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Sustainable Design with Circular Thinking: Reinventing Teak Wood Waste into Decorative Products

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Abstract

As a major global timber producer, Indonesia struggles more with furniture industry wood waste as well as a growing timber scarcity. This paper looks at the sustainable use of teak wood waste—a high-quality by-product typically discarded during furniture production—as a substitute material for decorative objects, including minimalist lamps. The project aims to explore how circular design ideas might be applied to transform industrial by-products into value-added products while promoting environmental responsibility and aesthetic creativity. By means of qualitative techniques combining literature analysis, market observation, and stakeholder participation, the study identifies viable methods to recycle teak wood waste. Material selection is given great importance depending on wood thickness and grain quality to ensure fit for certain design applications. A SWOT study examines the strengths, weaknesses, opportunities, and threats of teak wood waste use in the creative sector. Results show that although minimalist design ideas raise material use and lower secondary waste, they also preserve the natural appeal of teak wood. Market trends show growing customer demand for sustainable, artistically unique products, which strongly supports circular product manufacture. Still to be addressed, however, uneven material quality and technological limitations. This article contributes to the discussion on sustainable design by providing a consistent framework for converting waste materials into high-value manufacture. It also offers strategic concepts for lawmakers, manufacturers, and designers attempting to balance environmental goals with market-oriented product development.

Keywords: *Teak Wood Waste, Circular Design, Sustainable Resources, Decorative Products, Minimalist Lamp.*

Introduction

Circular design has become a strategic tool to tackle resource inefficiencies and waste accumulation, particularly in material-intensive industries such construction, furniture, and product design. This design concept seeks to prolong the life of resources by means of reuse, recycling, and redesign, therefore completing the material cycle [10][11]. Guldmann (2019) claims that including circular thinking into product development helps to create sustainable business models, especially when combined with minimalist design ideas stressing efficiency and aesthetic appeal [7].

Known for its tropical woods and biodiversity, Indonesia ranks among the top timber-producing nations globally. These woods are sources of raw materials [2] as well as significant contributors to the world timber trade. Valued globally for its exceptional quality, Indonesian timber—especially teak, meranti, and mahogany—is often found in creative sectors, home furnishings, and construction [5],[6],[9]. Ranked fourth behind China, Italy, and Germany, the country is a significant contributor to worldwide furniture manufacture [17]. However, Indonesia's abundant natural resources are not helping it as a growing timber scarcity pushes an unsustainable dependence on forest exploitation and imports to satisfy industrial demands [5].

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The issue is made worse by notable wood waste from furniture manufacture. Valued for its mechanical endurance and natural beauty, teak wood (Tectona grandis) generates notable waste in the form of off-cuts, sawdust, and irregular pieces typically unutilised. Sutarman (2020) estimates that waste makes up 25–30% of timber used in industrial activities [20]. Much of this material, however, keeps notable structural and aesthetic qualities, which presents possibilities for sustainable reuse.

This paper investigates creating appealing items like minimalist lighting using teak wood waste as a replacement source [10]. This paper contends that the intentional selection and processing of teak waste—including thickness and grain quality—can produce high-value products satisfying aesthetic and environmental requirements [12],[21]. This supports United Nations Sustainable Development Goal 12: Responsible Consumption and Production, which advocates sustainable industrial practices including reducing material waste.

This study looks at design possibilities changing industrial wood by-products into economically viable, environmentally friendly products using qualitative techniques and SWOT analysis. The findings are intended to enable manufacturers, designers, and legislators to grasp the economic and environmental advantages of circular design utilising teak wood waste, so supporting the more general movement towards a circular economy.

Methods

Through literature studies, discussions, and observations, qualitative approaches will help to understand the possibilities, challenges, and prospects linked to using teak wood waste [19]. Those who follow this path might look at various perspectives on the benefits and difficulties experienced in transforming teak wood waste into sustainable products [1][11]. This method allows researchers to fully grasp best practices, ongoing innovations, and social and economic elements influencing the efficient use of wood waste [16]. Following qualitative data collecting, a SWOT (Strengths, Weaknesses, Opportunities, Threats) analysis will evaluate the state of teak wood waste use across the whole wood sector [18]. Among the advantages of utilising teak wood waste that researchers will evaluate are the high quality of the wood, the availability of local resources, and the possibility for product innovation. Processing technology limitations are among the shortcomings that will also be mentioned. Study of possibilities will comprise the market potential for teak wood waste-based products and consumers more and more searching for environmentally friendly goods. Among the challenges one might face are legal changes, rivalry from other goods, and outside industry impact.

This paper aims to provide a whole picture of the use of teak wood waste as an alternative material by means of a mix of qualitative techniques and SWOT analysis. Employing this approach, researchers hope to create strategic and practical recommendations for wood industry operators and other stakeholders to maximise the potential of teak wood waste towards enhanced sustainability.

Results and Discussion

SWOT Analysis

The SWOT study underlines the potential of employing teak wood waste by means of minimalist design as a sustainable and innovative solution in the wood-based industry. The benefits of the approach are in its fit with environmental sustainability, efficient use of local resources, and ability to create appealing, useful items that satisfy modern market demands. But problems such material instability, time-consuming processes, and the need of appropriate technology present difficulties that call for strategic responses. Prospects exist due to the rising global demand for green products, favourable government policies and the opportunity for product diversification and entering overseas markets. These choices emphasize a potential for such ventures to be consistent with economic and environmental objectives. Nevertheless, influencing factors consist of policies for waste management, dependence on the supply of trash and competition with other resources requiring flexible alternatives.

Table 1. SWOT Analysis Wood Waste

No	Indicator	Analysis
1	Strength	1. Sustainable Waste Use Using Waste Sustainably. Once regarded as industrial by-products, teak wood waste is now transformed into high-value economic and aesthetic items, therefore greatly cutting waste. 2. Effective Minimalist Design

		Minimalist design maximizes material use, lowers waste, and creates practical yet attractive items. 3. Value in Aesthetics and Function Especially those with simple designs, products made from teak wood waste mix the natural attractiveness of the wood with useful use.
2	Weakness	1. Low Material Variability The size, thickness, and state of teak wood waste change, which influences the quality of the finished product and design freedom. 2. Time-Consuming Manufacturing Method Lengthy Manufacturing Procedure Using new materials is less time-consuming than the selection, processing, and treatment of teak wood waste. 3. Reliance on Appropriate Technology Efficient processing of waste materials calls for particular technologies to guarantee uniform product quality.
3	Opportunity	1. Increasing Need for Sustainable Goods Increasingly, consumers prefer recycled and ecologically friendly goods. 2. Encouraging Environmental Policies Government rules encouraging sustainable industrial practices and waste reduction offer incentives for creativity in waste use. 4. Minimalist design allows for the development of adaptable, multifunctional goods, including modular furniture or ornamental accessories.Global markets exhibit high interest in unique recycled-material products, particularly those emphasizing simplicity in design.
4	Threat	1. Competition from Modern Industrial Materials Teak wood waste products compete with cheaper and easier-to-process materials like plastic and metal. 2. Limited Market Awareness Not all consumers know the benefits of sustainability or are interested in minimalist designs based on recycled materials. 3. Dependence on Wood Waste Availability Teak wood waste availability depends on the ongoing furniture sector, which could affect economic changes or policy modifications. 4. Changes in Waste Management Regulations Tighter waste management rules could raise running and manufacturing expenses.

Table 1's SWOT analysis underlines the potential of using teak wood waste by way of minimalist design as a creative and sustainable solution in the wood-based industry. The advantages of the approach are in its fit with environmental sustainability, efficient use of local resources, and capacity to produce appealing, functional products that meet modern market needs. But problems such material instability, time-consuming processes, and the need of appropriate technology present difficulties that call for strategic responses. The increasing global demand for environmentally friendly goods, supporting government policies, and the potential for product diversification and international market expansion provide possibilities. These alternatives highlight the potential in such initiatives in achieving economic and ecological targets. But extrinsic factors also play a role: namely competition from alternative fuel sources, reliance on trash as a feedstock, and the changing landscape of waste-management regulations to which firms must be able to adjust.

Table 2. Production Process

No	Production
1	The first step of the teak wood waste processing for product items, such as ornamental lamp, is to select the boards of the teak wood waste with the appropriate thickness to specification. This picking process, although simple, is very important, because the thickness and the nature of each piece of wood will have an incidence on the final quality and operation of the product.
2	Various types of commercially available teak wood waste shall be assessed by the research group or the manufacturers. The boards of proper thickness will be selected according to the requirements of decorative lamp desired to be

	manufactured. For example, thicker pieces of wood could be better suited to fabricate structural components with higher strength. Thinner plating can be employed in finished products as adornment or ornamentation for parts not requiring thickness or strength.
3	The wood waste to be used is required to be cleaned of dirt and other foreign matter. This washing step is important in order to clean the wood before further handling.
4	Once scrubbed, the chunks of wood can be cut to the dimensions needed to create the light. A precise measurement and a proper cut is very important to have a part fit the light that you intend to make. Sanding and shaping of wood on this step. The end result should be a stain-free, scratch-free surface. Surface treatment can also involve protection of the wood, to which paints or varnishes are applied.
5	After the wood is prepared and the faceplate processed, it is time to think about what shapes the decoration lamp will have. The positioning and or rearranging of the teak wood items are modified as per design requirements. Then assembly takes place, full of the various parts of a robust and well put together lamp.
6	Electric components, namely sockets and wiring, are necessary for decorative lamps. The electrical parts will be fixed with the assembled decorative lamp at this time. It must be installed with care to meet safety and functionality requirements. Once the lantern was hung, all that was left was last little details. This may involve adding further protective coatings or other ornamental features to improve the look and appearance of the lamp. Also all lamp joints, parts and accessories must be retested for strength and safety.
7	The completed decorative lamp shall pass through the test to ensure all parts are functioning properly and the electrical wiring without any problem. Once all inspections are past and the lamp runs fine, the luminaire is now marketed.

Production Process

Centered on sustainable production, table 1 illustrates a full seven stage cycle for the conversion of teak wood waste into decorative lighting. The process begins with the deliberate selection of waste components depending on wood thickness and texture. From boards with structural integrity, key components are set aside; from thinner or uneven areas, decorative components are made. Every part is carefully cleaned first; then, chopped, sanded, and polished. Surface improvement calls for using environmentally friendly coatings. Precise electrical component integration creates the result in a light structure. The last stage is quality checks and finishing touches before the item is packed and sent. The following steps describe the steps in the process of converting teak wood waste to decorative lights:

1. Choosing Materials
2. Washing
3. Exact Cutting
4. Finishing Surface
5. Construction
6. Integration of Electrical Components
7. Testing & Packaging Quality

Key phases of the production process transforming teak wood waste to ornamental lamps include carefully selecting wood trash where optimal thicknesses and wood criteria are considered for high quality output, thus resulting in maximising resource efficiency and minimizing waste. Manufacturers who are inspired to tan in eco-friendly chemicals and employ water reclamation techniques to lessen environmental effects clean the wood and clear away impurities after this crucial decision is made. CNC machining and other modern processes are then used to dimension the wood allowing material

useage to be maximised, off-cuts to be minimized (for use in smaller products). The wood is then sanded, surface refined with non-toxic finishes that seal the wood on the surface preventing the sawdust from being exposed and allowing for the sawdust produced to be then recycled and used as non-toxic biodegradable fille.

Fig. 1. Final Product Front and Side

Modular architecture contributes to sustainability in figures 1 and 2 with reference to design and assembly; the precise placement of electrical components emphasises safety in addition to favouring ecofriendly materials supply. The device is to be launched soon following final tweaks and extensive testing to ensure all function and safety requirements are met. Ultimately, the rule-of-preference for the first wood dimension—ensuring all pieces are ideally suited to their desired task—is to not only raise the quality of the finished object, but also underscore a general commitment to waste reduction and being green throughout the manufacturing process.

Fig. 2. Final Product Up and Below

Discussion

The enhanced material efficiency, environmental friendliness and sustainable innovation in the wood-based creative industry have been profoundly facilitated by implementing Circular Design idea. Here, these ideas are advocated, driven by the envisioning of teak wood waste as a prospective materials for value-added ornamental products, especially within the perspective of minimalist design thinking.

Previous work highlight the importance of controlling the production of wood waste in the home furnishing and furniture industries. Hartini et al. [14] and Azhar[5] highlight the potential of maximizing cutting strategies and choosing the right wood size to minimize off-cuts —a notion that aligns with the core Circular Design principle of “designing out waste”. This research confirms these strategies in that product performance could be directly affected by consideration of teak wood thickness and grain quality, likely contributing to reduced secondary waste and material waste.

This comparison is further completed out with Nasihah [18] who also examines how waste wood could be converted to biofuels and composites. This finds alignment with the Circular Design goal of “slowing resource loops”, keeping resources in play and usefulness for longer. Compared to purely industrial purposes, the current work combines aesthetics and function to provide a model for using industrial by-products in an up-cycled, market-driven, handcrafted product. This creative valorisation adds economic and environmental value to the rationale for circular product development methods.

Viewed in the light of Circular Design analysis, this paper contributes to the Ellen MacArthur Foundation's four key strategies: (i) narrow loops by paring down resource use through minimalist design approaches; (ii) slow loops by crafting durable, design-oriented products; (iii) close loops by reintroducing waste material into the production mix; and (iv) support regeneration in a secondary sense by reducing reliance on virgin timber and associated environmental burdens. Such approaches do not only lead to resource productivity improvements but also signal changes in design paradigms, focusing on system innovation and lifecycle thinking.

The circular perspective is counterbalanced with the SWOT analysis by positioning the teak wood waste in a strategic context. Material strength and aesthetics are some of the available key elements designers get. Recognized imperfections—including material size and quality variations—require both adaptive designs and dedicated manufacturing techniques. Shifting consumer tastes towards sustainable products and more state backing to reduce waste offer opportunities. External threats, on the other hand, such as regulation uncertainty and synthetic material substitution, also reinforces the importance of market orientation and value chain integration.

From an operational perspective, the addition of Circular Design concepts also provides opportunities for business model innovation. Combining modular design ideas and on-demand production with locally sourced teak waste helps producers to reduce inventory costs and offer customisable products with less environmental effect. These policies support the development of more resilient, responsive manufacturing systems consistent with sustainable development goals.

In the end, this article demonstrates that the transformation of teak wood waste by circular design is a deliberate reconfiguration of design, manufacturing, and consumption processes rather than just an environmental intervention. By transforming wood waste from a burden to a design asset, the study contributes to the growing body of knowledge supporting circular economy modifications in creative industries. It provides theoretical basis and empirical data for advancing design-led sustainability and strengthens the more general relevance of Circular Design as a driver for sustainable industrial transformation.

Conclusion

The combination of teak waste and minimalism for incorporating sustainability address a problem of industrial waste and comply with the global trend of eco-friendly and innovative product development. This not only meets the new aesthetic requirements about ecofriendly to the end users but also creates a path to help the wood industry to realize sustainable development. The SWOT analysis suggests that utilizing recycled teak wood waste by minimalist design is a smart and green idea to produce value-added products. The power of this approach is that it can convert industrial waste into positive, desirable goods that are both fashionable and of-the-moment, and in line with current public attitudes to product consumption. Minimalist design principles make manufacturing more efficient – it uses less material and results in less waste and suggests efficiency.

An interesting result of this strategy is represented by ornamental artifacts, such as minimal lamps made of teak wood where the natural grain and figure are preserved and drastically reduced in the number and size of cuts and operations, thus minimizing the production of secondary waste. The practical use and the environmental value of waste material have been identified by the character of the simple design. The way in which this approach to sustainability is willing to address waste issues, encourage efficient use of materials and encourage environmentally responsible behaviours. Thoughtful product development also means that waste treatment can be used to decrease industrial waste and provide for the market need for new and exciting environmentally sound solutions. But here is how it works in a pragmatic case: we focused on the technical required attributes for a lamp, the aesthetic aspects and the environmental concerns, raising awareness on the possibility to use wood waste as an alternative material in the production of significant and responsible products.

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