Bartın Orman Fakültesi Dergisi | Journal of Bartin Faculty of Forestry
2025, 27(2): 364 – 375 | DOI: 10.24011/barofd.1740781

BAROFD

Developing Engineered Wood Products from Natural Fibers to Advance Sustainability in the Philippines

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Article History
Received: 12.07.2025
Accepted: 04.08.2025
Published: 30.08.2025

Review Article

Abstract − Philippines, home to diverse natural resources and an agriculture-based economy, is increasingly pressured to practice sustainability in the construction and manufacturing sectors. This article investigated the production of engineered wood products from natural fibres and agricultural residues to enhance sustainability and resource optimization. It considers using native raw materials such as bamboo, abaca, coconut husks, banana stalks, rice straw, and peanut shells for new building materials, including more sustainable particleboard, fiberboard and engineered wood. These materials have satisfactory mechanical properties and provide eco-friendly solutions to replace wood and solve deforestation, agrowaste accumulation, and rural economic inequality. The findings focused on new processing methods, product performance, resin development, policy, industry collaboration, and research driving innovation. Although facing real challenges such as variability of quality, low scalability and lack of infrastructure, the Philippines is in a good position to become a regional leader in engineered wood products from sustainable sources. The authors also highlighted the perspectives for research, policy, and industry collaborations that will maximize the opportunities offered by such natural fibre reinforced composites to foster the development of a circular low carbon economy.

Keywords − *Agrowaste, Biocomposite, Eco-design, Greentech, Renewable Resource*

Filipinler'de Sürdürülebilirliğin Artırılmasına Yönelik Doğal Liflerden Üretilmiş Ahşap Ürünlerin Geliştirilmesi

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Makale Tarihçesi
Gönderim: 12.07.2025
Kabul: 04.08.2025
Yayım: 30.08.2025

Derleme Makalesi

Öz − Filipinler, çeşitli doğal kaynaklara ve tarıma dayalı bir ekonomiye sahip bir ülke olarak, inşaat ve imalat sektörlerinde sürdürülebilir uygulamaları benimseme konusunda giderek artan bir baskı altındadır. Bu makalede, sürdürülebilirliği geliştirmek ve kaynakların etkin kullanımını sağlamak amacıyla tarımsal artık niteliğindeki doğal liflerden mühendislik ahşap ürünlerinin üretimi incelenmiştir. Bambu, abaka, hindistancevizi kabuğu, muz sapı, pirinç samanı ve yer fıstığı kabuğu gibi yerli hammaddelerin daha sürdürülebilir yonga levha, lif levha ve mühendislik ahşapları gibi yeni yapı malzemeleri üretiminde kullanımı ele alınmıştır. Bu malzemeler yalnızca tatmin edici mekanik özelliklere sahip olmakla kalmayıp, aynı zamanda orman tahribatı, tarımsal atık birikimi ve kırsal ekonomik eşitsizlik gibi sorunlara çözüm sunan çevre dostu alternatifler olarak öne çıkmaktadır. Çalışmada, yeni işleme yöntemleri, ürün performansı, reçine geliştirme süreci ile politika yapımı, sanayi iş birlikleri ve araştırma yoluyla yenilikçiliğin teşvik edilmesi gibi konulara odaklanılmıştır. Kalite değişkenliği, düşük ölçeklenebilirlik ve altyapı eksikliği gibi bazı gerçek zorluklarla karşı karşıya olmasına rağmen, Filipinler, sürdürülebilir kaynaklardan elde edilen mühendislik ahşap ürünleri alanında bölgesel bir lider olma potansiyeline sahiptir. Yazarlar ayrıca, doğal lif takviyeli bu kompozitlerin sunduğu fırsatların en üst düzeye çıkarılmasını sağlayacak araştırma, politika ve sanayi iş birliklerine yönelik perspektifleri vurgulamıştır. Bu yönüyle, döngüsel ve düşük karbonlu bir ekonominin geliştirilmesine katkı sağlanması amaçlanmaktadır.

Anahtar Kelimeler – *Tarım Atıkları, Biyokompozit, Ekotasarım, Yeşil Teknoloji, Yenilenebilir Kaynak*

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1. Introduction

Being a biodiversity-rich country and an agro-based economy, the Philippines has been trying to find diverse approaches to the sustainable exploitation and use of its natural resources (Raihan, 2023; Maharjan et al., 2025). One such alternative is the production of composite boards, which blend different materials to create products with improved properties that can be used in the construction and furniture markets (Acda, 2022; Acda et al., 2025). With this, its drive towards sustainable development (Loreño & Huang, 2025) has prompted research and industry endeavors on recycling agricultural wastes into composite materials for high-end uses (Aguilar & Lawagon, 2022; Cagadas et al., 2023) of environmental and economic importance.

As the global shift toward eco-friendly construction materials continues (Abera, 2024), composite boards have increasingly become a popular replacement for conventional wood. (Neitzel et al., 2023; Jeyaguru & Thiagamani, 2025). The Philippines, noting this inclination, has committed to producing bio-composites using agricultural refuse materials (Ramirez-Peñafiel et al., 2022). This method offers a sustainable waste disposal approach and limits traditional wood use (helping preserve forests) (Ricciardi et al., 2021). The recycling of agricultural waste, including not only rice straw, but other natural fibrous materials as well as materials as diverse as banana stalks and coconut husks and into composite boards has gained the attention of researchers, aiming to improve properties and maintain a sustainable environment (Pogosa et al., 2018).

Furthermore, the environmentally friendly orientation of the Philippine government has created an innovative atmosphere in the composite board industry (Balanay et al., 2022; Hosung, 2024; Palma-Torres et al., 2024; Department of Trade and Industry, 2025). Policies promoting the utilization of sustainable resources and the production of eco-friendly materials have received growing attention from research institutes and business stakeholders (DTI, 2025). These partnerships are designed to develop better manufacturing processes, enhance product quality, and enhance the utilization of composite boards in different industries such as construction, furniture, and interior design (Tuazon & Dizon, 2024; Vitug & Alvarez, 2024).

To address the rapid increase in the production and processing of bio-based composite board in the Philippines through natural fibers, agro-based waste, and engineered wood composites, this review is culled its progress about natural fibers and thoughtfully compiled to disclose further problems and future trends facing the industry in the face of environmental and economic issues. From the review of earlier and recent literature and ongoing changes in sustainable composite materials, the authors intend to determine whether or not advances have been achieved and suggest future research and application areas.

2. Utilization of Natural Fibers

With its abundant agricultural and forestry resources, the Philippines can supply sufficient natural fiber for composite board production, particularly from the most studied sources—bamboo and abaca (Department of Environment and Natural Resources - Forest Management Bureau, 2024; Limbaro et al., 2025).

2.1. Bamboo Fiber

Bamboo, for example, is being emphasized because of its rapid growth, high strength-to-weight ratio, and common availability in many regions of the country (Pioquinto-Laguardia et al., 2025). Cross-laminated bamboo (CLB) made from such species as *Bambusa blumeana* and *Dendrocalamus asper* was found to comply with structural performance needs for wall, slab and flooring systems (Department of Science and Technology-Forest Products Research and Development Institute, 2023).

2.2. Abaca Fiber

Abaca *(Musa textilis)*, a native fiber plant of the Philippines, is globally recognized for its exceptional strength, flexibility, and biodegradability (Oulanti et al., 2025). Traditionally used in rope and textile industries, abaca has gained increasing attention as a reinforcement material in engineered wood composites due to its high tensile properties and environmental advantages (Asyraf et al., 2024). As leading abaca fiber producer the world, contributing over 63% of the global supply (Food and Agriculture Organization, 2024), the Philippines holds a strategic position in developing sustainable composite products (DOST-FPRDI, 2023). This shift supports the global transition from synthetic, non-renewable materials, aligning with goals for circular and bio-based economies in sectors like furniture and construction (Morgan, 2024).

Studies have shown that incorporating untreated or chemically modified abaca fibres can significantly improve mechanical properties of composite boards (Shakir & Singh, 2024). Panneerselvam et al. (2025) reported enhanced modulus of rupture and internal bonding strength in abaca-reinforced particleboards, while treatments such as alkali and silane have further improved fiber-resin adhesion (Zein et al., 2025). Abaca's natural pest resistance and low moisture absorption make it especially suitable for humid and tropical climates (Señeris et al., 2022; Araya-Gutiérrez et al., 2023). Moreover, using abaca reduces the carbon footprint of engineered products (Arvizu-Montes et al., 2025) and supports rural livelihoods through fiber cultivation and agroforestry (Señeris, 2024). Scaling up its use in the Philippine wood industry will require coordinated efforts among researchers, industries, and policymakers to ensure quality standards, foster innovation, and create incentives for green materials (Bales et al., 2025).

3. Utilization of Agricultural Residues

3.1. Coconut *(Cocos nucifera)* Husks

The country also has rich agricultural resources yielding substantial biomass wastes and opportunities for green material development (Montefrio et al., 2012; Perea-Moreno et al., 2020). In these residues, the coconut husk has been widely researched as a possible raw material for composite board production (Pogosa et al., 2018; Martinez, 2025). Coconut husk, as a waste of about 16 billion coconuts/yearly, can be used to fabricate binderless boards for cladding material in frame houses (Greer, 2009; Böger et al., 2018). This has several advantages; it adds value to what would have been initially waste and provides a sustainable substitute to non-renewable construction materials (Lokko, 2016; Martinez, 2025).

The development of composite boards is also accelerated by innovative utilization of recyclable materials (Krauklis et al., 2021; Zanuttini & Negro, 2021). One of the pioneering developments of composite board technology in the country is the utilization of coconut coir and other agro-industrial wastes (Eco-Friendly Tips PH, 2025). Provinces that are significant producers of coconut produce vast amounts of husk each year, with a significant amount wasted or burnt (Pogosa et al., 2018). Recent work aims to develop durable particleboards by blending coconut coir fibers with urea-formaldehyde resin as a binder (Manjunathan et al., 2024; Rao et al., 2025). These boards have exhibited good mechanical properties such as good internal bond and modulus of rupture (Rao et al., 2025).

Coconut coir-based boards provide an ecologically sustainable and economically feasible alternative for furniture-making and interior panelling (Thirunavukkarasu et al, 2018). This method reduces environmental contamination and links to a value chain for coconut growers using a waste product high in lignocellulosic content (Vieira et al., 2024). Moreover, optimization of pressing conditions and resin recipes is still an ongoing area of research in order to increase durability and water resistance of boards, as well as to assess if this innovation could be scaled up and transferred to coconut-producing regions in any coconut producing country (Kumar et al., 2023; Vieira et al., 2024).

Other agricultural residues, including coconut leaves, have also been researched for use in the production of composite board (Martinez, 2025). Independent studies have been carried out to confirm the applicability of these materials, observing that they can effectively reduce pollution effects, and affordable building materials can also be made based on these (Okeke et al., 2024; Sarma & Paul, 2024). These endeavors align with international sustainability targets and demonstrate the Philippines' dedication to pioneering waste management technology (Figueroa et al., 2021).

3.2. Banana Fruit Stalk Fibers

Over a billion kilograms of banana stalk waste are produced annually in the Philippines and were previously left unutilized (DOST-FPRDI 2022). Recent trials at FPRDI show that it can produce fire-retardant thermal insulation boards with low thermal conductivity. The saba banana *(Musa paradisiaca)* is one of the most extensively grown crops in the Philippines, significantly generating agro-waste materials specifically from the fruit stalks (Castillo-Israel, 2015). Banana stalks *(Musa paradisiaca)* have been identified as a good fiber for insulation and lightweight boards (DOST-FPRDI, 2022). These initiatives serve dual, environmentally focused purposes—reducing agricultural waste and providing economic incentives, via the generation of value-added products from current resources.

3.3. Rice Straw

Additionally, rice straw, a common agricultural by-product in the Philippines, has recently been explored for composite board-making (Macatangay et al., 2012; Martinez, 2025). Rice straw is commonly regarded as trash and burned in the open to clear fields, thus leading to air pollution and greenhouse gas emissions (Musinguzi et al., 2019). Modern studies have used radiation to produce particleboard and medium-density fiberboard from rice straw, alone or combined with synthetic and bio-based adhesives (El-Kassas & Elsheikh, 2021; Luo et al., 2025). These boards have maintained acceptable mechanical behavior especially for non-structural uses like interior panels and ceiling boards.

Rice straw composites play a role in sustainable agriculture and waste valorization (Pelaez, 2019; Martinez, 2025). The pressing conditions, adhesive compositions and straw pretreatment processes are important to affect the properties of rice strawboard (Li et al., 2023; Hao et al., 2025). Scientists have been searching for industrially accepted and environmentally friendly adhesives. They are developing growing techniques that are more scalable for producing environmentally friendly adhesives, like tannin or soy-based resins (Lei et al., 2025). The rice straw technology has the potential of serving a dual purpose in the Philippines, as the country processes millions of tons of rice grains each year (Gomez, 2024), the technology could solve dual problems of waste disposal and supply of building materials.

3.4. Corn Husks, Peanut Shells and Banana Sheaths

Other agro-residues such as corn husk, peanut shell, and banana sheath have been investigated as potential sources of raw material for composite board production in the Philippines. Corn husk, which is produced on a large scale and often ends up in the field to be discarded, has a value of 80-87% cellulose and possesses medium strength and toughness, which are enough to use as fiberboard. With a 40:60 weight ratio of corn husks: chopped plastic bags, hot-pressed boards were produced that have been tested by the Philippine National Standard (PNS) for MOR, IB, and TS (Macatangay et al., 2012; Martinez, 2025). Also, due to the biodegradability and absorption characteristics of peanut shells, materials consisting of peanut shells were mixed with 12% urea-formaldehyde resin, and hot compressed to manufacture the boards which met the PNS criteria of density, internal bond and nail head pull-through, suggesting their possible application in department stores and furniture. For banana sheath, the fibers extracted from wild varieties were also found suitable in producing composite boards using urea-formaldehyde as adhesive, which met the PNS requirement for mechanical and physical properties. These findings show the potential of underutilized agro-waste as an alternative sustainable material for engineered boards in the country (Macatangay et al., 2012).

Reusing these agro-wastes as building materials opens new avenues for natural alternative products and presents a solution to the problem of their waste disposal in agriculture. The Philippines can build a more sustainable construction and manufacturing industry by turning high-added-value composite boards out of the detailed agriculture.

4. Engineered Wood Products

There are many suitable trees found in the Philippines that can be used for composite panel production. They can also be grouped according to their availability, characteristics of the wood, and compatibility with processing. The data in Table 1 presents a diverse range of tree species used in the panel industry by endemism and end use. These are complemented by several native species like *Pterocarpus indicus* (Narra), *Shorea contorta* (White Lauan), and *Shorea negrosensis* (Red Lauan), which are used for plywood and decorative veneer, implying their high quality of wood properties. Plywood is also made from other native species such as *Artocarpus blancoi* (Antipolo) and *Petersianthus quadrialatus* (To-og). Out of these, non-wood material from species such as *Durio zibethinus* (Durian) is already used for fiberboard manufacturing, emphasizing the utility of agricultural waste for responsible panel production. Many, such as (Falcata) *Falcataria moluccana*, (Mangium) *Acacia mangium*, and (Yemane) *Gmelina arborea*, have very rapid growth rates and are therefore widely used in commercial forestry and industrial applications, which is why they occupy a large portion of the market share concerning panel products such as plywood, particleboard and fiberboard.

The dominance of exotic species in the panel industry indicates a strong dependency on fast-growing, plantation-based (exotic) trees for sustainable raw materials supply. Species like *Tectona grandis* (Teak), *Swietenia macrophylla* (Mahogany) and *Hevea brasiliensis* (Rubber Mega) are frequently exploited in engineered wood products such as laminated veneer lumber (LVL) and glulam timber, thus confirming the relevance of the wood species in high-value applications. Conversely, the decrease in the use of some native species may reflect limited supply, conservation, and logging restrictions (DENR-FMB, 2024). The industrialization necessities must be balanced with conservation strategies of those native timber resources used for sustainable consumption of these unique trees and forests. Otherwise, they will be forever lost to future generations. Also, the data suggests a growing interest in taking advantage of alternative materials such as fruit husk fiberboard, using circular economy principles that create value from agricultural waste.

5. Challenges and Opportunities

Developing engineered wood products from natural fibers and agricultural wastes in the Philippines presents a promising yet complex path toward sustainable material innovation. However, this sector is not without its challenges. One of the foremost limitations in utilizing natural fibers such as bamboo (Chen et al., 2024) and abaca lies in the inherent variability in their properties (Señeris et al., 2025). Factors such as fiber dimensions, moisture content, and tensile strength tend to fluctuate depending on harvesting conditions, species, and region, resulting in inconsistent board performance (Kurien et al., 2023). Compounding this issue is the lack of standardized processing protocols for treatment, drying, and resin bonding, which hinders the production of uniformly high-quality products (Kelkar et al., 2023). In many rural regions with abundant natural fibres, the infrastructure and equipment necessary for fiber harvesting, grading, and transportation remain underdeveloped (Limbaro et al., 2025). Additionally, there are persistent technical challenges related to poor adhesion between natural fibers and certain resins, often necessitating chemical treatments that increase production costs and complicate environmental compliance (Islam et al., 2024).

Similarly, using agricultural residues such as coconut husks, banana stalks, rice straw, peanut shells, and corn husks encounters several practical and technological constraints. Many of these residues are biodegradable and moisture-sensitive, making it challenging to produce durable boards unless they undergo extensive pre-treatment. The collection and pre-processing of these materials are also labour-intensive and hindered by inefficiencies in post-harvest agricultural systems. While these materials offer tremendous ecological benefits, their full potential is often undermined by a continued reliance on synthetic binders such as urea-formaldehyde, limiting the final products' environmental advantages. Moreover, while research trials and laboratory-scale demonstrations have shown encouraging results, large-scale commercialization remains limited due to high initial investment costs, lack of established supply chains, and weak integration into government procurement frameworks.

Table 1
Tree species used in the Philippine wood-based composite panel industry

Tree species	**Area of use in the panel industry**	**Endemism (Co's Digital Flora)**	**Reference/Source**
Falcata [*Falcataria moluccana* (Miq.)] Barneby & J. W. Grimes]	Plywood, Particleboard, Fiberboard, Oriented Strand Board (OSB), Laminated Veneer Lumber (LVL)	Exotic	Hwang et al., 2008 ; Hassan & Rahman, 2019 ; Alipon et al., 2021 ; Baskara et al., 2022 ; Jimenez et al., 2022 ; Fauziyyah et al., 2025
Narra (*Pterocarpus indicus* Willd.)	Decorative veneer	Native	Mendoza et al., 2019
White Lauan (*Shorea contorta* S. Vidal)	Plywood	Native	Yoo et al., 1976 ; Santabárbara et al., 2021
Red Lauan (*Shorea negrosensis* Foxw.)	Plywood	Native	Yoo et al., 1976 ; Santabárbara et al., 2021
Antipolo (*Artocarpus blancoi* Merr.)	Plywood	Native	Jimenez et al., 2015
Teak (*Tectona grandis* L.f.)	Plywood, Particleboard	Exotic	Tenorio et al., 2012 ; Moya et al., 2014 ; De Souza et al., 2022
Malapapaya (*Polyscias nodosa* (Blume) Seem.)	Plywood	Native	Natividad, 2016
Mangium (*Acacia mangium* Willd.)	Plywood, Particleboard, Glulam Timber, Medium Density Fiberboard (MDF), Oriented Strand Board (OSB), Laminated Veneer Lumber	Exotic	Nuryawan et al., 2009 ; Darmawan et al., 2010 ; Tenorio et al., 2012 ; Alipon et al., 2017 ; Singan & Liew, 2019 ; Baskara et al., 2022 ; Xu et al., 2024 ; Cassiophea & Perkasa, 2025 ;
Durian (*Durio zibethinus* L.)	Fiberboard (Fruit husk)	Native	Aguilar & Lawagon, 2022
Avocado (*Persea americana* Mill.)	Plywood, Glulam Timber/Glue boards,	Exotic	Fuentes-Talavera et al., 2011 ; Cahyono et al., 2019
Gubas (*Endospermum peltatum* Merr.)	Particleboard, Plywood	Native	Pablo, 1986 ; Jimenez et al., 2015 ; Natividad, 2016
Mahogany (*Swietenia macrophylla* Roxb)	Plywood, Particleboard, Laminated Veneer Lumber (LVL)	Exotic	Krisnawati et al., 2011 ; Anoop et al., 2014 ; Cahyono et al., 2019 ; Silva et al., 2021
Rubber Tree *(Hevea brasiliensis* Müll.Arg.*)*	Particleboard, Laminated Veneer Lumber (LVL), Glulam Timber, Medium Density Fiberboard	Exotic	Pablo, 1986 ; Darmawan et al., 2010 ; Hwang et al., 2008 ; Xu et al., 2024 ; Amarang et., 2025
To-og (*Petersianthus quadrialatus* (Merr.) Merr.)	Plywood	Native	Villaflor & Razal, 1978 ; Tamolang et al., 1982
Ipil-ipil (*Leucaena leucocephala* (Lam.) de Wit.)	Particleboard	Exotic	Pablo, 1986
Rain Tree (*Samanea saman* (Jacq.) Merr.)	Particleboard	Exotic	Brito & Silva, 2023
Bagras (*Eucalyptus deglupta* Blume.)	Medium Density Fiberboard	Native	Seng Hua et al., 2022
Yemane (*Gmelina arborea* Roxb.)	Plywood, Particleboard, Fiberboard, Oriented Strand Board (OSB), Laminated Veneer Lumber (LVL)	Exotic	Nuryawan et al., 2009 ; Tenorio et al., 2012 ; Moya et al., 2014 ; Alipon at el., 2019 ; Sutrisno et al., 2020 ; Aisyah et al., 2021 ; Brito & Silva, 2023

In the realm of engineered wood products (EWPs), such as plywood, laminated veneer lumber (LVL), and medium-density fiberboard (MDF), the Philippine industry is still navigating between the needs of industrialization and the imperatives of forest conservation. Many EWPs rely heavily on fast-growing exotic species like falcata, acacia, and gmelina, which dominate commercial forestry due to their rapid growth rates and favorable wood characteristics (Limbaro et al., 2025). However, the use of native hardwood species has declined sharply, mainly due to limited supply, regulatory restrictions, and conservation priorities (DENR-FMB, 2024). Balancing the exploitation of these resources with long-term ecological stewardship remains a pressing policy concern. At the same time, the production of high-quality EWPs demands sophisticated technologies and manufacturing facilities, which are often beyond the reach of small and medium-scale enterprises. Moreover, the absence of widespread quality certification and adherence to international standards hampers the global competitiveness of Philippine-made EWPs.

Despite these challenges, significant opportunities exist for the Philippine composite board sector. The country's extensive biodiversity and agricultural productivity provide a sustainable and renewable source of raw materials that, if properly harnessed, could support a thriving green materials economy. National sustainability initiatives and growing public-private partnerships have created an enabling environment for innovation in fiber-based composites. As global demand rises for bio-based and circular products, the Philippines has increasing potential to position itself as a supplier of high-value, eco-friendly boards for domestic use and export. Furthermore, the growing awareness and preference among builders, architects, and consumers for environmentally certified and low-emission materials is paving the way for broader market acceptance of composite boards made from natural fibers and agro-wastes.

6. Future Outlook

Looking toward the future, several strategic actions must be prioritized to overcome the existing barriers and unlock full potential of the sector. There is a critical need for continued research and development in bio-based adhesives to replace synthetic resins and improve the environmental profile of composite products. Establishing regional hubs for the collection and preprocessing of agricultural residues would not only enhance supply chain efficiency and support inclusive rural development. Investment in capacity-building, technical training, and technology transfer can empower local communities and small-scale enterprises to participate in the value chain. In the form of tax incentives, green procurement policies, and carbon offset programs, government support will be essential to catalyze investment and encourage widespread adoption. Moreover, international collaboration in standards alignment, market access, and innovation exchange can strengthen the Philippines' position in the global green materials economy. With these coordinated efforts, the country is well-positioned to become a leader in sustainable engineered wood products, transforming waste into value and aligning material production with environmental resilience and economic sustainability goals.

7. Conclusions

Manufacturing composite wood products from lignocellulose and agricultural wastes is a game-changer for the Philippines in addressing its current environmental, economic and sustainable resource use concerns. This article indicates that incorporating locally available materials like bamboo, abaca, coconut husks, banana stalks, rice straw, and other agro-wastes in producing composite board is technically feasible, economically profitable and socially inclusive. These developments lead to waste minimization, forest preservation, and the production of added-value products for rural employment and industry competitive power. Nevertheless, to optimize the development of the sector several barriers need to be addressed: standardization for quality assurance, innovation in processing technologies, creation of markets, and increased policy support. Shared effort of researchers, government and industry is needed to scale production, increase material performance, and extend market acceptance. As international markets shift towards demand for sustainable products, the Philippines is poised to become a key player in the bio-composite industry, particularly with its abundant natural resources and efforts to implement strategies to create and circulate a circular economy. The group also proposed further study of the development of sustainable adhesives and enhancement of material durability, as well as the development of non-toxic, renewable binders, and compliance with international standards. To pave the way to the nation's greener and stronger wood industry.

Acknowledgement

The authors would like to acknowledge the anonymous reviewers for the careful perusal of the article.

Author Contributions

Gindol Rey Ayala Limbaro: Conceptualized and wrote the intial and final draft of the article.

Önder Tor: This auther planned, designed the study, reviewed and edited the final version of the article.

Conflicts of Interest

The authors declare no conflict of interest.

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