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Evaluating Sustainable Business Models for Coconut Shell Utilization among Indonesian SMEs: A Financial Feasibility Perspective

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ABSTRACT

The coconut industry plays a significant role in the economies of major producing countries such as Indonesia, the Philippines, and Vietnam. Despite the strong potential of coconut shells as a valuable by-product, they remain largely underutilized and are often treated as low-value waste, limiting economic opportunities for upstream actors and contributing to environmental inefficiency. This study develops a sustainable and financially feasible business model for coconut shell utilization by integrating value chain analysis, circular economy principles, and financial feasibility considerations. A qualitative research approach supported by simplified quantitative financial evaluation was adopted, combining a structured literature review with semi-structured interviews with practitioners from two Indonesian coconut processing companies, PT Coco Reina Global Indonesia and Inari Coco. The findings indicate that coconut shells possess strong potential to be transformed into higher-value products such as activated carbon, biochar, and charcoal briquettes, with growing market opportunities particularly in European and Middle Eastern export markets. The study concludes that circular economy approaches can simultaneously improve resource efficiency, reduce agricultural waste, and create additional economic value within the coconut industry, while also addressing sustainability reporting implications relevant to the Corporate Sustainability Reporting Directive (CSRD) for coconut-exporting SMEs seeking access to European markets.

Keywords: coconut shell utilization, circular economy, sustainable business model, value chain analysis

INTRODUCTION

The coconut industry is an important sector in many producing countries such as Indonesia, Vietnam, and the Philippines, supplying products such as oil, water, fibre, and charcoal to global markets. However, the industry still faces sustainability challenges, particularly in the management of by-products such as coconut shells. Large volumes of shells are either burned or discarded, which leads to waste and lost economic value (FAO, 2021). This situation limits the economic potential of the industry and prevents many actors in the value chain from capturing higher returns.

Coconut shells are produced in large quantities but are still often burned, discarded, or treated as low-value waste, creating environmental concerns and limiting opportunities for additional value creation. In many producing regions, farmers and small processors lack access to the technology, knowledge, and financial resources needed to process coconut shells into more profitable products. According to UNDP (2020), this contributes to inefficiencies within the value chain and limits income opportunities for upstream actors. As global markets increasingly emphasize sustainability and circular production systems, the underutilization of coconut shells becomes both economically and environmentally inefficient.

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At the same time, coconut shells have strong potential to be transformed into higher-value products such as activated carbon and biochar. Recent studies show that coconut shell-based activated carbon possesses strong adsorption capabilities and broad applications in water treatment and industrial purification processes (Saleem et al., 2024). These opportunities demonstrate that coconut shells can become valuable resources within circular economy business models rather than simply agricultural waste.

Despite these opportunities, many small and medium enterprises (SMEs) still face difficulties in evaluating the financial feasibility of coconut shell processing activities. Limited financial planning, cost analysis, and uncertainty regarding long-term profitability often discourage investment in higher-value production (Pongsa et al., 2023). In addition, increasing sustainability requirements from international markets, particularly the European Union through regulations such as the CSRD, create both opportunities and pressures for producers to adopt more sustainable and transparent business practices (European Commission, 2023).

In order to turn coconut shells into profitable circular products that satisfy EU reporting and traceability requirements, industry players farmers, collectors, cooperatives, and SMEs lack a workable, financially sound, and sustainability-aligned framework. Cost structures, investment requirements, profitability, and the sustainability data needed for export markets remain unclear to managers, which hinders the sector's capacity to advance and makes strategic decision-making challenging.

Although coconut shells hold strong potential to be converted into high-value circular products such as activated carbon, biochar, and handicrafts, most producers in coconut-producing countries still treat shells as low-value waste. SMEs lack clear business models, financial feasibility assessments, sustainability reporting practices, and value chain transparency, which prevents them from entering higher-value markets, especially in Europe, where sustainability regulations such as CSRD and the Digital Product Passport (DPP) require traceability and environmental accountability. As a result, the coconut shell value chain remains inefficient, economically underdeveloped, and poorly aligned with global circular economy opportunities.

Main research question: How can a financially feasible business model be developed for processing coconut shells into higher-value products? (1) Where in the coconut shell value chain does the selected product create the highest added value, and what improvements are needed to support this upgrade? (2) Is producing the selected coconut shell product financially feasible, considering expected costs, revenues, and investment requirements?

This research aims to develop a sustainable and financially feasible business model for coconut shell-based production by mapping the value chain, identifying opportunities for value creation, and proposing circular business model options. It further evaluates the financial feasibility of these options through cost analysis, projected cash flows, and investment requirements, while also examining key accounting implications such as cost allocation and sustainability reporting.

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THEORETICAL FRAMEWORK

Coconut Industry in Global Context

The coconut industry is an important agro-industrial sector that contributes to economic, social, and environmental development in many producing countries. Countries such as Indonesia, the Philippines, Vietnam, India, and Sri Lanka are among the world's largest coconut producers, with Indonesia playing a significant role through domestic production and export-oriented processing activities. According to FAO (2021), global demand for coconut-based products continues to increase due to growing consumer preferences for natural and sustainable products. However, this growth has not always improved the welfare of smallholder farmers and upstream actors, largely because the industry still relies heavily

on low-value products, raw material exports, and limited adoption of advanced processing technologies.

Value Chain of Coconut and Coconut By-Products

The coconut value chain involves interconnected actors, from farmers as raw material producers to collectors, processors, exporters, and end buyers. Economic value created along the chain is often distributed unevenly, with upstream actors receiving a relatively small share of total value. Limited bargaining power, weak market information, and restricted access to technology and financing make it difficult for farmers to move into higher-value activities (UNDP, 2020). Ayuya and Oloo (2024) and Muriuki et al. (2024) further highlight that limited coordination among actors, fragmented production structures, and weak infrastructure restrain the evolution of better-integrated and more efficient processes, so that by-products such as shells and husks are frequently treated as waste rather than as inputs for further product development.

Material Flows and Coconut Shell as a Strategic By-Product

The coconut industry has a complex material flow, yet downstream processing traditionally focuses on coconut meat, while the shell and husk are treated as low-value by-products. According to Vieira et al. (2024), this linear approach results in inefficient resource use and significant losses in potential value creation, as well as greater carbon emissions and local environmental pollution. Coconut shells have a high carbon content, a stable porous structure, and strong heat resistance; Ajien et al. (2022) showed that these characteristics make coconut shells suitable raw materials for activated carbon and biochar, which have significant application potential in agriculture, water treatment, and pollution control due to their adsorption ability and resistance to degradation.

Circular Economy as a Framework for Transforming the Coconut Agroindustry

The circular economy emphasizes a transition from linear production systems toward regenerative and resource-efficient systems, maximizing the use of biomass and minimizing waste. Within the coconut industry, these principles are particularly relevant given the large quantity of underutilized by-products such as shells and husks, which possess strong potential to be transformed into higher-value products (Vieira et al., 2024). Vieira et al. (2024) and the article Harnessing Coconut's Potential (2025) note that implementing a circular economy in the coconut industry requires a systemic approach integrating technology, institutional support, and business model design, and that long-term sustainability of circular initiatives depends heavily on financially feasible business models.

Sustainability Analysis Based on the Triple Bottom Line

From an environmental perspective, inefficient coconut waste management reflects poor resource utilization, converting coconut shells into biochar can reduce greenhouse gas emissions while improving soil quality and agricultural productivity (Ajien et al., 2022). From a social perspective, low farmer incomes, limited technology access, and weak market integration remain major challenges, although improving local value addition through coconut by-product processing can help create employment opportunities and support rural economic development (Muriuki et al., 2024). From an economic perspective, coconut shell-based products such as biochar can be financially viable when supported by sufficient production scale, optimized production conditions, and reliable market access (Pongsa et al., 2023).

Challenges, Reporting Implications, and EU Regulations

The transition toward a circular economy faces challenges such as weak institutional coordination, low technological investment, and market uncertainty. Ayuya and Oloo (2024) explain that successful circular systems require supportive policies, stronger coordination, and greater access to technology and financing. On the reporting side, Palamarchuk et al. (2025) highlight the importance of integrated accounting approaches that can reflect economic, environmental, and social value creation simultaneously. The Corporate Sustainability Reporting Directive (CSRD) in the European Union raises demands for greater transparency across the value chain, including resource use, waste management, and environmental impacts, making it increasingly important for coconut-exporting countries such as Indonesia to improve value chain transparency, environmental data quality, and sustainability reporting practices (European Commission, 2023).

METHODOLOGY

Research Design

This study adopts a predominantly qualitative research approach supported by simplified quantitative financial evaluation. Rather than statistically testing hypotheses, the research focuses on designing and assessing a sustainable business model for coconut shell utilization within the coconut value chain, following a design-oriented and constructive approach in which circular economy and sustainability principles are translated into a practical and financially feasible business model. The research follows a problem-solution-evaluation logic: (1) identification of sustainability challenges in the coconut value chain, (2) development of a sustainable business model for coconut shell utilization, and (3) evaluation of financial feasibility and accounting implications.

Unit of Analysis

The unit of analysis is the coconut shell as a by-product within the coconut value chain. The research focuses on the value creation potential, circular utilization opportunities, and business model development related to coconut shell processing activities, rather than the overall performance of a single company.

Data Collection and Sources

Secondary data form the main data source, including academic literature on coconut value chains, circular economy, and sustainable business models, as well as reports from international organisations such as FAO and UNDP and European Union sustainability regulations. Primary data were obtained through semi-structured interviews with industry practitioners from two Indonesian coconut processing companies, focusing on coconut shell availability and utilization, operational processes, cost components, and market potential. The primary data serve a supportive and contextual role rather than being used for statistical generalisation. To enhance reliability, the study applies data triangulation by combining academic literature, industry reports, and practitioner insights.

Baseline Company Selection

This research adopts a baseline company approach rather than a full case study, in order to ground the proposed sustainable business model in real-world industrial conditions without focusing on firm-specific performance. The baseline companies used in this research are Inari Coco (PT Inari Berkah Sahaja) and PT Coco Reina Global Charcoal, part of PT Coco Total Karbon Indonesia, both of which operate in coconut processing and coconut shell-based product industries in Indonesia and utilize coconut shells for products such as charcoal briquettes for export-oriented markets, particularly in Europe and the Middle East. Selection criteria included involvement in coconut processing, generation of coconut shell

as a by-product, and relevance to export-oriented and sustainability-driven markets. No confidential or firm-specific financial data are disclosed.

Data Analysis Approach

Qualitative information from the interviews was analysed using thematic classification, identifying key themes such as coconut shell utilization, operational processes, cost components, sustainability practices, and market demand. Interview findings were used to validate and refine assumptions derived from the literature review, which were then translated into simplified quantitative inputs including estimated production capacity, operating costs, and potential revenue for the financial feasibility analysis. Insights from the literature review and the baseline companies were integrated into a Sustainable Business Model Canvas (SBMC) to systematically structure the proposed business model.

FINDINGS AND DISCUSSION

Interview Findings

The findings show that both companies generate and utilize coconut shells in significant quantities as part of their operational activities. PT Coco Reina Global Indonesia mainly processes coconut shells into charcoal briquettes, while Inari Coco utilizes coconut shells for products such as BBQ briquettes, shisha briquettes, and activated carbon. These results indicate that coconut shells are no longer viewed only as waste materials, but increasingly as resources with higher economic value and business potential. Both companies emphasized the renewable nature of coconut shell products; Inari Coco also highlighted the role of the coconut industry in supporting local farmer welfare, while PT Coco Reina Global Indonesia specified that its coconut shell supply is sourced from Indonesian farmers, mainly in Java, Sumatra, and Borneo.

Several operational and market-related challenges were also identified, including fluctuations in raw material supply, high moisture content during rainy seasons, logistics costs, export requirements, and limitations in processing efficiency. Despite these challenges, both companies identified strong international demand for coconut shell-based products, particularly from Europe and the Middle East, with activated carbon products also mentioned as having growing market potential, especially in Asian markets.

Table 1. Comparison Between PT Coco Reina Global Indonesia and Inari Coco

Aspect	**PT Coco Reina Global Indonesia**	**Inari Coco**
Main coconut shell utilization	Charcoal briquettes	BBQ briquettes, shisha briquettes, activated carbon
Sustainability focus	Renewable and eco-friendly fuel	Renewable energy and farmer welfare
Main operational challenges	Moisture, supply consistency, logistics	Weather, traditional processing, export regulations
Main cost components	Labor, machinery, packaging, logistics	Machinery, warehouse, transport, labour
Main export markets	Europe, Middle East, United States	Europe, Middle East, China
Higher-value opportunities	Activated carbon, biochar	Renewable energy expansion

Translation of Findings into Assumptions

Following the thematic analysis, the interview findings were translated into operational and financial assumptions for the feasibility analysis. Information related to coconut shell availability was used to estimate production capacity assumptions, while industry benchmarks supported the estimation process due to limited access to detailed company data. Market-related findings were used to support revenue assumptions, as the interviews indicated strong international demand for coconut shell-based products, particularly from Europe and the Middle East, while activated carbon products were identified as having strong future potential due to increasing industrial and environmental demand (Ajien et al., 2022).

Table 2. Key Assumptions Derived from Interview Findings

Interview Insight	Analytical Assumption
Coconut shell available in significant quantity	Sufficient raw material availability
Production is export oriented	Export market revenue assumption
Labor and logistics are major costs	Included in operating cost structure
Demand exists in Europe and Middle East	Stable export demand assumption
Activated carbon seen as opportunity	Higher-value product potential
Operational challenges affect production efficiency	Operational risk included in feasibility discussion

Value Chain and Value Creation Analysis

Within the coconut value chain, coconut shells are generated as a by-product during the processing of coconut-based products. Both companies already utilize coconut shells commercially, mainly for charcoal briquettes and other energy-related products; however, the level of value creation still varies depending on processing capabilities and product diversification. While charcoal briquettes already provide added value compared to untreated waste, applications such as activated carbon and biochar remain relatively less developed, even though they offer stronger economic potential and growing market demand. FAO (2021) similarly highlights that coconut by-products possess substantial untapped economic value within global coconut-producing industries.

Table 3. Coconut Shell Value Creation Opportunities

Current Utilization	Proposed Higher-Value Product	Potential Added Value
Raw coconut shell	Activated carbon	High
Charcoal briquettes	Biochar	Medium–High
Agricultural waste	Renewable energy material	Medium

Value loss still occurs when coconut shells are used only for low-value fuel purposes or sold without further processing. The interviews also identified several operational challenges, including inconsistent moisture levels during rainy seasons, logistics constraints, dependence on export markets, and limitations in production technology, as well as increasing sustainability and traceability requirements from international buyers. Based on both interview findings and literature analysis, this study proposes the development of higher-value coconut shell products, particularly activated carbon and biochar, which offer wider industrial applications than conventional charcoal briquettes. Activated carbon is widely used in water filtration, air purification, and industrial processing, while biochar is increasingly recognized for its applications in sustainable agriculture and environmental management (Ajien et al., 2022). From a circular economy perspective, transforming coconut shell by-products into higher-value products can help reduce waste, improve

resource efficiency, and create additional economic value within the coconut industry (Vieira et al., 2024).

Simplified Financial Model

The simplified financial model is based on assumptions derived from interview findings and supported by secondary data, since the interviewed companies operate using order-based production systems and do not publicly share detailed financial information. Production assumptions are based on the continuous availability of coconut shells identified through the interviews, while revenue assumptions are supported by strong export demand, particularly from Europe and the Middle East. The revenue estimation follows the approach: Revenue = Estimated Selling Price × Estimated Production Quantity.

Table 4. Simplified Financial Assumptions from Interviewed Companies

Financial Aspect	PT Coco Reina Global Indonesia	Inari Coco
Production capacity	Approx. 12 tons/day	Approx. 100 MT/month
Estimated annual production	Approx. 4,320 MT/year (estimated)	Approx. 1,200 MT/year
Annual sales / revenue information	Approx. USD 5.4–5.8 million/year (estimated)	Approx. IDR 3 billion/year
Revenue basis	Estimated using annual production and average export price	Company operational information
Estimated export price benchmark	Approx. USD 1,250–1,350/ton	Based on export market references

The estimated cost structure was developed based on interview findings and supported by secondary literature. Both companies identified labour, machinery, transportation, warehousing, logistics, and packaging as the main operational cost components, and the proposed business model requires investment in machinery, production facilities, storage, and supporting infrastructure to process coconut shells into higher-value products.

Table 5. Estimated Cost Components

Cost Component	Description
Labor	Operational workforce
Machinery	Processing equipment
Logistics	Transportation and export
Packaging	Export packaging
Warehouse	Storage costs

Financial Feasibility Analysis

The financial feasibility analysis uses a simplified and assumption-based approach, since detailed financial information from the interviewed companies is not publicly available. The evaluation applies common financial indicators such as Net Present Value (NPV), Internal Rate of Return (IRR), Payback Period, and Break-even Analysis to assess whether the proposed business model shows reasonable economic potential under the defined assumptions; simplified feasibility approaches of this kind are commonly applied in sustainability-oriented investment analysis when detailed company financial data is limited (Petreski et al., 2024). Overall, the findings suggest that coconut shell utilization has promising financial potential due to the continuous availability of raw materials, growing

export demand, and opportunities for developing higher-value products, although the results should be interpreted carefully because the model relies on estimated assumptions and industry benchmarks rather than exact company financial information.

Discussion

The findings suggest that coconut shell utilization has promising economic potential due to several supporting factors identified through interviews and literature analysis. Coconut shells are continuously generated as by-products from coconut processing activities, creating a relatively stable supply of raw materials for further processing, although coconut by-products in many producing countries remain underutilized despite their significant economic potential (FAO, 2021). International demand for coconut shell-based products already exists, particularly in export-oriented markets such as Europe, the Middle East, and Asia; both interviewed companies confirmed that charcoal briquettes already have established market demand, while activated carbon and biochar were identified as products with strong future potential due to increasing sustainability awareness (Vieira et al., 2024).

Several risks and uncertainties remain relevant to the proposed business model. The limited availability of detailed financial information from the interviewed companies means the financial model relies on assumption-based estimations rather than exact corporate financial data, so the feasibility results should be interpreted as an indicative assessment rather than a precise investment forecast. Operational risks identified through the interviews include moisture issues during rainy seasons, inconsistent raw material quality, logistics and transportation costs, and supply consistency challenges. Because the industry is highly export-oriented, companies are also exposed to changing international market conditions and sustainability requirements, particularly from European markets (European Commission, 2023); Ayuya and Oloo (2024) similarly identify operational inefficiencies and supply chain limitations as common challenges affecting circular production systems within coconut value chains.

From a circular economy perspective, the proposed business model supports more sustainable utilization of coconut shell by-products by transforming agricultural waste into higher-value economic products. Vieira et al. (2024) explain that utilizing coconut waste in this way can help reduce waste generation while improving resource efficiency and value creation. The development of products such as activated carbon and biochar also supports additional value creation within the coconut value chain, with broader environmental and industrial applications including water filtration, soil improvement, and renewable fuel alternatives (Ajien et al., 2022).

CONCLUSION

This study aimed to develop and evaluate a sustainable and financially feasible business model for coconut shell utilization within the coconut value chain. Based on the findings from the literature review and interview analysis, the study concludes that coconut shells possess strong potential to be transformed into higher-value products such as activated carbon, biochar, and charcoal briquettes, aligning with circular economy principles by improving resource efficiency, reducing waste, and creating additional economic value from agricultural by-products.

The proposed business model demonstrates promising economic potential when supported by stable raw material availability, export market demand, and efficient operational management. Interview findings from the Indonesian coconut processing industry indicate that international demand for coconut shell-based products already exists, particularly in export-oriented markets such as Europe and the Middle East, and that activated carbon and biochar have future growth potential due to increasing sustainability awareness. However, the study also identifies several challenges related to technology

access, investment requirements, operational complexity, logistics, and limited financial information among SMEs. Despite these limitations, the simplified financial analysis and interview findings still indicate that higher-value coconut shell utilization represents a feasible and promising opportunity for developing more sustainable and value-added business practices within the coconut industry.

Theoretically, this research contributes to the literature on circular economy and sustainable business models within the coconut industry, showing how circular economy principles can support higher-value product development and value chain upgrading while integrating sustainability considerations with financial feasibility analysis. Practically, the findings provide insights for SMEs and coconut processors regarding the economic potential of coconut shell utilization, highlighting the importance of operational efficiency, value-added processing, and export-oriented markets. From a sustainability perspective, the study demonstrates that coconut shell utilization can support more efficient resource use and waste reduction, with products such as activated carbon and biochar contributing to circular economy objectives by transforming agricultural by-products into economically valuable and environmentally beneficial products.

POLICY IMPLICATIONS AND LIMITATIONS

Policy Implications

The findings suggest that greater attention should be given to circular economy practices within the coconut industry, especially in utilizing coconut shell by-products that are still often treated as waste. Transforming coconut shells into higher-value products such as activated carbon and biochar can help improve resource efficiency, reduce waste, and create additional economic value. Many SMEs involved in coconut processing still face challenges related to technology access, financing, operational capability, and sustainability-related knowledge; as international markets increasingly prioritize sustainability, traceability, and environmental compliance, additional support may help SMEs improve their export readiness and competitiveness.

Limitations

Several limitations should be acknowledged. First, the research mainly relies on qualitative insights and assumption-based financial estimations due to the limited availability of detailed company financial data, so the financial feasibility analysis is intended to provide an indicative evaluation rather than precise financial forecasting. Second, the primary data were obtained from a limited number of industry practitioners, meaning that the findings may not fully represent the broader coconut processing industry across different regions and business scales. Third, market conditions, export demand, and sustainability-related regulations may continue to change over time, which can influence the long-term feasibility of coconut shell-based businesses; technological developments, international trade conditions, and future regulatory changes are factors beyond the scope of this research.

Recommendations

SMEs involved in coconut processing should consider exploring higher-value coconut shell products such as activated carbon and biochar, as these products show promising market potential and sustainability value. Improving operational efficiency, adopting appropriate processing technology, and developing sustainability-oriented business practices may help SMEs strengthen their competitiveness within export-oriented markets. Greater support from industry-related institutions and policymakers may help SMEs improve access to financing, technology, sustainability training, and market information. For future research, more detailed financial analysis using actual operational and accounting data from coconut processing companies may provide more accurate feasibility evaluations, and further studies

may explore sustainability reporting, traceability systems, and broader circular economy applications within the coconut industry.

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