Green Innovation from Nusantara: Economic and Environmental Potential of Bambu Betung and Kayu Ori-Based Tableware

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Abstract:

Purpose: This paper explores the potential of Bambusa Betung (bamboo) and Kayu Ori (local wood) as sustainable and environmentally friendly alternatives in the production of consumer goods, with a specific focus on disposable tableware and eco-friendly utensils.

Methods: Using a case study approach, the research examines the production processes, market acceptance, and environmental impact of these materials within Indonesia's growing green economy.

Results: The study highlights local businesses and industries that have successfully integrated bamboo and Kayu Ori into their operations, demonstrating how these materials offer significant advantages in terms of reducing carbon emissions, minimizing plastic waste, and supporting the principles of the circular economy. The research also delves into the role of innovation in enhancing the durability and functionality of bamboo and wood products, exploring their diverse applications in packaging, cutlery, and other biodegradable items. As the demand for sustainable products increases globally, the use of these materials offers a viable solution for reducing environmental harm while providing local businesses with opportunities to tap into eco-conscious markets.

Conclusions: The study reveals that incorporating bamboo and Kayu Ori into production processes not only contributes to environmental sustainability but also presents considerable economic benefits for local communities. By fostering a green economy, these materials provide a means for small and medium enterprises to thrive while promoting social responsibility. The paper concludes with strategic recommendations to enhance production, scalability, reduce production costs, and encouraging broader adoption in both local and international markets, ultimately facilitating the transition towards a more sustainable and circular economy in the Nusantara region.

Keywords:

Bamboo-Based Products, Circular Economy, Eco-friendly Tableware, Green Economy, Sustainable Innovation

1. Introduction

Global environmental issues caused by single-use plastic waste have become a serious concern over the past few decades. Theories such as Green Economy Theory, Sustainable Innovation Theory, and Circular Economy Framework highlight the importance of shifting towards sustainable materials. The Green Economy Theory, for instance,

emphasizes that economic growth should be aligned with environmental preservation, reducing carbon footprints, and promoting renewable materials.

The Green Economy Theory, for instance, emphasizes that economic growth should be aligned with environmental preservation, reducing carbon footprints, and promoting renewable materials. According to Ekawati et al. (2022), the current global situation of bamboo utilization has shifted from traditional to modern bamboo, along with improved technology and innovations. This demonstrates how sustainable innovation plays a crucial role in enhancing bamboo's usability and market competitiveness (Ekawati et al., 2022).

Data shows that global plastic production has risen sharply since the 1950s, reaching 413.8 million tons in 2023, with the majority being used for packaging, including disposable utensils and tableware. Indonesia is committed to reducing GHG emissions by 29% through domestic efforts and up to 41% with international support by 2030. The country aims to achieve carbon neutrality by 2060 or earlier, in line with long-term strategies for a low-carbon economy and climate resilience (Hermala et al., 2025). In the food sector, plastic accounts for nearly 40% of total plastic production, creating significant challenges in waste management and its impact on ecosystems. To address this issue, the development of environmentally friendly alternative products, such as biodegradable tableware, has attracted global attention (Green & Erasmus, 2024).

One promising solution is the use of agro-food waste and natural materials to produce biodegradable products. In Asia, traditional materials such as banana leaves and bamboo have long been used as alternatives to plastic for food presentation. But their industrial-scale utilization of bamboo and wood as substitutes for plastic still holds significant potential for development, particularly in the Indonesian archipelago, which is rich in biodiversity This research explores the economic and environmental potential of Bambusa Betung (Dendrocalamus asper) and Kayu Ori (Schizostachyum brachycladum) as sustainable alternatives in the production of disposable tableware (Chen et al., 2023).

In recent years, innovations in eco-friendly materials have made significant progress. A major focus has been on reducing the use of single-use plastics, which globally generate over 300 million tons of waste annually (Marsh & Bugusu, 2007). As an alternative, bamboo and wood are increasingly being used for products such as disposable tableware, including plates, spoons, forks, and straws.

Bamboo, including species such as *Dendrocalamus asper* (Bamboo Betung), offers exceptional advantages due to its fast growth rate and renewability. As a negative-carbon material, bamboo can absorb more carbon dioxide than trees during the same growth cycle, making it a key solution for climate change mitigation. Furthermore, bamboo products, such as tableware, can decompose naturally within 4–6 months in appropriate compost conditions, significantly faster than wood or certain bioplastics (Dybka-Stępień et al., 2021).

Indonesia, as one of the countries with the largest bamboo reserves in the world, has great potential to develop natural material-based products such as bamboo betung (*Dendrocalamus asper*) and wood from *Schizostachyum brachycladum*. *Schizostachyum apus*, commonly found in Indonesia, also has great potential for processing into

environmentally friendly products. Modern technology has enabled bamboo and wood to be processed efficiently without the use of harmful chemicals, ensuring the safety and sustainability of the final products. Both of these bamboo species are known for their strong mechanical properties, fast growth, and abundant availability, making them ideal materials for the production of disposable tableware such as spoons, forks, and knives. Furthermore, the production process for bamboo and wood requires less energy compared to plastic, resulting in minimal carbon emissions and the potential for long-term carbon storage, aligning with green economy principles. The innovative approach in utilizing bamboo betung and wood from *Schizostachyum apus* not only provides a solution to plastic waste issues but also opens up economic opportunities for local communities. Through the development of eco-friendly products, the green economy potential in Indonesia can be strengthened, supporting the growth of sustainable natural resource-based industries while also creating new job opportunities (Devi & Idrus, 2023).

In Denmark, the implementation of bamboo-based utensils has helped reduce plastic waste by 20% since 2021. This initiative demonstrates the potential of bamboo-based utensils in supporting the circular economy. Additionally, countries like India and China have utilized bamboo processing to create job opportunities for rural communities, a model that is relevant for Indonesia in boosting a locally-based green economy (Hendarsh, 2023).

The global demand for environmentally friendly products has seen a significant increase, driven by rising public awareness of environmental issues and consumer preferences for more sustainable choices. According to a report by the Economist Intelligence Unit commissioned by WWF, searches for environmentally friendly products have increased by 71% in the past five years, with significant growth even during the COVID-19 pandemic. This trend is evident in developed countries like the United States, the United Kingdom, and Germany, as well as in emerging markets like Ecuador and Indonesia (WWF, 2021).

On the international stage, many countries are working together to agree on reducing global plastic pollution through international agreements. In a meeting held in Busan, Korea, at the end of 2024, major countries will draft plans to reduce plastic production, aiming to mitigate the growing impact of plastic pollution (Suradja et al., 2024).

National and international policies regarding the ban on single-use plastics and support for the green economy have rapidly evolved in recent years. For instance, in the United States, the Biden administration announced measures to reduce single-use plastic consumption, supporting a more sustainable economy through policies aimed at reducing plastic waste and increasing the use of recyclable or reusable products.

Moreover, several other countries and regions have already implemented bans on single-use plastics and replaced them with more environmentally friendly alternatives. For example, in the European Union, regulations such as the ban on single-use plastic bags from the market have successfully spurred demand for more eco-friendly alternatives, including organic and recycled materials. These policies open opportunities for the green economy and support sectors focused on environmentally friendly products, including packaging and biodegradable materials that are more eco-friendly compared to conventional plastics.

Indonesia, as one of the world's largest bamboo producers, has a great opportunity to lead in this market, both locally and in exports. With its wealth of natural resources and diverse species of bamboo and timber, this sustainable approach aligns with national targets to reduce carbon emissions by 29% by 2030, as per the Paris Agreement. Bamboo has gained attention as an environmentally friendly alternative, especially in products like utensils and packaging. Its strong and lightweight nature, along with its rapid growth, makes it an ideal choice to replace plastic and other synthetic materials. Additionally, bamboo has a shorter harvest cycle compared to wood, typically only 3-4 years, allowing for more sustainable production without causing deforestation. Some studies indicate that bamboo, often referred to as "organic steel," is well-suited for use in products focused on sustainability and reducing environmental impact (Hantoro et al., 2018; Zhafira, 2019).

The culture of utilizing bamboo in Indonesian society has gradually developed, with its use spanning various aspects such as construction, agricultural tools, crafts, musical instruments, and food products. However, bamboo has not been prioritized as a main material for industry development and is often viewed as a lower-quality, less durable material. It is important to pay special attention to bamboo plantation management, craft development, and the promotion of bamboo products in order to optimize the potential of this material.

As a local resource, bamboo has a fast growth cycle and can serve as an alternative to increasingly scarce and expensive wood. Bamboo's advantages, including high elasticity, durability, shape flexibility, and affordable pricing, make it highly potential for development. With both simple and modern technology, bamboo can be processed into various value-added products (Setiawan, 2021).

Ecologically, bamboo has two main growth patterns: the sympodial type, which grows in clumps and is commonly found in tropical regions, and the monopodial type, which grows more individually. This pattern allows bamboo to thrive in tropical climates like Indonesia, making it an ideal raw material for innovative products like eating utensils (spoons, forks, and knives). The development of bamboo-based products, such as eating utensils, not only increases their economic value but also expands export opportunities and supports an eco-friendly lifestyle. Policy support and public education are essential to changing perceptions of bamboo and promoting its broader utilization (Long et al., 2023).

Bamboo and wood offer great potential in creating environmentally friendly products; however, the development of the bamboo industry in Indonesia still faces various challenges. These include technological limitations, an underdeveloped industry structure, and issues with raw material supply continuity. Meanwhile, the growing awareness of the importance of sustainability opens up vast opportunities for innovation in the use of bamboo and wood. For example, bamboo products used in a zero-waste lifestyle show a developing market potential, especially among younger consumers who are increasingly concerned with environmental issues (Irwansyah et al., 2023; Parameswara et al., 2023).

The Indonesian government has been actively promoting bamboo as a sustainable resource with economic value. Bamboo is seen as an important element in social forestry

programs and rural economic development. Initiatives like the "1000 Bamboo Villages" program aim to empower local communities, especially women, by enhancing their bamboo craft skills, increasing the value of their products, and expanding market access. This initiative has proven to help rural communities escape poverty while stimulating the use of bamboo both traditionally and innovatively in various industries such as construction, household products, and energy. Bamboo products are increasingly in demand in global markets due to their environmentally friendly properties (Komariah et al., 2024; Okfrianti et al., 2024).

The development of bamboo-based industries not only contributes to environmental sustainability but also generates substantial employment opportunities According to Ritonga (2024), the expansion of bamboo-based industries in Indonesia has the potential to create approximately 50,000 new jobs annually, particularly in rural areas where bamboo cultivation and processing are concentrated. Processing facilities, such as those in Wonosalam Village, Mojokerto District, Bali, and East Nusa Tenggara, play a crucial role in local economic empowerment by providing employment opportunities and fostering skill development. By utilizing bamboo in innovative ways—such as bamboo building materials and crafts—Indonesia is opening new opportunities for SMEs, enhancing production standards, and paving the way for eco-friendly business models. Similar trends have been observed in China and India, where bamboo model This initiative not only helps improve production standards but also paves the way for eco-friendly business models. Empowerment provides a competitive edge for small businesses in the global market. Additionally, the bamboo industry supports environmental recovery by promoting sustainable forest management (Amin et al., 2019; Khomsah et al., 2023; Ritonga et al., 2024).

The growing global demand for environmentally friendly products offers significant opportunities for Indonesian SMEs working with bamboo. Through value-added products like bamboo furniture, household goods, and packaging, local industries can capitalize on both domestic and international trends. The development of the bamboo industry is also supported by sustainable management practices, which align with the global shift toward more environmentally conscious consumption. This could boost export potential and economic growth, especially as the demand for biodegradable and non-toxic materials continues to rise worldwide (Sawarkar et al., 2023).

Generation Z, in particular, has become a major driver of demand for environmentally friendly products. Despite concerns about climate change, affordability remains a barrier for many consumers, which drives circular economy practices such as buying second-hand goods. This generation is actively seeking products that align with their sustainability values, but at more affordable prices (Maulana & Putra, 2024). Companies that do not adapt to this trend risk falling behind, as consumers are increasingly prioritizing sustainability in their purchasing decisions. Many companies are now integrating responsible sourcing and sustainable production methods into their value chains (Islam et al., 2025).

Community empowerment often begins with enhancing their capacity and involvement in decision-making processes. Successful empowerment projects not only improve the quality of life of communities but also contribute to job creation that impacts

the local economy. One key example of empowerment is involving the community in the planning and implementation of programs, which builds a sense of responsibility and ownership. This allows communities to acquire new skills, which in turn can open new economic opportunities, including job creation (Kusumaningtyas et al., 2022; Subekti et al., 2019).

Furthermore, these empowerment programs focus on meeting community needs, such as education, access to basic services, and better resource management. Community involvement in these initiatives encourages collective action to address existing socio-economic challenges.

Thus, empowerment not only contributes to poverty reduction but also strengthens the local economy through skill enhancement and sustainable job creation. Programs based on collaboration between the public sector, communities, and other organizations also show more effective results in enhancing competitiveness and the overall quality of life.

This study aims to explore the potential of utilizing bamboo betung and *Schizostachyum apus* wood in producing eco-friendly products, particularly disposable tableware, and to examine their impact on the development of the green economy in Indonesia. With a focus on sustainability, this research is expected to make a significant contribution to the creation of innovative solutions for future environmental and economic challenges.

2. Methods

The methodology of this study adopts a case study approach, focusing on the Wonosalam region in Mojokerto to observe the direct production process of bamboo-based tableware. The research integrates semi-structured interviews with local artisans to collect data on raw materials, production techniques, and industry challenges. In addition to interviews, this study conducted a survey with 100 respondents to assess consumer preferences regarding bamboo-based tableware. The survey aimed to gather insights on consumer awareness, purchasing behavior, and willingness to switch from plastic to eco-friendly alternatives.

Interviews with artisans in Wonosalam revealed several key challenges and opportunities in bamboo-based tableware production. One artisan noted, “One of our main challenges is the inconsistent supply of raw materials, especially during the rainy season, as wet bamboo is difficult to process and prone to mold.” Another artisan highlighted market difficulties, stating, “Most of our products are still sold locally, and expanding distribution remains a challenge.” These insights provide a clearer picture of the real conditions faced by bamboo artisans in Indonesia.

This study conducted a survey with 100 respondents, including small business owners and eco-conscious consumer. Participants were selected using purposive sampling to ensure relevance to the research objectives. The research includes semi structured interviews with local artisans to collect data on raw materials, production techniques, and industry challenges. Additionally, market analysis is conducted through consumer surveys to understand preferences for eco-friendly products and assess the global demand trends for biodegradable items. The study also integrates a green economy

approach by evaluating the impact of bamboo products on local job creation and assessing the economic and environmental benefits of developing a bamboo-based industry. This comprehensive methodology provides insights into both local and international market dynamics while supporting sustainable development.

3. Results and Discussion

Implementation of Bamboo-Based Tableware

In Denmark, the implementation of bamboo-based tableware successfully reduced plastic waste by 20% over three years (2021–2024), demonstrating the tangible impact of substituting plastic with biodegradable materials like bamboo. Key success factors include government regulatory support and heightened consumer awareness regarding sustainability issues (Lybæk & Kjær, 2024).

According to Denmark's Ministry of Environment Report (2023), regulations on plastic waste reduction have accelerated the transition to biodegradable alternatives (State of Green, 2020). The success was underpinned by strict government regulations on single-use plastics, including bans on plastic products such as straws, utensils, and bags. These regulations incentivized local producers to shift to eco-friendly materials like bamboo. Additionally, subsidies and tax incentives for manufacturers of biodegradable products improved their competitiveness against traditionally cheaper plastic alternatives.

Educational campaigns and advocacy efforts by the government, NGOs, and private sectors enhanced public awareness about the environmental impact of plastic waste. Denmark's consumers, renowned for their sustainable lifestyles, actively supported these initiatives by opting for bamboo-based tableware, despite its often higher price compared to plastic. A local survey revealed that 65% of Danish consumers choose eco-friendly products when alternatives are available (Hussain et al., 2024).

This initiative was also bolstered by advancements in bamboo processing technology, enabling the production of hygienic and aesthetically pleasing tableware. Bamboo materials are treated to ensure durability, water resistance, and user comfort. Denmark imports some bamboo from Asia, including Indonesia, which holds significant potential as a primary supplier. Denmark's success serves as a model for other countries aiming to reduce plastic waste. However, adaptations are necessary to align with local market characteristics. Developing nations can leverage abundant local bamboo resources to drive green economies while meeting global market demands.

Trends in Demand for Eco-Friendly Products

About 71% global increase in demand for eco-friendly products over the past five years reflects a significant shift in consumption patterns. According to WWF (2021), environmental awareness has become a priority, particularly in developed countries such as the United States and Germany, as well as emerging economies like Indonesia (WWF, 2021).

The experiences of bamboo artisans in Wonosalam align with these trends. According to one artisan, "Customers are becoming more interested in bamboo-based products, particularly those looking for eco-friendly alternatives to plastic." Additionally, a survey conducted in this study found that 78% of respondents preferred sustainable tableware,

but 62% identified price as a key barrier. These findings highlight both the growing market potential and the constraints in expanding bamboo-based industries, emphasizing the need for greater production efficiency and wider market access.

The COVID-19 pandemic emerged as a key catalyst for heightened consumer focus on sustainability, exposing the close link between human health and environmental well-being. This led to a preference for eco-friendly products. Environmental policies worldwide, such as carbon reduction initiatives and bans on single-use plastics, further propelled both consumers and producers toward sustainable options. In developed countries, incentives for green products have accelerated this transition.

Companies increasingly respond to consumer pressure by adopting sustainable business models. Many global brands now emphasize supply chain transparency and the use of recycled materials. Technological innovation has enhanced the competitiveness of sustainable products in terms of quality and pricing. Materials like bioplastics, natural fiber-based textiles, and biodegradable packaging are key focal points.

In nations like the United States and Germany, consumers are willing to pay a premium for products with eco-friendly labels. Surveys indicate around 70% of consumers in developed countries consider a product's carbon footprint before purchasing. In Indonesia, interest in eco-friendly products is gradually growing, driven by NGO campaigns, government support, and global community pressures. However, challenges remain, such as limited access and higher prices compared to conventional products.

Bamboo-Based Green Economy Development in Indonesia

Indonesia has one of the largest bamboo reserves globally. Programs like "1000 Bamboo Villages" have created new jobs and improved community skills. The success of local artisans in Wonosalam Village serves as an example of how bamboo innovation can drive economic growth while promoting sustainability.. For instance, a single bamboo clump can store up to 5,000 liters of water during a rainy season, making it ideal for rehabilitating degraded land.

Indonesia has one of the largest bamboo reserves globally. Programs like "1000 Bamboo Villages" have created new jobs and improved community skills. The success of local artisans in Wonosalam Village serves as an example of how bamboo innovation can drive economic growth while promoting sustainability. According to Ekawati et al. (2022), the use of bamboo as an environmentally friendly material extends across multiple sectors, including construction, furniture, household appliances, and even textiles. This aligns with the principles of Circular Economy, where renewable materials like bamboo contribute to waste reduction and resource efficiency (Ekawati et al., 2022).

Bamboo also offers significant environmental benefits, such as carbon absorption and CO2 deposition, supporting Indonesia's low-carbon strategy. These efforts align with government policies promoting sustainable economies while providing incentives to bamboo forest managers. These programs demonstrate how bamboo management not only boosts local economies but also contributes significantly to environmental preservation and achieving sustainable development goals.

Export Opportunities and Innovations

Bamboo-based tableware has strong prospects in international markets, particularly among environmentally conscious consumers, especially Generation Z, who prioritize sustainability. The global trend toward reducing plastic waste and transitioning to biodegradable products like bamboo is reinforced by government policies in several countries. For instance, the European Union and the United States have implemented bans on single-use plastics, driving demand for eco-friendly alternatives, including bamboo tableware.

One example of Indonesia's success in utilizing bamboo potential is an initiative in Wonosalam, Mojokerto. Local artisans there have successfully produced bamboo-based utensils, such as spoons and forks, that are eco-friendly and sustainable. These products not only meet high-quality standards but also adhere to sustainability principles. The initiative supports local economic empowerment and significantly contributes to reducing plastic waste. It also opens opportunities for Indonesian bamboo products to penetrate global markets, given the growing demand for eco-friendly products in developed countries.

Residents of Pucangrejo Hamlet, Wonosalam Village/District, Jombang, have developed bamboo tableware of a quality comparable to plastic products. This success highlights how innovation and supportive policies can enhance the competitiveness of Indonesian bamboo products in international markets. Two types of bamboo used in production, *betung* bamboo and *ori* bamboo, have distinct advantages: *Ori* bamboo offers a clean white finish suitable for fine crafts, while *Betung* bamboo's robust texture ensures durability, making it ideal for sturdy products. Additionally, teak wood is sometimes used for complementary products.

Local artisans source these raw materials from farmers at affordable prices, and the abundance and quality of bamboo in Wonosalam enhance the efficiency and competitiveness of bamboo tableware production. Such initiatives, alongside policies supporting eco-friendly products, strengthen Indonesia's position as a leader in the global bamboo industry. With increasing environmental awareness worldwide, demand for bamboo-based products is projected to grow, paving the way for further expansion of locally sourced bamboo innovations. With the right policies and optimal utilization of local resources, Indonesia has a tremendous opportunity to develop its bamboo industry and promote eco-friendly products globally.

4. Conclusions

This study highlights the significant potential of Bambusa Betung and Kayu Ori as sustainable alternatives to plastic-based tableware. The findings suggest that bamboo-based products play a crucial role in reducing plastic waste and carbon emissions, thereby contributing to environmental sustainability. Additionally, the growing market demand for eco-friendly products presents a promising opportunity for the expansion of the bamboo industry. However, affordability remains a key barrier to widespread adoption, indicating the need for cost-efficient production strategies and market incentives. To further support this industry, stronger policies and incentives are essential

to empower local artisans and enhance the commercial viability of bamboo-based products.

Future research should focus on assessing the scalability of bamboo-based production to meet global demand, evaluating the long-term economic impact of bamboo adoption on local communities, and analyzing the effectiveness of government incentives in fostering a sustainable bamboo industry. By integrating these aspects into a broader framework of circular economy and sustainable entrepreneurship, the bamboo industry has the potential to address pressing environmental challenges while simultaneously supporting economic growth and social development.

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