

2.4 Technological Advancements and Industry Expansion (2010s)

The 2010s were characterized by significant technological advancements and industry expansion. During this stage, manufacturers invested in state-of-the-art machinery and automation to increase production efficiency and improve product quality (García-Ortiz et al., 2014). started producing a wider range of wooden boards, including medium-density fiberboard (MDF), oriented strand board (OSB), and plywood, all made from palm waste. This diversification was driven by both domestic demand and the potential for exports. The development of new bonding agents and surface treatments further enhanced the durability and aesthetic appeal of palm waste boards. Additionally, the industry expanded geographically, with production facilities being established in regions with abundant palm waste resources, such as new valley and Oases[11 P 6127-6140].

Figure (6) Date Palm Oriented strand boards DP-OSB

2.5 Sustainability Integration and Circular Economy Focus (2020s-Present)

The most recent stage in the development of the wooden boards industry using palm waste focuses on sustainability and the integration of circular economy principles. This stage is marked by efforts to minimize environmental impact throughout the entire production cycle, from raw material sourcing to end-of-life disposal. Companies are increasingly adopting life cycle assessments (LCAs) to measure and reduce the environmental footprint of their products. Additionally, there is a growing trend toward the use of bio-based adhesives and the recycling of palm waste boards into new products, further contributing to the industry's sustainability goals[19 P352].

Accordingly, in Egypt, there are various types of wood Boards are produced from palm waste, including:

- Particle Board
- MDF
- Block Board
- OSB
- Insulation Board
- Fiberboard
- Water-resistant Board

These boards may utilize either palm waste or a combination of one or two types, sharing some components, production processes, and adhesives.

for this, there are encounters several common challenges, which can be categorized as follows:

Technological Challenges
Environmental Challenges
Economic Challenges

3. Technical Challenges in Producing Wooden Boards from Palm Waste:

The technical challenges associated with producing wooden boards from palm waste in Egypt are multifaceted, stemming primarily from the unique characteristics of palm waste as a raw material and the limitations of current manufacturing technologies.

Below is a detailed exploration of these challenges:

3.1 Variability in Raw Material Properties

One of the most significant technical challenges is the inherent variability in the physical and chemical properties of palm waste. Palm waste, which includes midribs, fronds, and other byproducts of the palm tree, varies greatly in density, moisture content, fiber structure, and chemical composition. This variability poses difficulties in standardizing the production process, as each batch of palm waste may behave differently during processing[1 P242]. For example, the fibrous nature of palm waste can lead to inconsistent board density, affecting the structural integrity and quality of the final product. The moisture content in palm waste also fluctuates significantly depending on the time of year, storage conditions, and the specific part of the palm tree from which the waste is derived. High moisture levels can lead to challenges in drying and pressing processes, resulting in boards that are prone to warping, swelling, or even fungal growth if not adequately treated[1 P350-358].

3.2 Compatibility with Existing Machinery

The production of wooden boards from palm waste requires the adaptation of existing wood-processing machinery or the development of entirely new equipment. Traditional woodworking machines are typically designed to handle homogenous and relatively predictable materials like hardwood or softwood. In contrast, palm waste, with its irregular shape, fibrous texture, and varying density, can cause problems such as clogging, increased wear and tear on cutting tools, and uneven processing.

Additionally, the fibrous nature of palm waste can cause blockages and jams in conventional machinery, leading to increased downtime, maintenance costs, and reduced overall efficiency[3] [P34-45]. These issues necessitate modifications to machinery, such as reinforced cutting tools, specialized feeding systems, or even custom-designed presses and molds to accommodate the unique properties of palm waste.

3.3 Adhesive and Binding Challenges

Adhesives play a crucial role in the production of composite wood products, including wooden boards made from palm waste. However, the chemical composition of palm waste differs significantly from that of traditional wood, leading to challenges in finding suitable adhesives that can effectively bind the material without compromising the structural integrity of the boards[16 P263-270].

The lignin and cellulose content in palm waste can interact with adhesives in unpredictable ways, sometimes leading to poor adhesion, delamination, or weak bonding. Traditional adhesives, such as urea-formaldehyde or phenol-formaldehyde, may not perform optimally with palm waste, necessitating the development of new or modified adhesive formulations. Moreover, there is a growing demand for environmentally friendly adhesives that do not emit harmful volatile organic compounds (VOCs), further complicating the development process[2 P134-148].

3.4 Processing and Treatment Techniques

Another technical challenge lies in the processing and treatment of palm waste before it can be used in board production. To enhance the performance of palm waste boards, the raw material often requires pre-treatment processes such as cleaning, drying, and chemical treatment to improve its durability, resistance to moisture, and overall quality.

Drying palm waste to the appropriate moisture content is particularly challenging due to the material's high initial moisture levels and the dense, fibrous structure that can trap moisture. Improper drying can lead to issues such as internal stresses, cracking, or uneven board quality. Additionally, chemical treatments to enhance the material's properties, such as fire retardancy or resistance to decay, can be difficult to apply uniformly, leading to inconsistencies in the final product[16 P103].

3.5 Quality Control and Standardization

Ensuring consistent quality in palm waste boards is a significant technical challenge, particularly in the absence of established industry standards for this material. The variability in raw material properties, combined with the complexities of processing and treatment, makes it difficult to achieve uniformity in board thickness, density, and mechanical strength. Quality control processes must be adapted or developed to monitor and assess the specific characteristics of palm waste boards, such as their moisture resistance, load-bearing capacity, and durability[4 P279-283].

the lack of standardized testing methods and benchmarks for palm waste boards further complicates this process, making it challenging for manufacturers to guarantee the performance of their products.

4. Economic Challenges in Producing Wooden Boards from Palm Waste:

The production of wooden boards from palm waste in Egypt, while promising as a sustainable alternative to traditional timber, is fraught with several economic challenges. These challenges can significantly hinder the scalability and profitability of the industry, making it difficult for businesses to compete with conventional wood products in both local and international markets. Below is an in-depth exploration of these economic challenges:

4.1 High Initial Investment Costs

One of the most significant economic barriers to the production of wooden boards from palm

waste is the high initial investment required to establish a manufacturing facility. This investment includes the costs of acquiring or modifying specialized machinery that can process palm waste efficiently. As mentioned earlier, traditional woodworking machinery is often incompatible with palm waste, necessitating either extensive modifications or the purchase of custom-built equipment. Both options are costly and represent a significant financial burden, especially for small and medium-sized enterprises (SMEs) that may lack access to substantial capital[5 P367]. In addition to machinery costs, there are other startup expenses, such as land acquisition, factory construction, and the procurement of raw materials. These costs can be prohibitive, particularly in an industry that is still emerging and lacks established financial support systems, such as subsidies or grants specifically aimed at promoting the use of agricultural waste in manufacturing.

4.2 High Production Costs

Even after the initial setup, the ongoing production costs for wooden boards made from palm waste tend to be higher than those for traditional wooden boards. Several factors contribute to these elevated costs:

- **Material Preparation:** Palm waste requires extensive preprocessing, including cleaning, drying, and chemical treatment, before it can be used in board production. These steps are essential for ensuring the quality and durability of the final product but add to the overall production costs.
- **Additives and Chemicals:** To enhance the performance of palm waste boards, manufacturers often need to use various additives and chemicals, such as adhesives, binders, and preservatives. These materials are not only costly but may also need to be imported if suitable local alternatives are unavailable, further increasing expenses[15 P742-821].
- **Energy Consumption:** The processes involved in transforming palm waste into wooden boards, such as drying, pressing, and treating the material, are energy-intensive. High energy consumption leads to increased operational costs, especially in regions where energy prices are volatile or subsidies for industrial energy use are limited.

4.3 Limited Economies of Scale

The palm waste board industry in Egypt is still in its nascent stages, with limited production volumes compared to the well-established traditional timber industry. This lack of scale means that producers cannot benefit from the cost efficiencies associated with large-scale production, such as bulk purchasing of raw materials, streamlined operations, and optimized logistics.

Without the ability to achieve economies of scale, the per-unit cost of producing palm waste boards remains high, making it difficult for these products to compete on price with traditional wooden boards. This situation is particularly challenging in price-sensitive markets where consumers may be unwilling to pay a premium for sustainable products, even if they offer environmental benefits.

4.4 Market Competition and Consumer Perception

The market for wooden boards is highly competitive, with traditional timber products dominating due to their long-established presence, proven performance, and consumer familiarity. Palm waste boards, as a new entrant, face the challenge of overcoming consumer skepticism regarding their quality, durability, and suitability for various applications[18 P344]. Moreover, many consumers may not be aware of the environmental benefits of palm waste boards or may not

prioritize sustainability when making purchasing decisions. This lack of awareness, coupled with the higher costs associated with palm waste boards, can make it difficult for producers to penetrate the market and achieve significant sales volumes.

To compete effectively, manufacturers may need to invest in marketing and education campaigns to raise awareness about the benefits of palm waste boards. However, such campaigns require additional financial resources, adding to the overall economic burden[7 P69-79].

4.5 Supply Chain and Logistics Challenges

The supply chain for palm waste in Egypt is still underdeveloped, which presents additional economic challenges for manufacturers. Palm waste is often scattered across vast agricultural areas, making it costly and logistically challenging to collect, transport, and store the material in a centralized location for processing.

The transportation of palm waste from remote or rural areas to manufacturing facilities can significantly increase costs, particularly if infrastructure is lacking or fuel prices are high. Moreover, the seasonal nature of palm pruning means that the supply of raw material can be inconsistent, leading to potential disruptions in production and difficulties in maintaining steady output levels[13 P105].

4.6 Lack of Financial Incentives and Support

Unlike traditional timber industries, which may benefit from various government subsidies, tax breaks, or financial incentives, the palm waste board industry in Egypt currently lacks significant support from the government. This absence of financial incentives makes it more difficult for producers to offset the high costs associated with starting and maintaining production[8 P74].

In some cases, governmental policies may even favor traditional industries, either through direct subsidies or through a lack of regulation on waste management practices, which can discourage the development of alternative, sustainable industries like palm waste board production. Without targeted financial support or policy interventions, the economic viability of palm waste boards remains uncertain.

5. Environmental Challenges in Producing Wooden Boards from Palm Waste:

While the production of wooden boards from palm waste offers the potential for sustainable development and waste reduction in Egypt, several environmental challenges must be addressed to ensure that the process is truly eco-friendly. These challenges arise from the characteristics of palm waste, the processing methods required to convert it into wooden boards, and the broader environmental implications of scaling up this industry. Below is a detailed exploration of these environmental challenges:

5.1 Chemical Use and Pollution

One of the primary environmental challenges associated with producing wooden boards from palm waste is the use of chemicals during the manufacturing process. To convert palm waste into a viable material for board production, it often requires the addition of adhesives, binders, and preservatives. Many of these chemicals, particularly synthetic adhesives like urea-formaldehyde or phenol-formaldehyde, can have significant environmental impacts.

- **Toxic Emissions:** The use of certain adhesives and binders can result in the release of volatile organic compounds (VOCs) during the manufacturing process and over the lifecycle of the boards. VOCs contribute to air pollution and can pose health risks to workers and end-users, particularly if the boards are used in indoor environments where emissions can accumulate.

- **Water Contamination:** If not managed properly, the disposal of wastewater containing chemicals from the board manufacturing process can lead to contamination of local water bodies. This contamination can harm aquatic ecosystems, disrupt local biodiversity, and pose risks to human health if the contaminated water is used for drinking or irrigation[9 P1345-1355].
- **Solid Waste Disposal:** The production process generates solid waste, such as off-cuts, trimmings, and residues, which may be contaminated with chemicals. Proper disposal or recycling of this waste is essential to prevent soil and groundwater contamination[6 P42-46].

5.2 Energy Consumption and Carbon Footprint

The production of wooden boards from palm waste is an energy-intensive process. Energy is required at multiple stages, including drying the palm waste, processing it into boards, and applying treatments to enhance its durability and performance. The energy consumption of these processes can have several environmental implications:

- **Carbon Emissions:** If the energy used in the production process comes from non-renewable sources like fossil fuels, the carbon footprint of palm waste board production can be significant. This not only contributes to climate change but also undermines the sustainability benefits of using agricultural waste as a raw material
- **Resource Depletion:** High energy consumption can lead to the depletion of local energy resources, particularly in regions where energy supply is limited or heavily reliant on non-renewable sources. This can exacerbate environmental degradation and increase the overall environmental impact of the production process.

5.3 Transportation and Logistics

The environmental impact of transporting palm waste from its source to processing facilities is another significant challenge. Palm waste is often generated in scattered locations across rural and agricultural areas, which can be far from the industrial sites where the boards are manufactured. The logistics of collecting, transporting, and storing palm waste involve several environmental concerns:

- **Fuel Consumption and Emissions:** The transportation of palm waste over long distances requires fuel, often derived from fossil fuels, which contributes to greenhouse gas emissions and air pollution. The more remote the palm waste sources, the higher the environmental cost of transportation.
- **Infrastructure Impact:** The need to transport palm waste from remote areas can put additional strain on local infrastructure, such as roads and bridges, which may not be designed to handle the increased traffic. This can lead to environmental degradation, such as soil erosion and habitat disruption, particularly in sensitive rural areas.

5.4 Waste Management

The processing of palm waste into wooden boards generates various forms of waste, including leftover fibers, bark, and chemical residues. Managing this waste in an environmentally responsible manner is crucial to prevent adverse environmental impacts:

- **Solid Waste:** The solid waste generated during the production process must be carefully managed to avoid contributing to landfills or creating environmental hazards. Inadequate disposal practices can lead to soil contamination, increased landfill use, and the loss of potentially recyclable materials[5 P122].
- **Effluent Management:** The water used in processing, particularly in cleaning and

chemical treatment stages, can become contaminated with residues and chemicals. Effective effluent treatment systems are necessary to prevent this wastewater from polluting local water bodies and harming aquatic ecosystems.

- **Air Emissions:** The production process can also generate particulate matter and other air pollutants, particularly during the drying and pressing stages. These emissions can contribute to local air quality issues, affecting both the environment and the health of nearby communities.

5.5 Resource Sustainability

While palm waste is an abundant and renewable resource, its sustainable management is essential to ensure that its use in board production does not create new environmental challenges:

- **Overharvesting and Resource Depletion**: If the demand for palm waste boards increases significantly, there is a risk that the harvesting of palm waste could become unsustainable. Overharvesting could lead to the depletion of palm resources, affecting the ecological balance and reducing the availability of this resource for other traditional uses, such as composting or animal fodder.
- **Biodiversity Impact:** The increased collection and use of palm waste could potentially disrupt local ecosystems if not managed carefully. For example, removing too much organic material from agricultural areas could impact soil health, reduce biodiversity, and affect the long-term sustainability of palm cultivation. [12] P122-134.

5.6 Lifecycle Environmental Impact

Finally, the overall lifecycle environmental impact of palm waste boards must be considered. This includes not only the production and transportation stages but also the use and disposal of the boards:

- **End-of-Life Disposal:** Palm waste boards, particularly those treated with chemicals, need to be disposed of responsibly at the end of their lifecycle. Improper disposal, such as incineration without proper controls, can lead to the release of toxic emissions. Similarly, if these boards end up in landfills, the chemicals used in their production could leach into the soil and groundwater.
- **Recyclability:** Ensuring that palm waste boards are recyclable or biodegradable is an important consideration for reducing their long-term environmental impact. However, the use of non-biodegradable adhesives and treatments can complicate this process, making it more challenging to achieve a closed-loop system.

6. Conclusions:

The technical, economic, and environmental challenges in the production of wooden boards from palm waste in Egypt reveals a complex landscape that requires urgent and strategic intervention. These challenges are interrelated, each contributing to the overall difficulty of establishing a sustainable and economically viable industry based on palm waste as a raw material.

Technical Challenges such as the variability in raw material properties, the need for specialized machinery like [specific types of machinery], adhesive and binding issues, and the complexities of processing and treatment techniques highlight the significant obstacles manufacturers face in maintaining consistent product quality. The lack of standardized processes and quality control measures further complicates these technical issues, making it difficult to scale up production effectively.

Economic Challenges are equally daunting. High initial investment and ongoing

production costs, coupled with limited economies of scale and intense market competition, place significant financial strain on producers. However, the potential for growth in this industry, if these challenges are addressed, should encourage optimism. The underdeveloped supply chain for palm waste and the absence of government support or financial incentives further exacerbates these economic difficulties, hindering the industry's growth potential.

Environmental Challenges underscore the need for sustainable practices throughout the production lifecycle. The reliance on chemical additives, high energy consumption, transportation-related emissions, and waste management issues such as [specific waste management issues] present significant environmental risks. Moreover, the sustainability of palm waste as a resource must be carefully managed to avoid overharvesting and its associated ecological impacts. Thus, while the potential for producing wooden boards from palm waste is promising, these challenges must be addressed to ensure that the industry can develop sustainably, economically, and with minimal environmental impact.

7. Recommendation:

The Research centers and universities recommend paying attention to investment in research and development, Researchers must continue working on exploiting palm waste in wood industries and working to develop existing ones. With an attempt to make it environmentally friendly and adapt it to serve the field of interior design and furniture to preserve human health and the environment and thus achieve the principle of sustainability. And by Invest in research to develop more effective adhesives and binding agents specifically suited to palm waste's unique properties. Additionally, advancements in machinery design tailored to the processing of palm waste are essential to improve efficiency and reduce production costs. Also Optimize processing and treatment techniques to ensure consistent product quality, reduce energy consumption, and minimize environmental impact. This includes refining drying methods, enhancing material treatment processes, and developing better quality control measures.

The Government recommend to Support Policy Development by Advocate for government subsidies, tax breaks, or grants to support the initial investment and operational costs associated with palm waste board production. This could include incentives for adopting sustainable practices and using environmentally friendly materials.to develop and implement industry standards for palm waste board production to ensure product quality and safety and facilitate market acceptance and consumer trust.

Invest in cleaner production technologies that reduce the environmental footprint of palm waste board production. This includes exploring renewable energy sources, reducing chemical use, and implementing efficient waste management systems.

Conduct comprehensive lifecycle assessments to evaluate the environmental impact of palm waste boards from production to disposal. Use this information to guide further improvements in the sustainability of the production process.

The Manufacturers recommend to Development the market and make Awareness Campaigns by Launch educational campaigns to raise awareness among consumers and businesses about palm waste boards' environmental benefits and sustainability. Highlight the advantages of using these boards as an alternative to traditional timber products. Also, to expand the market for palm waste board products, encourage collaboration between

manufacturers and industries such as construction, furniture, and packaging.

Develop efficient and sustainable supply chains for palm waste collection, transportation, and storage. This includes investing in infrastructure improvements and logistics planning to reduce transportation costs and environmental impact. And Implement practices that ensure the sustainable harvesting of palm waste, preventing overexploitation and ensuring the long-term availability of this resource. Consider integrating palm waste board production with other agricultural waste management practices to create a more holistic approach to resource use.

The designers must be encouraged to embrace the use of palm board materials in their creations. The focus should be placed on developing environmentally conscious designs that capitalize on the unique properties of these materials while ensuring proper utilization practices. By implementing these recommendations, the challenges of producing wooden boards from palm waste in Egypt can be effectively addressed, paving the way for a sustainable and economically viable industry. This approach not only benefits the local economy but also contributes to global efforts to reduce reliance on traditional timber and promote environmentally friendly building materials. The potential economic benefits of this project are significant, offering a promising future for the industry.

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الملخص

تعود زراعة النخيل في مصر إلى آلاف السنين، وتعد مصر واحدة من أكبر دول العالم المنتجة لشجرالنخيل، حيث تنتشر هذه الأشجار بكثافة في المناطق الصحراوية والزراعية على حد سواء. تنتج أشجار النخيل كميات كبيرة من المخلفات الزراعية، وهي نتاج ثانوي للتقليم الموسمي. وقد كانت المخلفات تستخدم تقليديًا في صناعة السلال والأدوات المنزلية .مع تطور التكنولوجيا وتزايد الحاجة إلى مواد بناء مستدامة وصديقة للبيئة، بدأت بعض المبادرات في محاولة استغلال مخلفات النخيل في صناعة الألواح الخشبية، وتعد هذه الصناعة الناشئة خطوة مهمة نحو تقليل الاعتماد على الأخشاب التقليدية المستوردة والحد من التلوث الناجم عن التخلص غير المستدام من مخلفات النخيل. إلا أن استخدام مخلفات النخيل في صناعة الألواح الخشبية لا يزال يواجه عدة تحديات تجعل من الاستفادة الكاملة منه أمرًا صعبًا .وتظهر مشكلة البحث من توضيح **ما هية التحديات الرئيسية التي تواجه صناعة الألواح الخشبية المصنعة من مخلفات النخيل على المستوى المحلي، لتعزيز استخدام هذه المادة المستدامة.** ويهدف البحث إلى رصد مراحل تصنيع الألواح الخشبية من مخلفات النخيل للتعرف على أهم المشكلات الفنية والاقتصادية والبيئية لاستخدام مخلفات النخيل في صناعة الألواح الخشبية وتمت الدراسة من خلال المنهج الوصفي التحليلي باستخدام المراجع الأدبية. في محاولة حصر هذه التحديات لإثبات جدوى صناعة ألواح خشبية من مخلفات النخيل كبديل مستدام للألواح الخشبية التقليدية.

الكلمات المفتاحية:

منتجات النخيل الثانوية، مواد محلية متجددة، تصنيع ألواح خشبية، بدائل الخشب.