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Techno-Economic Analysis of Sawdust-Based Trash Cans and Their Contribution to Indonesia's Green Tourism Policy and the Sustainable Development Goals (SDGs)

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ABSTRACT

This study investigated the techno-economic feasibility of producing trash cans from sawdust waste to support sustainable waste management and smart tourism infrastructure in Indonesia. With the growing volume of tourist-generated waste and increasing demand for eco-friendly public facilities, this innovation offers a low-cost, circular economy solution. A 20-year financial projection was conducted using indicators such as Net Present Value (NPV), Gross Profit Margin (GPM), Payback Period (PBP), and Return on Investment (ROI). Results indicate strong economic viability, with an initial investment of USD 19,500 and a payback period of just over two years. The model contributes to SDG 11 (Sustainable Cities and Communities) and SDG 12 (Responsible Consumption and Production), and aligns with national policy frameworks such as RIPPARNAS, RPJMN, and Ministerial Regulation No. P.75/MENLHK/2019. This study presents a scalable solution for local governments and tourism authorities to enhance environmental infrastructure while promoting sustainability and community-driven innovation in tourism destinations.

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1. INTRODUCTION

Waste management is a major challenge in developing countries like Indonesia, causing pollution, marine litter, and health risks for waste pickers (Clauser *et al*., 2018, Rahmat *et al*., 2023). Rapid urbanization and industrial growth have increased waste generation, especially sawdust from wood processing. Indonesia's wood waste comes from forest harvesting (branches, stumps, broken stems) and wood industries (sawdust, wood chips, bark) (Pierucci, 2022, Fullerton & Kinnaman, 1995, Haryanto *et al*., 2021). Sawdust, a by-product with low market value (Hidayah *et al*., 2021, Subagyono *et al*., 2021, Nurjamil *et al*., 2021, Anggraeni *et al*., 2021), is identified as a potential material for applications like trash cans (Owebor *et al*., 2023, Ali *et al*., 2021, Nwankwo *et al*., 2023). A 2017 study estimated wood waste costs at 18–36 USD/t in several countries (Rodionov & Nakata, 2011). Waste production is closely tied to human activities (Ferronato & Torretta, 2019).

The tourism sector, particularly in emerging economies like Indonesia, significantly contributes to the national economy but simultaneously generates substantial volumes of waste. That is why many reports regarding tourism have been well-documented (Warlina & Damayanty, 2021, Pramanik & Rahmanita, 2023, Yulius & Rahmanita, 2025, Glushchenkom 2023, Hibatullah & Paksi, 2025, Bomato & Daud, 2024). Tourist destinations often experience an influx of visitors that surpasses the waste management capacity of local infrastructure. As the number of visitors increases, so does the volume of solid waste, including plastics, food containers, packaging, and various non-biodegradable materials. Poor waste management in such areas not only affects environmental health but also diminishes the attractiveness and cleanliness of tourist sites, ultimately reducing tourist satisfaction and potentially deterring return visits. Therefore, implementing sustainable waste solutions in tourism zones becomes a priority, aligning with the goals of smart tourism development.

Smart tourism emphasizes the integration of advanced technologies, innovation, and sustainability into the planning, operation, and management of tourism destinations. A critical component of this concept is environmental sustainability, particularly through improved infrastructure such as eco-friendly waste disposal systems. In this context, the development of waste containers from recycled and locally sourced materials, such as sawdust, offers a practical, low-cost, and environmentally sound solution. By introducing smart, sustainable trash bins made from sawdust, tourist destinations can showcase their commitment to green practices while addressing the increasing problem of solid waste.

Previous research on sawdust has focused on its environmental benefits and technical applications, such as particleboard and biofuels, but often lacks detailed economic analysis, particularly for scaled-up production in developing countries like Indonesia (Olaiya *et al*., 2023, El-Nadoury, 2021, Petchwattana *et al*., 2020, Akhator *et al*., 2017). Studies on sustainability, circular economy practices, and product development from sawdust have similarly overlooked comprehensive economic evaluations. While the environmental advantages of sawdust utilization are widely acknowledged, its financial feasibility, particularly when applied to infrastructure in public areas such as tourist destinations, has not been fully explored.

At the same time, tourism areas in Indonesia increasingly demand environmentally responsible infrastructure as part of the smart tourism agenda, which emphasizes sustainable, technology-driven, and policy-based development (Warlina & Damayanty, 2021, Pramanik & Rahmanita, 2023). Smart tourism promotes innovations that benefit both visitors and local communities, including green waste solutions in public areas. Integrating sustainable products such as trash cans made from recycled sawdust aligns with this vision

and supports government efforts to reduce environmental pressure in tourist destinations. The presence of smart and innovative waste management tools can also educate tourists and local communities about sustainable practices and waste reduction.

The issue of waste, particularly in tourism hotspots, has become a focal point for policymakers and urban planners. Public spaces, parks, and recreational facilities often lack durable and eco-friendly waste containers, leading to unmanaged waste and environmental degradation. In response, this study proposes a sustainable innovation: producing trash bins from sawdust waste as a solution for both waste valorization and improved public infrastructure. The production of such bins addresses two critical concerns—recycling industrial wood waste and meeting the need for efficient and sustainable waste management tools in tourism areas. Moreover, using recycled materials for public facilities promotes the principles of circular economy and reduces reliance on virgin resources.

This concept aligns with the broader goals of sustainable development and smart tourism policy, which advocate for environmentally responsible planning and resource use. Smart tourism cities aim to balance visitor needs with resident well-being and ecological integrity by leveraging local innovations and sustainable practices (Glushchenko, 2023, Hibatullah & Paksi, 2025). In this context, producing and deploying trash cans made from sawdust is not only a technical and economic innovation but also a form of environmental messaging. Tourists interacting with such products can perceive the destination as forward-thinking and environmentally conscious, potentially enhancing the overall tourist experience.

Further, the project contributes to local economic development by supporting small and medium-sized enterprises (SMEs) that can engage in the manufacturing process. The relatively low investment and operational costs of producing sawdust-based trash bins make this approach scalable and adaptable across diverse regions, including rural and peri-urban tourist destinations. As tourism grows, the demand for supporting infrastructure also increases, and sustainable waste solutions become essential to accommodate growth without compromising environmental standards.

In addressing these intertwined challenges, this research bridges the gap by integrating technological and economic assessments to evaluate the production of trash cans from sawdust. It aligns with smart tourism goals, which leverage advanced technology and sustainable practices to enhance tourist experiences (Gretzel & Koo, 2021, Mehraliyev *et al*., 2019) and promote eco-friendly development. By examining production costs, market demand, and environmental benefits, the study highlights how circular economy practices can transform waste management in Indonesia. It also provides actionable insights for sustainable waste management and supports tourism sector sustainability objectives.

The purpose of this study is to analyze the techno-economic viability of producing trash cans from sawdust waste and to assess how such innovations can be integrated into smart tourism policy frameworks. The novelty lies in linking small-scale waste-based manufacturing to broader sustainability policies in tourism infrastructure. This contribution is expected to influence strategic public decision-making and promote eco-conscious practices in tourism environments. This study adds new information regarding techno-economic analysis as reported in **Table 1**.

Table 1. Previous studies regarding techno-economic analysis.

No	Title	Ref
1	Techno-economic analysis on the production of zinc sulfide nanoparticles by microwave irradiation method	Nurdiana *et al.* (2022)
2	Techno-economic evaluation of hyaluronic acid production through extraction method using yellowfin tuna eyeball	Elia *et al.* (2023)
3	Techno-economic evaluation of gold nanoparticles using banana peel *(Musa Paradisiaca*)	Maratussolihah *et al*. (2022)
4	Techno-economic analysis of the business potential of recycling lithium-ion batteries using hydrometallurgical methods	Rachmadhani and Priyono (2024)
5	Computational bibliometric analysis on publication of techno-economic education	Ragahita, R., and Nandiyanto
6	Domestic waste (eggshells and banana peels particles) as sustainable and renewable resources for improving resin-based brakepad performance: Bibliometric literature review, techno-economic analysis, dual-sized reinforcing experiments, to comparison with commercial product	Nandiyanto *et al.* (2022)
7	Alternative energy options for a thai durian farm: Feasibility study and experiments for the combination of solar photovoltaics and repurposed lithium-ion batteries	Wangsupphaphol *et al*. (2024)
8	Feasibility analysis of the development of STEM-based physics e-book with self-regulated learning on global warming topics	Lestari *et al*. (2024)
9	Cost analysis and economic evaluation for the fabrication of activated carbon and silica particles from rice straw waste	Nandiyanto (2018)

2. LITERATURE REVIEW

Sawdust has proven to be a versatile material, widely utilized in the development of construction materials, chemicals (Goodger, 1995), and as a renewable energy source or fuel (Cumo *et al*., 2013). Its abundance as an industrial by-product and low economic value make it a promising candidate for sustainable product innovation. In particular, efforts to process sawdust into composite materials, such as wood-plastic composites and alternative construction materials, have gained attention due to their ecological and economic benefits (Petchwattana *et al*., 2020, Olaiya *et al*., 2023).

One practical and innovative application of sawdust is its transformation into trash cans. This product holds potential not only as a functional public utility but also as a symbol of environmental awareness and waste valorization. The process of converting sawdust into trash cans involves several key stages. As shown in **Figure 1**, the production steps include collecting and sorting the sawdust, mixing it with adhesives and water, compressing the mixture using a hydraulic press, drying it for approximately three hours, shaping and assembling with angle irons, and finally painting and finishing the surface.

While the technical feasibility of converting sawdust into useful products is well supported, there remains a lack of literature specifically addressing its application for public environmental infrastructure, such as waste bins. The majority of prior studies emphasize the performance characteristics and material properties of sawdust-derived products, including strength, durability, biodegradability, and cost efficiency (El-Nadoury, 2021, Akhator *et al*., 2017). However, these studies rarely explore the socio-economic and policy implications of deploying such products in real-world public settings.

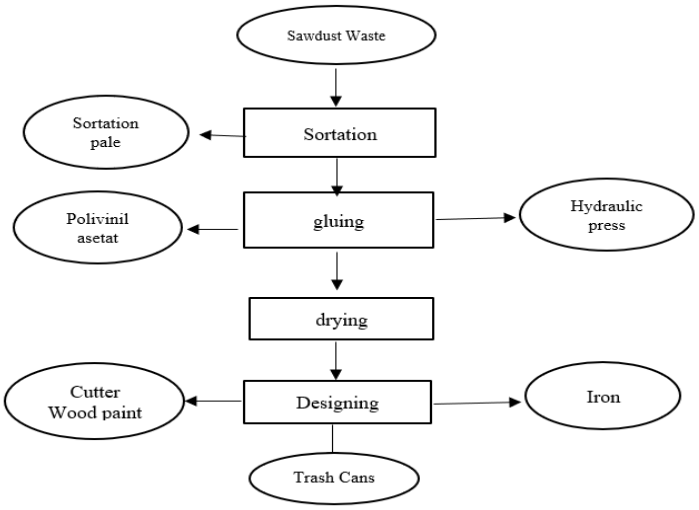

Figure 1. The steps in making garbage cans.

Furthermore, the integration of sawdust-based innovations into the tourism sector, especially under the umbrella of smart tourism, is still underexplored. As smart tourism emphasizes the use of technology and innovation to improve tourist experiences, resource efficiency, and environmental management (Gretzel & Koo, 2021, Mehraliyev et al., 2019), the deployment of eco-friendly infrastructure such as sawdust-based trash cans can be seen as a form of sustainable smart infrastructure. Smart tourism research has highlighted the importance of waste management and environmental quality in shaping tourist satisfaction and destination image (Warlina & Damayanty, 2021, Glushchenko, 2023), yet specific technological solutions like waste bin innovations remain underrepresented in both policy documents and scholarly analysis.

In the context of circular economy principles, sawdust valorization supports waste reduction and resource efficiency. Several studies have emphasized the environmental rationale for sawdust utilization, ranging from power generation to consumer goods (Hidayah *et al*., 2021, Subagyono *et al*., 2021, Nurjamil *et al*., 2021). In many cases, however, these studies focus more on industrial or energy applications than on public infrastructure or tourism-related utilities. Some experimental works also demonstrate how particle size and material composition affect the performance of sawdust composites, reinforcing the material's potential adaptability (Anggraeni *et al*., 2021).

Additionally, studies related to urban tourism, smart cities, and sustainability have begun to point out the significance of waste control innovations. For example, destinations that offer clean and well-maintained public areas tend to receive more positive visitor feedback and repeated tourism activity (Hibatullah & Paksi, 2025, Pramanik & Rahmanita, 2023). Nevertheless, there is still a gap in applied studies that integrate material innovation (like sawdust products) with practical smart tourism strategies, particularly in the context of developing countries where low-cost and sustainable solutions are most needed.

To sum up, the existing body of literature supports the technical feasibility and environmental benefit of sawdust utilization, and it recognizes the growing need for sustainable infrastructure in the tourism sector. However, there is a clear gap in research that holistically evaluates the techno-economic viability of sawdust-derived public products like trash cans, particularly their role in supporting smart tourism policy goals. This study seeks to address that gap by conducting an integrated assessment of production technology, cost

feasibility, and the alignment of sawdust-based waste bins with environmentally sustainable tourism infrastructure.

In addition, as summarized in Table 2, previous studies have either focused on the technical properties of sawdust (Hidayah *et al*., 2021, Subagyono *et al*., 2021, Nurjamil *et al*., 2021) or the strategic goals of smart tourism (Gretzel & Koo, 2021, Mehraliyev *et al*., 2019). However, none of these studies have explicitly combined material innovation, waste valorization, and tourism policy into a unified techno-economic evaluation. This study aims to fill that critical gap by examining the production and application of sawdust-based trash cans as a practical solution supporting smart tourism objectives.

Table 2. Comparison of previous studies on sawdust utilization and smart tourism integration.

No	Study	Focus Area	Strength	Limitation
1	Hidayah *et al.* (2021)	Use of sawdust for steam power generation	Showed the feasibility of sawdust energy use	Did not discuss material innovation for public infrastructure
2	Subagyono et al. (2021)	Pyrolysis of fast-growing wood species	Detailed chemical analysis of sawdust properties	No application for tourism or public waste management
3	Nurjamil et al. (2021)	Eco-friendly battery from rice husks and wood grains	Highlighted circular economy practice	Limited to the energy sector, not tourism
4	Anggraeni et al. (2021)	Effect of particle size on briquette performance	Provided material performance insights	No policy linkage or infrastructure application
5	Petchwattana et al. (2020)	Wood plastic composites using sawdust	Demonstrated toughness improvements with bioplasticizers	Focused on industrial materials, not public space solutions
6	Warlina & Damayanty (2021)	Tourism facility expansion and spatial patterns	Highlighted urban tourism infrastructure needs	No specific technological innovation proposed
7	Gretzel & Koo (2021)	Smart tourism cities	Defined concept of sustainable, tech-driven tourism	No specific case study linking material innovation
8	Mehraliyev et al. (2019)	Progress on smart tourism research	Provided systematic review of smart tourism	Lacked focus on physical environmental infrastructure innovations

3. Method

This research employed a techno-economic analysis framework to evaluate the feasibility of producing innovative trash cans from sawdust waste, emphasizing the practical potential of the product in supporting sustainable infrastructure within tourist destinations. The study integrates both engineering and financial evaluation methods to assess how small-scale, waste-based production can contribute to broader environmental and policy goals in the

context of smart tourism. Detailed information regarding this analysis is reported elsewhere (Fiandini & Nandiyanto, 2024).

The technical component of the analysis focused on the process of converting sawdust into functional waste bins through simple, scalable technology. The key stages of production include sorting sawdust, blending it with adhesives and water, pressing the material, drying, cutting, assembling, and final finishing (see **Figure 1** in the Literature Review). Material specifications and equipment selection were based on commercially available machinery suitable for small to medium-sized enterprises.

The economic analysis involved calculating multiple financial indicators using Microsoft Excel as the computational tool. A 20-year production period was assumed to simulate long-term viability, aligning with typical investment and policy planning cycles. The following economic indicators were measured:

(i) Cumulative Net Present Value (CNPV): To measure the present value of cash flows across the project lifetime.
(ii) Gross Profit Margin (GPM): To assess profitability after deducting direct production costs.
(iii) Payback Period (PBP): To determine how quickly initial investments could be recovered.
(iv) Break-Even Point (BEP): To identify the minimum production volume needed to cover costs.
(v) Return on Investment (ROI) and Profitability Index (PI): To gauge overall project efficiency.

Several assumptions were used in the calculations:

(i) Production Composition: Raw materials consist of sawdust, polyvinyl acetate adhesive, and paint.
(ii) Currency Standard: All prices and computations were based on USD, with a fixed exchange rate of 1 USD = IDR 15,000.
(iii) Raw Material Pricing: Based on commercial rates—USD 1.66 per 5 kg of sawdust waste per unit, USD 1.66/kg for adhesive, and USD 10/kg for paint.
(iv) Investment Estimation: Total Investment Cost (TIC) was calculated using the Lang Factor approach, separating the investment into construction and operation phases (40% in the first year).
(v) Utility Costs: Electricity consumption was estimated at USD 0.33 per kilowatt hour.
(vi) Labor Cost: Assumed to be USD 2,272.73 per production cycle.
(vii) Operational Days: 300 days per year, allowing for setup and cleaning days.
(viii) Production Time: Each production cycle took approximately 5 hours.
(ix) Selling Price: Set at USD 33.3 per unit of trash can.

All cost components were itemized, including fixed costs (equipment depreciation, capital interest, etc.) and variable costs (materials, labor, utilities). Equipment specification included low-cost items such as sorting units, hydraulic or pneumatic press machines, cutting tools, and containers—all priced for small-scale adoption.

The method also integrated scenario analysis to test the financial robustness of the model under different production conditions, ranging from ideal to worst-case scenarios. This sensitivity analysis ensured that results could remain reliable under fluctuating economic inputs, such as increased material prices or labor shortages. It further strengthens the model's applicability to real-world situations, particularly in rural or resource-constrained tourism destinations.

Finally, the findings from the techno-economic model are contextualized within the framework of smart tourism policy. While the financial evaluation serves as the core assessment, the interpretation of results is aligned with the broader goal of improving environmental infrastructure in tourist areas. The goal is not only to assess whether the project is profitable, but also to demonstrate that low-cost, eco-friendly innovations can support local governments and communities in achieving their sustainable tourism objectives.

4. RESULTS AND DISCUSSION

4.1. Engineering and Economic Evaluation

The economic analysis for the production of garbage cans from sawdust waste was conducted using several predefined assumptions. The production process involves sawdust as the primary material, mixed with polyvinyl acetate glue and water. All prices are denominated in USD with a conversion rate of 1 USD = IDR 15,000. The cost structure includes material procurement, equipment investment, labor, and utilities. The project is designed for a 20-year production period, simulating long-term operations in a sustainable small enterprise model.

From a technical perspective, the engineering analysis demonstrates that transforming 5 kg of sawdust per unit into trash cans is economically feasible. The total cost of equipment required is approximately USD 813.97 (see **Table 3**), which includes machines and tools such as a hydraulic press, meter, bucket, saw, and angle iron. This low-cost setup supports the scalability and replication of the model by small and medium enterprises, particularly in local tourism destinations. The factory operates 300 days per year and targets an annual output of 300 units, resulting in an estimated utilization of 1.5 tons of sawdust per year or 20 tons over 20 years.

Table 3. Equipment specification.

No	Equipment	Unit Price	Quantity	Total Price
1	Sortation	$50.00	1	$50.00
2	Hydraulic or Pneumatic Press	$748.00	1	$748.00
3	Meter/Measure	$2.63	1	$2.63
4	Bucket/Drum	$3.33	1	$3.33
5	Saw/Cutter	$10.00	1	$10.00
6	6 M Angle Iron	$40.00	—	—
	Total			**$813.97**

The estimated total production cost is USD 68,072.74, which includes raw materials, labor, direct supervision, and utility costs. Labor is a major component, with five technicians working 8 hours per day. Manufacturing cost accounts for 10–20% of the total project expenditure. The financial indicators indicate strong economic potential. The total fixed capital investment, including depreciation, amounts to USD 10,294.16, while variable costs, including materials and sales, are USD 63,490. These values are summarized in **Table 4**.

In terms of investment returns, the CNPV/TIC curve (see **Figure 2**) shows a financial loss in the first two years due to initial capital expenditure. However, by the third year, the business reaches the payback point, with sustained growth in cumulative profit thereafter. The short payback period (approximately 2 to 3 years) is highly competitive for waste-based production models.

Table 4. Production and cost assumptions.

Component	Parameter	Cost (USD)
Fixed Cost	Capital-related cost	$9,640.77
	Depreciation	$653.39
	Total Fixed Cost	$10,294.16
Variable Cost	Raw Materials	$6,000
	Utilities	$390
	Operating Labor	$30,000
	Labor-Related Cost	$20,100
	Sales-Related Cost	$7,000
	Total Variable Cost	$63,490
Sales Estimate	Revenue	$100,000
	Manufacturing Cost	$73,130.77
	Investment	$7,003.47
	Estimated Profit	$0.000018
	Profit to Sales Ratio	$0.000256
Break-Even Point	Unit	3,000
	BEP Value	$563,909.32
	ROI	$274,150.88
	Payback Time	0.24 years

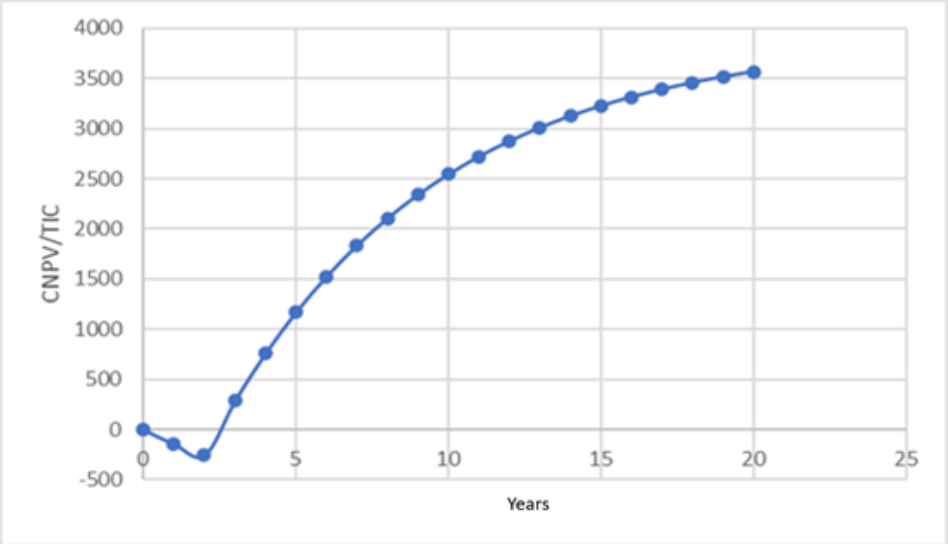

Figure 2. CNPV/TIC results curve.

The scalability of the model is confirmed through scenario testing under ideal and worst-case conditions. In the worst-case scenario, where labor, raw material prices, and utility costs increase, the model still maintains its feasibility, albeit with a longer return on investment. This robustness makes the model adaptable to diverse regional conditions, including low-resource areas.

4.2. Discussion from Engineering and Economic Evaluation

The results of this techno-economic analysis confirm that the production of innovative trash cans using sawdust waste is both a practical and sustainable solution, especially when positioned within the broader discourse of environmental responsibility and smart tourism. From a technical standpoint, the use of low-cost, commercially available equipment supports the adoption of this model by micro and small enterprises. These actors often serve as the backbone of local economies in developing regions, including areas near tourist attractions.

Financially, the short payback period of under three years and a return on investment exceeding $274,000 demonstrate that the project is not only self-sustaining but potentially profitable. Importantly, the sensitivity analysis confirms that even under less-than-ideal conditions (such as fluctuations in labor, utilities, or raw material prices) the project remains viable. This robustness enhances its relevance to regions with unstable economic or supply chain conditions.

More significantly, this study illustrates how a waste-to-product model can directly contribute to smart tourism development. Tourist destinations increasingly grapple with waste management issues, especially during peak seasons. Trash accumulation, if unmanaged, threatens not only environmental quality but also visitor satisfaction and destination branding. Providing eco-friendly, locally produced trash bins offers a visible and functional symbol of sustainability. Their deployment sends a strong message to visitors about the destination's commitment to environmental stewardship, which is increasingly valued by environmentally conscious travelers.

This type of innovation also supports the circular economy model, where industrial by-products (in this case, sawdust) are reintegrated into the economy in the form of new products. Instead of becoming a landfill or unused biomass, sawdust is transformed into durable, useful infrastructure. When implemented in tourism contexts, these circular practices reinforce long-term sustainability strategies that many governments and destination managers now adopt as part of their green tourism roadmaps.

In a broader sense, this study bridges an existing gap in the literature between materials engineering, entrepreneurship, and public policy in tourism. While many prior studies have explored sawdust in the context of material science or bioenergy, few have linked it to public infrastructure innovation or policy development. Similarly, discussions of smart tourism tend to focus on digital technology, but overlook simple, low-tech innovations like sustainable waste bins that play a critical role in day-to-day visitor experience and environmental quality.

Therefore, the value of this study lies not only in its economic calculations but also in the way it demonstrates that sustainability-driven product design can directly contribute to the infrastructural and policy needs of tourism development. The project aligns with SDG 11 (Sustainable Cities and Communities) and SDG 12 (Responsible Consumption and Production), reinforcing the global relevance of the proposed model.

4.3. Policy Implications

The findings from this study carry significant implications for public policy, particularly in the domains of tourism development, environmental management, and community-based innovation. The points are in the following:

(i) Integration into Local Tourism Infrastructure Plans. Local governments can adopt this model by integrating sawdust-based trash cans into urban and rural tourism development projects. Municipal authorities could issue green procurement guidelines favoring eco-friendly, locally produced waste containers for parks, cultural sites, beaches, and other public tourism spaces.

(ii) Support for SMEs in Green Manufacturing. The low capital requirements of the model make it highly suitable for community-based enterprises. Policymakers should consider providing financial incentives (e.g., microloans, tax credits) and capacity-building programs to help SMEs adopt this production model, especially in regions near forests or timber industries where sawdust is abundant.
(iii) Strategic Environmental Communication. Placing signage or QR codes on the trash cans that explain their eco-friendly origin can educate tourists about local sustainability efforts. This aligns with smart tourism objectives by using simple infrastructure as a channel for environmental awareness.
(iv) National Tourism and Waste Management Policies. National development strategies can include this type of innovation under green economy initiatives. Ministries of tourism and environment can collaborate to scale similar solutions through national parks and state-funded destination development programs.

4.4. Alignment with Indonesian Green Tourism Policies

Indonesia has made significant progress in integrating sustainability principles into its national and regional tourism development strategies (see Table 4). The findings of this study, which emphasize low-cost, waste-based innovation for public infrastructure, directly support several existing policies and programs related to green tourism, circular economy, and sustainable waste management. Several policies are in the following:

(i) National Tourism Development Master Plan (RIPPARNAS (Rencana Induk Pembangunan Kepariwisataan Nasional). The National Tourism Development Master Plan (RIPPARNAS) 2010–2025 outlines a vision for tourism that emphasizes environmental sustainability, community involvement, and cultural preservation. This study's innovation aligns with RIPPARNAS goals by offering an environmentally friendly product that improves destination cleanliness, encourages local production, and contributes to the carrying capacity of tourism zones.
(ii) National Medium-Term Development Plan in 2020–2024 (RPJMN (Rencana Pembangunan Jangka Menengah Nasional). Indonesia's Medium-Term National Development Plan prioritizes the green economy and circular economy as pillars for sustainable growth. One key policy direction is the promotion of eco-innovation in small and medium enterprises. The sawdust-based trash can project embodies this approach by converting industrial waste into a public utility that supports tourism development and waste reduction.
(iii) Tourism Ministry regulation for green tourism (i.e. Kementerian Pariwisata: Strategi Pariwisata Hijau). The Ministry of Tourism and Creative Economy (Kemenparekraf) has introduced guidelines for pariwisata berkelanjutan through the Indonesian Sustainable Tourism Certification (ISTC) and "Destinasi Pariwisata Berkelanjutan" program. This study provides a practical product that destinations can use to fulfill criteria in the ISTC framework, particularly those related to environmental management, waste handling infrastructure, and community engagement.
(iv) Government regulation (i.e. Peraturan Menteri LHK No P.75/MENLHK/SETJEN/KUM.1/10/2019). This regulation on the roadmap for waste reduction by producers mandates reductions in single-use and non-recyclable packaging, while promoting eco-friendly product design. By using recycled sawdust, the product designed in this study adheres to the spirit of the regulation by valorizing waste and replacing synthetic material-based bins in public spaces.

(v) Indonesian climate village program (Program Kampung Iklim (PROKLIM))
Although originally focused on climate adaptation and mitigation at the community level, PROKLIM encourages innovations that reduce greenhouse gas emissions and manage waste sustainably. This model could be piloted in PROKLIM-participating tourism villages as part of their infrastructure improvements.

(vi) Perda dan Pergub relating to Waste Management and Tourism (i.e. Kebersihan dan Pariwisata). At the local government level, many regions (e.g., Bali, Yogyakarta, West Java) have issued regional regulations (Perda) and governor regulations (Pergub) regarding clean and sustainable tourism. The sawdust trash can initiative can be adopted as a flagship local innovation, supported through public-private partnerships, CSR programs, or BUMDes (village-owned enterprises).

(vii) Indonesia's SDG Roadmap. This project also contributes to Indonesia's SDGs roadmap, specifically SDG 11 (Sustainable Cities and Communities) and SDG 12 (Responsible Consumption and Production), both of which are embedded in national policies under BAPPENAS coordination.

Table 4. List of relevant Indonesian policies and programs.

No	Policy / Program	Institution / Legal Basis	Main Focus	Relevance to This Study
1	RIPPARNAS 2010–2025 (National Tourism Development Master Plan)	Ministry of Tourism and Creative Economy	Sustainable tourism development	Emphasizes environmental and green infrastructure in destinations
2	RPJMN 2020–2024 (National Medium-Term Development Plan)	BAPPENAS (National Planning Agency)	Circular economy, green innovation, MSME development	Encourages the use of industrial waste (e.g., sawdust) for innovative local products
3	Regulation of the Minister of Environment and Forestry No. P.75/MENLHK/2019	Ministry of Environment and Forestry	Roadmap for waste reduction by producers	Promotes eco-friendly product design and material recycling
4	Indonesian Sustainable Tourism Certification (ISTC)	Ministry of Tourism and Creative Economy	National standards for sustainable tourism destinations	Requires clean infrastructure and efficient waste management
5	Sustainable Tourism Destination Program	Ministry of Tourism and Creative Economy	Development of environmentally-based tourism areas	Supports waste-based products such as innovative trash bins
6	Climate Village Program (PROKLIM)	Ministry of Environment and Forestry	Community-based climate adaptation and mitigation	Can be integrated into green innovation in tourism villages

Table 4 (Continue). List of relevant Indonesian policies and programs.

No	Policy / Program	Institution / Legal Basis	Main Focus	Relevance to This Study
7	Regional Regulations (Perda) and Governor Regulations (Pergub) on Cleanliness and Tourism	Provincial/Local Governments (e.g., Bali, Yogyakarta)	Waste reduction and cleanliness in tourism zones	Regulatory basis for implementation of waste-based public products
8	Indonesia's SDG Roadmap	BAPPENAS	SDG 11 (Sustainable Cities) and SDG 12 (Responsible Consumption and Production)	The study directly supports both SDG targets
9	Clean Indonesia Movement (GIB)	Coordinating Ministry for Human Development & Culture, and the Ministry of Environment	National anti-waste campaign	The product can serve as a flagship campaign tool

4.5. Future Research Directions

While this study provides a comprehensive economic and engineering analysis, several avenues remain open for further investigation:

(i) Life Cycle Assessment (LCA). Future research should assess the full environmental footprint of sawdust-based trash cans compared to traditional plastic or metal alternatives. This includes energy use, emissions, and end-of-life disposal.

(ii) User Acceptance Studies in Tourism Areas. It would be valuable to examine tourists' and local stakeholders' perceptions of these products. Surveys and interviews could reveal how visible eco-innovation influences visitor satisfaction, environmental attitudes, and behavioral intentions.

(iii) Geographic Replication and Case Studies. Applying this model to different regions (e.g., coastal vs. mountain destinations) can test its scalability and contextual adaptability. Future case studies could document implementation experiences and outcomes.

(iv) Integration with Smart Technologies. Further innovation might involve integrating basic sensors or IoT devices into the bins (e.g., for waste level monitoring), aligning with the digital side of smart tourism, and improving operational efficiency for sanitation services.

(v) Cost–Benefit Analysis Including Externalities. A more extensive economic model could include social and environmental externalities, such as reduced pollution costs or job creation, providing a fuller picture for policymaking.

(vi) Finally, this study adds new information regarding SDGs, as reported in **Table 5**.

Table 5. Previous studies regarding SDGs.

No	Title	Ref
1	Low-carbon food consumption for solving climate change mitigation: Literature review with bibliometric and simple calculation application for cultivating sustainability consciousness in facing sustainable development goals (SDGs)	Nurramadhani *et al*. (2024)
2	Towards sustainable wind energy: A systematic review of airfoil and blade technologies over the past 25 years for supporting sustainable development goals (SDGs).	Krishnan *et al*. (2024)
3	Assessment of student awareness and application of eco-friendly curriculum and technologies in Indonesian higher education for supporting sustainable development goals (SDGs): A case study on environmental challenges	Djirong *et al*. (2024)
4	Effect of substrate and water on cultivation of Sumba seaworm (nyale) and experimental practicum design for improving critical and creative thinking skills of prospective science teacher in biology and supporting sustainable development goals (SDGs)	Kerans *et al*. (2024)
5	Characteristics of jengkol peel (pithecellobium jiringa) biochar produced at various pyrolysis temperatures for enhanced agricultural waste management and supporting sustainable development goals (SDGs).	Rahmat *et al*. (2025)
6	Sustainable packaging: Bioplastics as a low-carbon future step for the sustainable development goals (SDGs).	Basnur *et al*. (2024)
7	Smart learning as transformative impact of technology: A paradigm for accomplishing sustainable development goals (SDGs) in education	Makinde *et al*. (2024)
8	The relationship of vocational education skills in agribusiness processing agricultural products in achieving sustainable development goals (SDGs)	Gemil *et al*. (2024)
9	The influence of environmentally friendly packaging on consumer interest in implementing zero waste in the food industry to meet sustainable development goals (SDGs) needs	Haq *et al*. (2024)
11	Implementation of sustainable development goals (SDGs) no. 12: Responsible production and consumption by optimizing lemon commodities and community empowerment to reduce household waste	Maulana *et al*. (2023)
12	Analysis of the application of mediterranean diet patterns on sustainability to support the achievement of sustainable development goals (SDGs): Zero hunger, good health and well beings, responsible consumption, and production	Nurnabila *et al*. (2023)
13	Efforts to improve sustainable development goals (SDGs) through education on diversification of food using infographic: Animal and vegetable protein	Awalussilmi *et al*. (2023)
14	Safe food treatment technology: The key to realizing the sustainable development goals (SDGs) zero hunger and optimal health	Rahmah *et al*. (2024)
15	Analysis of student's awareness of sustainable diet in reducing carbon footprint to support sustainable development goals (SDGs) 2030	Keisyafa *et al*. (2024)

5. CONCLUSION

This study concludes that the production of innovative trash cans from sawdust waste is technically and economically feasible, and strategically relevant for supporting sustainable

tourism development. The engineering analysis shows that using 5 kg of sawdust per unit, combined with low-cost and accessible equipment, can yield durable waste containers suitable for deployment in public spaces. With an initial capital investment of only USD 19,500 and a short payback period of just over two years, the project offers a promising return on investment for small and medium-sized enterprises, especially those operating near timber industries or tourist zones.

Beyond the financial calculations, the model contributes meaningfully to environmental sustainability by transforming wood waste into functional public infrastructure. It supports the circular economy by minimizing resource extraction, reducing landfill waste, and repurposing industrial by-products. More importantly, the deployment of sawdust-based trash cans in tourist areas directly aligns with the principles of smart tourism—enhancing destination cleanliness, improving waste management, and communicating eco-conscious values to visitors.

The study also resonates with multiple Indonesian policy frameworks, including the National Tourism Development Master Plan (RIPPARNAS), the Medium-Term Development Plan (RPJMN), and waste reduction regulations from the Ministry of Environment and Forestry. By integrating innovation, sustainability, and policy alignment, this research offers a practical, scalable model that can be replicated across diverse regions. As such, it bridges the gap between technical innovation and tourism policy implementation, contributing both to academic discourse and real-world solutions for sustainable destination management.

6. AUTHORS' NOTE

The authors declare that there is no conflict of interest regarding the publication of this article. Authors confirmed that the paper was free of plagiarism.

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