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Value Chain Analysis of Cigar Waste Utilization as an Alternative Raw Material for the Hand-Rolled Kretek Cigarette (SKT) Industry in Jember Regency, East Java

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Abstract: Cigar waste, consisting of leftover leaves, wrapper dust, and stem fragments from tobacco processing, holds potential as an alternative raw material for the hand-rolled kretek cigarette (SKT) industry in Jember Regency, one of Indonesia's main cigar production centers. This study aims to (i) map the value chain of cigar waste utilization, (ii) identify key technical, institutional, and coordination constraints, and (iii) prioritize policy strategies to support a localized circular economy in the tobacco sector. A mixed qualitative–quantitative approach was employed, combining Porter's value chain framework for activity and actor mapping, Interpretative Structural Modelling (ISM) for structuring interrelationships among constraints, and the Analytical Hierarchy Process (AHP) for ranking policy alternatives based on expert judgments. The findings show that only about 44% of cigar waste is currently reused in SKT and related agro-industrial processes, while the remainder is sold at low value or discarded. ISM results indicate that institutional performance and coordination occupy the highest positions as independent, system-driving elements, shaping the behaviour of other technical and market constraints. AHP analysis further identifies policy coordination for cigar-waste downstreaming as the most influential strategic option, followed by SME empowerment and data transparency. Rather than offering definitive causal claims, the study provides an exploratory, empirically grounded diagnosis of how cigar-waste flows, actor relations, and governance gaps interact in a specific industrial cluster. The proposed policy options—such as a downstreaming forum, cooperative-based microfinance, and a digital waste inventory—are discussed as context-sensitive scenarios that require further piloting and evaluation.

Keywords: cigar waste; Hand-Rolled Kretek Cigarette (SKT); circular economy; Interpretative Structural Modelling (ISM); Analytical Hierarchy Process (AHP)

1. Introduction

Cigar waste is generated from various stages of tobacco processing and typically consists of leftover leaves, wrapper dust, and stem fragments (Rachman & Kadarwati, 2020). From the perspective of agro-



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industrial systems, this material represents a biomass resource with potential economic and environmental value (Amalia & Arif, 2022; Wardani, 2023). Jember Regency, in East Java Province, is recognized as one of Indonesia's main cigar production centers. The local cigar industry produces substantial volumes of solid waste each year, but current utilization rates remain relatively low and fragmented. At the same time, cigar waste contains nicotine and characteristic aroma compounds that make it suitable as an input for other tobacco-based products, organic fertilizers, and bioenergy applications (Sukmana et al., 2025; Kesumawati et al., 2019).

The hand-rolled kretek cigarette (SKT) industry faces multiple pressures, including fluctuating tobacco prices, supply volatility, and tighter excise policies (Fajar & Maulidah, 2021; Yaqin et al., 2025). In response, stakeholders have begun to explore the partial substitution of conventional leaf tobacco with cigar waste in SKT and related agro-industrial processes (Yusriana et al., 2023). In Jember, several SMEs have used cigar dust for local kretek production since 2018, and independent drying and processing units have gradually emerged. However, these initiatives are still scattered, and linkages among cigar producers, waste processors, and SKT manufacturers remain weak.

Figure 1 illustrates trends in cigar-waste volume and SKT raw-material requirements in Jember between 2015 and 2024. While cigar-waste volume has increased from about 120 tons to 185 tons over this period, SKT raw-material demand has also risen from 200 to 270 tons. This widening gap indicates that a substantial proportion of locally generated waste is not yet integrated into the value chain, despite the growth in downstream demand (Hermawati et al., 2023; Biro Perekonomian Provinsi Jawa Timur, 2022). Previous studies suggest that integrating tobacco-processing residues into circular economy schemes can reduce production costs and support environmental objectives (Bahtiar & Kamelia, 2023; Haifa et al., 2024; Mistry, 2024). However, they also highlight persistent challenges in institutional support, regulatory coherence, and actor coordination.

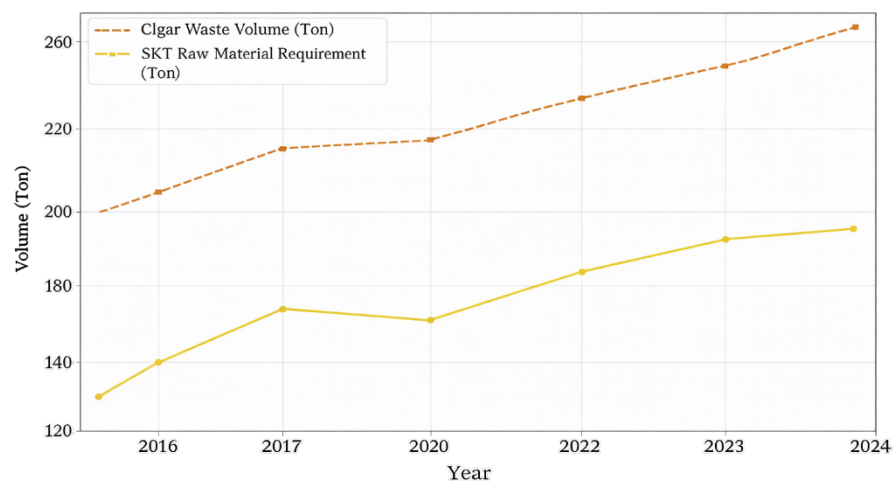


Figure 1. Fluctuations in Cigar Waste Volume and Raw Material Requirements for Hand-Rolled Kretek Cigarettes (SKT) in Jember Regency, 2015–2024. Source: East Java Provincial Bureau of Economy (2022).

Meanwhile, the demand for raw materials in the SKT industry has also shown a consistent upward trend, increasing from 200 tons in 2015 to 270 tons in 2024. This rise aligns with the growing market demand for hand-rolled kretek products, both in domestic and international markets. Nevertheless, (Wahyono et al., 2025) the data reveal a gap between the available volume of cigar waste and the total annual raw material requirements of the SKT industry. This indicates that the utilization of cigar waste has not yet been fully optimized, leaving substantial opportunities for its integration into the kretek industry's value chain. According to (Bahtiar & Kamelia, 2023), The utilization of tobacco waste from cigar production processes holds significant potential in supporting the implementation of a circular economy. In addition to reducing dependence on primary tobacco raw materials, this approach can also lower production costs in the Hand-Rolled Kretek Cigarette (SKT) industry. This condition provides a strong rationale for conducting a comprehensive value chain analysis of the cigar waste processing system. Optimizing the use of this waste (Haifa et al., 2024) not only impacts industrial efficiency but also generates social and environmental value, such as reducing solid waste and creating employment opportunities. (Burhan, 2025) It is also emphasized that, with appropriate downstream processing and branding strategies, cigar waste has the potential to become a value-added commodity that strengthens the tobacco product sector in a sustainable manner. To

position this research within a broader academic context, a systematic comparison was conducted between previous studies and the present work. Seven aspects were compared, including the research focus, methodology, study location, practical and theoretical contributions, as well as identified research gaps. This study places greater emphasis on a systemic mapping of the cigar waste value chain in Jember, integrating actor analysis, value-added flow assessment, and a circular economy approach. According to (Rouam, 2025) By comparing the two, the novel contributions of this study can be identified in both theoretical and practical aspects. Theoretically, it provides a more structured and localized analytical framework; practically, it offers policy recommendations and a business model based on vertical integration. Table 1 presents a detailed comparison between previous studies and the present research.

Table 1. Comparison of previous studies and the present study.

Aspect	Previous Studies	Present Study
Topic	Utilization of tobacco waste for cost efficiency and tobacco industry sustainability	Value chain analysis of cigar waste processing as raw material for SKT in Jember Regency
Researchers	(Bahtiar & Kamelia, 2023; Burhan, 2025; Kesumawati et al., 2019; Yusriana et al., 2023)	(Wahyono et al., 2024a) (Wahyono et al., 2024b, 2024c) and the present study (2025)
Methodology	Value chain analysis, case study, SWOT	Actor–activity–value-added mapping, Porter’s value chain analysis, and circular economy model
Geographical Focus	East Java in general, without specific focus on a particular regency	Specifically focused on Jember Regency
Theoretical Contribution	Demonstrates potential for efficiency and sustainability opportunities	Provides a structured mapping and integration strategy for incorporating tobacco waste value chains into SKT production
Practical Contribution	Cost efficiency and SME support	Policy recommendations, institutional schemes, and local value chain–based distribution models
Weakness	Limited mapping of actors and value distribution	Attempts to address this gap through a systemic approach

Several previous studies have examined the potential of tobacco waste as an alternative raw material in the tobacco product industry, particularly in the hand-rolled kretek cigarette (SKT) sector. (Yusriana, Rachman Jaya, 2023), Through value chain analysis, it has been shown that the utilization of cigar waste in SKT production has only reached approximately 40% of its actual potential. This reflects a significant opportunity to improve raw material use efficiency and to support the principles of industrial sustainability. (Bahtiar & Kamelia, 2023; Ellen MacArthur Foundation, 2020). highlighting the role of the circular economy, particularly through cooperatives and SMEs, which can reduce production costs by up to 22%. However, important aspects such as value distribution, actor mapping, and institutional roles have not been explored in depth. Meanwhile, it identifies structural constraints in Jember (Wardhani & Kurniati, 2025), such as limited incentives and weak institutional support for the integration of cigar waste. In this context, the contributions of Nanang Dwi Wahyono are highly relevant. Through a series of his publications, including (Wahyono et al., 2024a), Wahyono et al., 2024b), dan (Wahyono et al., 2024c)— Wahyono emphasizes the importance of a locally based agribusiness approach and cluster development to enhance the competitiveness of agro-industries, including the tobacco subsector. Nevertheless, to date, no research has comprehensively mapped the cigar waste processing value chain from upstream to downstream. In the midst of limited supplies of high-quality tobacco and a high dependence on imports, cigar waste holds potential as an alternative raw material solution. Challenges such as limited technology, weak linkages among business actors, and the absence of supportive policies remain major obstacles to its utilization.

Against this background, the present study examines how cigar-waste flows, actor interactions, and governance arrangements shape the possibilities for circular utilization in Jember. Rather than treating tobacco waste as a homogeneous category, the analysis focuses on a specific waste stream (cigar waste) and its potential linkage to the SKT industry. The study combines value-chain mapping with structural and multi-criteria modelling to understand how constraints are interrelated and which policy options appear most promising from the perspective of local stakeholders.

Research Gap and Novelty (Reframed)

Studies on tobacco-sector circularity and agro-industrial waste have documented multiple approaches for utilizing tobacco residues, including their conversion into pesticides, fertilizers, or alternative raw materials (Kesumawati et al., 2019; Slamet et al., 2022; Yusriana et al., 2023). Much of this work, however, either treats tobacco waste in general terms or focuses on single technologies or cost-efficiency calculations. The specific dynamics of cigar-waste streams—including how waste is generated, classified, traded, and incorporated into downstream industries—have received much less empirical attention.

At the same time, international literature on circular economy and value-chain upgrading emphasizes that the success of waste-based innovations depends not only on technical feasibility but also on institutional coordination, governance quality, and actor incentives along the chain (Ibnu, 2023; Santoso et al., 2025; Setiawati & Hakim, 2024). Yet, in the context of Indonesia's tobacco regions, there is still a limited number of studies that combine detailed, actor-level mapping with explicit analysis of institutional arrangements and policy trade-offs.

This study seeks to contribute to these debates in three modest but concrete ways:

- (1) **Problem focus:** It concentrates on a specific and under-studied waste stream—cigar waste in Jember—and its linkage to the SKT industry, rather than on tobacco waste in general.
- (2) **Analytical approach:** It integrates activity-based value chain mapping with ISM and AHP in a single framework, not to claim methodological novelty per se, but to explore how structural constraints and policy options can be visualized and prioritized in a complex, multi-actor setting.
- (3) **Empirical grounding:** It develops an exploratory, actor-based picture of cigar-waste utilization using primary data from local industries, cooperatives, SMEs, and government agencies, with explicit reflection on the limitations of this evidence.

The intention is not to propose a universally generalizable model, but to offer a context-specific, empirically informed diagnosis that may inform further comparative work on circular economy initiatives in resource-dependent regions. To clarify the distinctive contribution of the present study in relation to earlier works, an illustrative comparison between previous studies and the present research is presented in Table 2.

Table 2. Illustrative comparison between previous studies and the present research.

Aspect	Previous Studies	Present Study	Distinctive Emphasis
Scope	Tobacco waste or agro-industrial residues in general	Specific focus on cigar waste and its linkage to SKT in Jember	Zooms in on a particular waste stream and locality
Primary Objective	Cost reduction, pollution control, or generic sustainability	Understanding how waste, actors, and institutions interact along a localized chain	Links material flows with governance and coordination issues
Methodology	Descriptive case studies, SWOT, or single-method analyses	Combined use of value chain mapping, ISM, and AHP	Uses structural and multi-criteria tools in an exploratory way
Data Basis	Secondary statistics and broad surveys	Primary data from interviews, FGDs, and observations with local stakeholders	Emphasizes actor-level perceptions and relationships
Main Output	Conceptual recommendations for waste reuse	Prioritized set of policy and coordination options for a specific industrial cluster	Supports scenario building for local policy experiments

2. Research Methodology

2.1. Theoretical Justification for Method Integration

2.1.1. Research Design

This study adopts an exploratory mixed-methods design. The choice of methods reflects the dual objective of (i) describing how cigar waste currently moves through the local production system and (ii) structuring stakeholders' perceptions of key constraints and policy options. Porter's value chain framework is used to map activities, actors, and value-adding processes. Interpretative Structural Modelling (ISM) is then applied to organize perceived constraints and institutional factors into a hierarchical structure,

consistent with its use in systems thinking and governance studies. Finally, the Analytical Hierarchy Process (AHP) is used as a multi-criteria decision tool to prioritize alternative policy strategies based on expert judgments (Saaty, 2008; Checkland & Scholes, 1999).

The integration of these three approaches is not intended as a methodological innovation in itself, but as a pragmatic combination: value chain analysis to understand “who does what” and “where value is created”; ISM to reveal how constraints are structurally related; and AHP to derive relative priorities among feasible interventions under local conditions (Ponte et. al. 2019).

2.1.2. Sampling and Data Collection

The empirical work focuses on Jember Regency as a single case study. A total of 30 respondents were selected purposively as key informants, not as a statistically representative sample of all actors. They include managers of cigar factories, SKT producers, SME waste processors, cooperative leaders, and officials from relevant government agencies. Data were collected between February and June 2025 through semi-structured interviews, direct observations of processing activities, and three focus group discussions (FGDs).

The number and composition of informants follow the logic of expert elicitation commonly used in ISM and AHP studies, where the emphasis lies on the quality and diversity of perspectives rather than on sample size per se. Saturation was assessed qualitatively: after the second FGD, no substantially new constraint categories or policy ideas emerged, and this was confirmed in the third FGD.

2.1.3. ISM Procedure

Potential constraint elements were first identified through open coding of interview and FGD transcripts, supported by document review. Seven consolidated constraint elements were then subjected to pairwise comparison using the standard ISM notation (V, A, X, O) by the expert group. The resulting Structural Self-Interaction Matrix (SSIM) was converted into an initial reachability matrix and further refined to obtain the final reachability and driving-power matrix. Elements were classified into autonomous, dependent, linkage, and independent sectors. The full SSIM and final matrix are provided in enhance transparency and reproducibility.

2.1.4. AHP Procedure

The AHP model was constructed with one main goal (improving the cigar-waste value chain), five criteria (e.g., supply sustainability, job creation), and four policy alternatives (e.g., policy coordination, SME support). A subset of 15 informants with strategic roles in the chain participated as the AHP expert panel. They performed pairwise comparisons using Saaty’s 1–9 scale. Local weights, global weights, and the Consistency Ratio (CR) were calculated following standard procedures. The overall CR of 0.06, below the 0.10 threshold, indicates acceptable internal consistency. Detailed pairwise matrices and consistency calculations are presented.

2.2. Reliability, Validity, and Triangulation

To strengthen reliability and validity:

- (a) Data triangulation was pursued by combining interviews, FGDs, direct observations, and secondary statistics from provincial and regency offices.
- (b) Method triangulation was achieved by juxtaposing qualitative narratives (from interviews and FGDs) with structured outputs (ISM hierarchies and AHP weights).
- (c) Member checking was conducted by presenting preliminary ISM and AHP results in a validation FGD, allowing stakeholders to comment on plausibility and adjust misinterpretations.

Given the exploratory nature and case-study scope, the study does not claim statistical generalizability but aims at analytical generalization within comparable institutional and industrial contexts.

3. Discussion (Condensed and Analytical)

3.1. Value Chain Mapping and Material Flows

The value chain mapping confirms that cigar waste in Jember is primarily generated at the sorting and finishing stages of cigar production and then flows through informal channels to SMEs, home-based processors, and a small number of SKT manufacturers. Only about 44% of the estimated waste volume is

currently used as input for SKT, fertilizers, or other products, while the remainder is sold at low prices or discarded. This pattern reflects a classic “under-valorization” problem: materials with potential value are trapped in low-value uses due to missing coordination mechanisms, limited information, and weak bargaining power on the SME side.

When compared with idealized value chains described in international studies on circular economy and agro-industrial upgrading, the Jember case shows a similar combination of technical feasibility and institutional bottlenecks. The main barriers are not the absence of technologies for drying or blending waste, but the lack of standardized classification, transparent pricing, and integrative distribution mechanisms connecting cigar factories, intermediaries, and downstream processors.

Field findings indicate that constraints in the utilization of cigar waste include the suboptimal organization of business actors, limited data on production waste, weak cross-sector coordination, and minimal investment in processing technology development. All of these constraints are summarized in a matrix, as presented in Table 3.

Table 3. Mapping of activities, constraints, and actors involved in the Cigar Waste–SKT value chain.

Mapping Activity	Constraints	Actors Involved
Core process mapping	Absence of a structured system to connect cigar waste producers (cigar industry) with processors (hand-rolled kretek industry)	Cigar industry, MSME waste processors, kretek industry associations
Actor mapping	Limited role of associations or intermediary institutions in linking waste providers with processors	Cigar industry, tobacco farmer cooperatives, research institutions, business incubators
Product flow mapping	Poor documentation of cigar waste distribution channels, causing delays and mismatches in supply	Cigar industry, SKT raw material distributors, MSMEs
Information flow mapping	Lack of a transparent cigar waste database from government institutions or associations, making it difficult for businesses to forecast potential and value addition	Cigar industry, Department of Industry, Department of Agriculture, MSMEs, universities, research consortia
Mapping of product volume, number of actors, and employment	Utilized cigar waste accounts for only a small portion of available potential, and the number of processing businesses remains limited	Cigar industry, waste processors, local workers, farmer cooperatives, SKT processing MSMEs
Mapping of relationships and linkages among value chain actors	Weak relationships among actors, minimal integration between upstream (cigar industry) and downstream (SKT processors), and lack of synergy in building a circular industry ecosystem	Cigar industry, cooperatives, MSME waste processors, SKT exporters, local government, domestic and international market players

Based on the constraint matrix in Table 3, it is evident that part of the obstacles in mapping the cigar waste value chain lies in the non-functioning distribution and connectivity systems between waste sources (cigar industry) and downstream processing actors. This indicates a gap in the role of intermediary institutions or industrial waste distribution centers, which should serve as a bridge between secondary raw material suppliers (cigar waste) and the small and medium-sized enterprises (SMEs) that process it.

In the context of industrial product management institutions (Ibnu, 2023), the presence of intermediary bodies—such as cigar processing units—functions as a key driver of the value chain and an enabler of improved welfare for business actors. This concept can be adapted to the cigar waste industry, where an institutional system is needed to manage waste distribution, classify residual material quality, and set prices in a transparent and competitive manner to support supply chain integration and empower SMEs. This aligns with the findings of (Maghfuri, 2023; Santoso et al., 2025) in their study on value chains, which emphasized that establishing sustainable business strategies requires mapping environmental, economic, and social factors. A novel approach using Power Query was developed to integrate economic, environmental, and employment data into value chain maps. Applied in 12 European countries, this method produced 240 industry maps representing 94.41% of emissions, providing strategic insights for

researchers, business practitioners, and policymakers. The overall flow of cigar waste production, processing, and distribution in Jember Regency is illustrated in Figure 2.

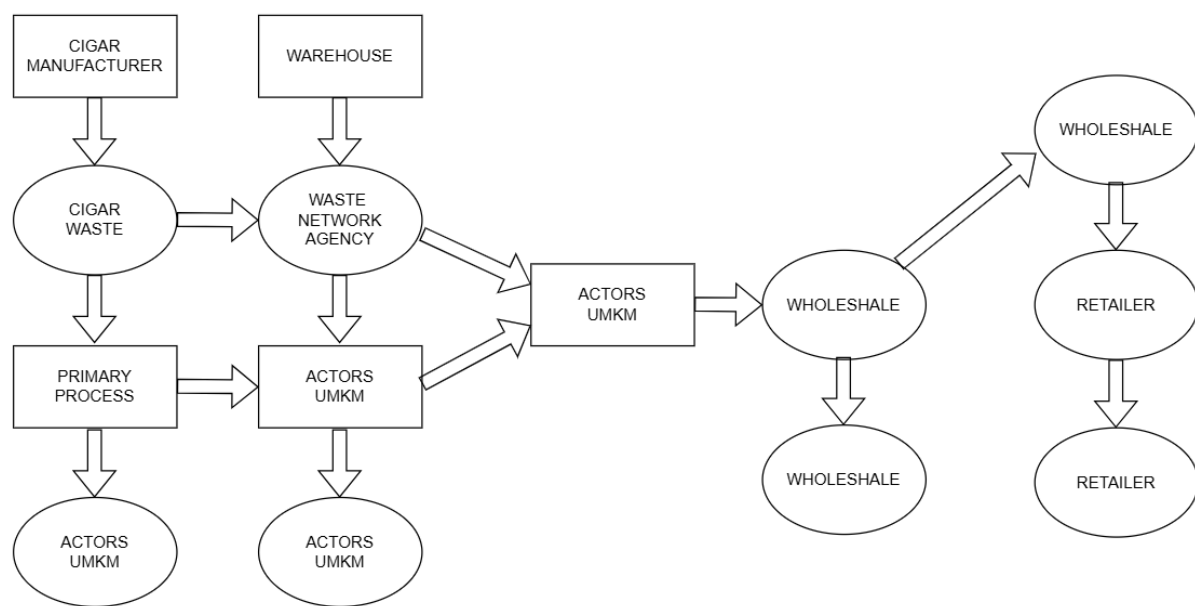


Figure 2. Value Chain of Cigar Waste Production, Processing, and Distribution in Jember Regency.

In contrast to the ideal distribution schemes in Europe, cigar distribution there is influenced by several factors, including consumer preferences, regulations, and distribution channels. Germany is the largest cigar market in Europe, with a strong preference for premium cigars and a well-developed retail infrastructure. Overall, Europe is projected to experience a CAGR growth of 4.3% over the period 2025–2032, driven by tourism, duty-free sales, and shifting consumer preferences.

Field observations in Jember Regency's cigar industry reveal that cigar manufacturers tend to sell their production waste—such as residual shredded tobacco, midribs, and stems—directly to small-scale processors and home industries without going through a structured distribution system. This practice exists due to informal agreements between cigar manufacturers and SMEs processing cigar waste, in which SMEs are granted access to waste raw materials in exchange for fixed purchases or supply contracts. In return, cigar manufacturers sometimes provide simple production equipment or flexible payment arrangements.

While this relationship is mutually beneficial, it also reflects a high dependence of SMEs on upstream industry waste supply. Production costs and access to waste raw materials are among the main reasons why SMEs avoid open auction mechanisms or government-regulated distribution systems. They prefer direct partnerships to ensure supply certainty, even though in many cases SMEs have a very low bargaining position.

This low bargaining power carries the risk of unfair pricing, especially when waste supply is abundant. Furthermore, the lack of optimal support and regulation from local government agencies—namely the Department of Industry and the Department of Cooperatives—has resulted in price structure imbalances and distribution system disparities. Delays in government intervention to establish a circular, waste-based industrial ecosystem have led SMEs to accept schemes that predominantly benefit large-scale industries.

Another issue is that the volume of cigar waste utilized as raw material for SKT production accounts for only about 44.33% of total waste generated. The remainder is not optimally used, with some even being discarded without processing. Some SKT producers opt to import similar raw materials from other countries (such as India, Myanmar, or Vietnam) at significantly higher prices of IDR 15,000–20,000 per kilogram, compared to the local waste price of only IDR 5,000–7,500 per kilogram.

According to interviews with tobacco processing industry actors, high processing costs are the primary obstacle to maintaining business sustainability. Nonetheless, production activities continue due to the involvement of a significant workforce and the presence of domestic and export markets bound by purchase contracts.

Most of these constraints stem from the suboptimal management and oversight of the cigar waste value chain from upstream to downstream. The absence of a regulated distribution system, weak supervisory institutions, and the lack of a national database on the types, quality, and potential of cigar waste are the root causes preventing the establishment of a circular, green industry in the tobacco sector.

3.2. Regulation and Governance in Cigar Waste Utilization

Governance in the utilization of cigar waste refers to (Mistry, 2024) in the system of rules and formal requirements that must be adhered to by all actors in the value chain—from producers, processors, and distributors to end consumers. Derivative products from cigar waste intended for the SKT industry, organic fertilizers, or bioenergy must comply with specific standards, covering aspects such as chemical content, product safety, and environmental sustainability.

One of the primary requirements in processing cigar waste into raw materials for consumer products is the application of a product safety system based on Hazard Analysis Critical Control Point (HACCP). Although commonly used in the food industry, HACCP principles are also relevant to ensuring that tobacco waste-based products do not contain harmful elements to human health.

In addition to HACCP, several other standards such as SNI, ISO 9001, ISO 14001, and eco-label product certification should be considered by industry players to enhance product competitiveness. These standards serve as tools for validating quality and sustainability commitments in the face of increasingly selective global market demands for environmentally friendly products.

From a regulatory perspective, both local and central governments need to formulate and implement policies that support waste integration into the circular economy system. For example, by promoting regional regulations (Perda) that provide incentives for tobacco waste processing industries, restricting the indiscriminate disposal of industrial waste, and establishing Waste Distribution Centers that ensure supply and price transparency.

The enforcement of these regulations should be carried out by technical agencies such as the Department of Industry, the Environmental Agency, and the Ministry of Cooperatives and SMEs, in accordance with the supervisory and development functions stipulated in ministerial regulations and relevant laws. Without the active presence of functioning institutions, the vast potential of cigar waste will continue to be underutilized, with only a small portion benefiting business actors who already have direct access to the source.

3.3. Constraint Structure and Institutional Drivers

The ISM results highlight that institutional performance and coordination occupy the highest level as independent elements, driving the behaviour of other constraints such as supply continuity, waste sorting quality, and SME capacity. Four linkage elements—policy enforcement, data transparency, inter-agency coordination, and SME participation—exhibit both high driving power and high dependence, indicating a tightly coupled system where partial interventions may lead to unintended consequences.

This configuration mirrors insights from governance and value-chain upgrading literature, which emphasize that fragmented institutional arrangements tend to increase transaction costs and uncertainty for smaller actors (Ibnu, 2023; Setiawati & Hakim, 2024). In Jember, the absence of a dedicated coordination forum or clear division of labour among agencies means that each actor adapts in an ad-hoc manner, resulting in inconsistent supply relationships and unstable prices for cigar-waste raw materials.

3.4. Constraint Elements in Cigar Waste Utilization

Within the constraint elements, seven sub-elements were identified in the value chain of cigar waste utilization shown Table 4. Of these:

- (a) Four sub-elements fall within the Linkage sector (3, 1, 2, and 4), meaning they have high influence and high dependence; changes in these elements will have a systemic impact on the entire value chain.
- (b) One sub-element is in the Independent sector (7), which plays a key role as a policy driver. Weak performance of related institutions is the main barrier to achieving effective governance.
- (c) One sub-element is in the Dependent sector (5), which is highly dependent on support from other elements, particularly in the areas of training and human resource policy.
- (d) One sub-element is in the Autonomous sector (6), which, although not directly significant, holds long-term potential if activated, such as through strengthening cooperatives or waste processor associations.

Understanding this structure allows policy formulation for the downstream processing and sustainable utilization of cigar waste to focus on strengthening the linkage and independent elements while activating support for the dependent and autonomous elements. Policymakers should carefully design measures for implementing cigar waste management policies so they align with actual field conditions. Eliminating constraints in this sector is crucial, as it will influence the effectiveness of actions taken in other constraint elements.

Table 4. Classification of sub-elements of constraints in cigar waste utilization.

No	Sub-Element of Constraint	D	P	R	Sector
1	The volume of cigar waste from the industry is insufficient to meet the raw material needs of processing industries (SKT, fertilizers, etc.)	4	4	2	III
2	Sustainability of waste raw material sources is threatened due to suboptimal sorting and separation systems	4	4	2	III
3	Weak implementation and supervision of regulations on tobacco industry waste management	5	6	1	III
4	Lack of initiative from cigar industry players to establish a transparent waste distribution system	5	7	1	III
5	Increasing demand for employment but limited training opportunities for workers in the waste processing sector	2	6	3	II
6	Inactive cooperatives or waste processor associations, leading to difficulties in accessing capital and markets	2	1	3	I
7	Government and private institutions are suboptimal in implementing governance solutions for cigar waste	5	1	1	IV

Notes: (a) D = *Driving Power* (Kekuatan Penggerak). (b) P = *Dependency* (Ketergantungan). (c) R = *Rating (Prioritas)*. (d) Sektor: (I) Autonomous (Low influence and low dependence); (II) Dependent (High dependence, low influence); (III) Linkage (High influence and high dependence; critical and complex); (IV) Independent (High influence, low dependence; policy key factors).

The sub-elements within the linkage sector represent the primary challenges, characterized by high driving power and high dependence. These sub-elements include:

- (1) The volume of cigar waste from the industry is insufficient to meet the raw material needs of processing industries (SKT, fertilizers, etc.).
- (2) The sustainability of cigar waste raw materials is threatened due to suboptimal sorting and separation processes.
- (3) Weak implementation and supervision of sustainable tobacco waste management regulations.
- (4) Low initiative from cigar industry players in establishing a transparent and integrated waste distribution system.

The characteristics of the linkage sector require serious attention, as the elements within it are interconnected in a complex and dynamic manner. Any policy change in this sector has mutually influencing consequences and must therefore be carried out with careful planning based on in-depth studies.

Sub-element (5)—the increasing need for labor in the cigar waste processing sector but with limited skills training—belongs to the dependent sector. This element has high dependence on changes in linkage elements, but relatively low influence on the overall system. Therefore, direct handling of this sub-element is not a top priority, as improvements in the linkage elements will indirectly address the challenges in this dependent sector.

Sub-element (6)—the inactivity of cooperatives or waste processor associations—falls into the autonomous sector. This element has low influence and low dependence on the overall system. Although its current contribution is small, the role of cooperatives should be reassessed for their strategic potential in improving access to capital, marketing, and bargaining power for cigar waste-processing SMEs in the future.

Overall, the classification results indicate that the most fundamental constraint in cigar waste management lies in sub-element (7)—government and private institutions being suboptimal in implementing agreed solutions. This sub-element belongs to the independent sector, meaning it has strong driving power but relatively low dependence on other elements. Therefore, strengthening the institutions that manage, supervise, and guide the cigar waste value chain should be the main focus in policy formulation.

To ensure that strategic objectives in cigar waste management are achieved in a targeted manner, a policy roadmap based on the principles of sustainable tobacco industry governance is required. This roadmap must be built on the principles of benefit, fairness, integration, transparency, independence, efficiency, sustainability, and equity.

Referring to the (Kementerian Pendayagunaan Aparatur Negara dan Reformasi Birokrasi, 2013), a roadmap is defined as a sequence or series of activities that must be carried out in a gradual and structured manner to achieve sustainable reform outcomes. In the context of cigar waste, this roadmap involves a transformation from passive waste management to a circular economy system that supports product innovation, SME growth, local empowerment, and export competitiveness.

3.5. Business Actor Needs in Cigar Waste Processing

In addition to identifying structural constraints, this study also examines the needs of business actors involved in cigar waste processing. The classification of these business actor needs is presented in Table 5.

Table 5. Classification of sub-elements of business actor needs in cigar waste processing.

No	Sub-Element of Need	D	P	R	Sector
1	Availability of cigar waste as raw material	2	6	3	II
2	Governance, regulation, and supervision of waste management	7	4	1	III
3	Technical guidance and training for SMEs	7	4	1	III
4	Solutions to overlapping or unclear tobacco waste regulations	7	4	1	III
5	Active institutions serving as a link and facilitator between industry and SMEs	7	4	1	III
6	Availability of business capital access for waste processing	2	7	3	II
7	Application of appropriate technology in cigar waste processing	3	6	2	II

Based on the results of the Interpretative Structural Modeling (ISM) analysis in Table 5, sub-elements (2) governance and supervision, (3) technical guidance and training, (4) solutions to regulatory ambiguity, and (5) active institutions are key sub-elements of business actor needs in cigar waste processing. These four sub-elements have both high driver power and significant dependency, thus falling within Sector III (linkage).

The analysis revealed that only 44% of total cigar waste in Jember is utilized by the SKT sector. The remaining 56% is either discarded or sold to informal traders at minimal value. This low utilization rate results from (1) lack of standardized waste classification, (2) weak coordination between cigar factories and SKT processors, and (3) limited financing for small-scale recyclers.

The ISM hierarchy demonstrates that institutional weakness is the dominant *independent variable* influencing the system. Four linkage elements—policy inconsistency, absence of data transparency, limited inter-agency cooperation, and insufficient SME participation—were found to both affect and be affected by other elements. The interdependence among these factors indicates that the problem is systemic rather than technical.

AHP analysis identified “Policy Coordination” (weight = 0.692) as the most influential strategy, followed by “SME Empowerment” (0.519) and “Data Digitization and Transparency” (0.415). The dominance of policy coordination suggests that regulatory fragmentation remains the central obstacle to efficient resource utilization. This aligns with *institutional coordination theory* and *transaction cost economics*, which emphasize that fragmented governance increases uncertainty and costs in supply networks.

The characteristics of the linkage sector require these sub-elements to be carefully assessed due to their complex and interdependent interactions. Therefore, strategies for meeting business actors’ needs in cigar waste management must consider harmonization among sub-elements so that the policies implemented are truly effective and supported by the existing system.

Yusuf (2024) emphasizes the importance of institutional synergy through regulation, MCS, co-management, and open market distribution systems. Sub-elements such as waste supply, access to capital, and technology are classified as dependent, requiring government intervention. Discussions with local agencies and SMEs indicate that the success of cigar waste processing depends on supply, regulation, institutional strength, and continuous assistance. Muizu et al. (2024) stress the need for policies based on the gap between actual and ideal performance. In line with the Kementerian Pendayagunaan Aparatur Negara dan Reformasi Birokrasi (2013), the cigar waste processing roadmap must be environmentally, socially, and economically integrative, moving toward an inclusive green industry.

3.6. Institutional Elements in Cigar Waste Management

Policies for cigar waste management must be aligned with field realities and supported by strong and well-coordinated institutions. This is essential to creating a governance system that is sustainable and competitive, in accordance with (Indonesia, Pemerintah Pusat, 2009) on Environmental Protection and Management. (Setiawati & Hakim, 2024) emphasizing the importance of synergy among the government, industry associations, and legal institutions in building a system of oversight and social protection. In the context of cigar waste, small-scale traders are highly dependent on raw material supplies from SMEs, making the strengthening of upstream–downstream value chains critically important.

The classification results presented in Table 6 indicate that, out of the nine institutional sub-elements:

- (a) Two sub-elements fall within the Independent sector (1 and 2), namely Disperindag and the Industrial Waste Management Unit under DLH, both serving as primary policy drivers with low dependence. They are key in the institutional structure, as inter-agency coordination largely depends on their effectiveness.
- (b) Two sub-elements are in the Dependent sector (3 and 6), namely cooperatives and industry associations of waste processors, which rely heavily on regulatory and distribution support from Sectors IV and III.
- (c) Five sub-elements belong to the Linkage sector (4, 5, 7, 8, 9), meaning they have high influence and high dependence, functioning as critical nodes in cross-institutional coordination.

Table 6. Classification of sub-elements of institutional arrangements in cigar waste management.

No	Institutional Sub-Element	DP	D	R	Sector
1	Jember Regency Office of Industry and Trade (Disperindag)	9	4	1	IV
2	Industrial Waste Management Unit (under the Environmental Agency/DLH)	9	4	1	IV
3	Cigar Waste Processing Cooperative	4	9	4	II
4	Association of Tobacco and Cigar SMEs	5	9	5	III
5	Village Community Empowerment Institution (LPMD)	7	9	3	III
6	National Tobacco Industry Association (AITN) or APPTI	4	7	4	II
7	Research Institutions / Universities	5	7	5	III
8	Civil Service Police Unit (Satpol PP) & Industrial Regulation Enforcement	8	5	2	III
9	Office of Cooperatives and SMEs	8	5	2	III

Sub-elements such as Satpol PP, the Office of Cooperatives, LPMD, and SME associations often face coordination challenges due to differences in perception regarding their duties and authorities under sectoral regulations. Sectoral ego and overlapping institutional functions often lead to inefficiencies in policy enforcement and waste management implementation.

Field observations suggest the need for an integrated cross-agency coordination mechanism that clarifies the roles and responsibilities of each institution. One strategic solution is the formation of the Cigar Waste Downstreaming Coordination Forum (FKHLC) as a cross-sectoral platform involving:

- (a) Local government agencies (Disperindag, DLH, Cooperatives)
- (b) Academia (Research institutions)
- (c) Business actors (Cigar industry and SME waste processors)
- (d) Social institutions (LPMD, corporate CSR programs)
- (e) Law enforcement (Satpol PP)

The role of research institutions and universities is also crucial in promoting innovation in cigar waste processing. Through a science and technology (IPTEK)-based approach, universities can design processing systems that are more efficient, environmentally friendly, and applicable for SME actors. This supports the statement by Franky et al. (2025), that an environmentally friendly technological approach is a fundamental pillar of sustainability in natural resource-based industries.

Ultimately, the success of institutional systems in cigar waste management is highly dependent on a clear mapping of the roles and relationships among sub-elements, as well as a shared commitment to achieving governance that is synergistic and collaboration-based.

3.7. Policy Prioritization and Strategic Options

The AHP model assigns the highest global weight to policy coordination for cigar-waste downstreaming, followed by SME assistance and data validity. This ranking is consistent with the ISM structure: without stronger coordination among key institutions—particularly the Office of Industry and Trade, the Environmental Agency, and cooperative bodies—interventions focused solely on technology or credit risk remaining fragmented.

At the same time, the AHP results should be interpreted with caution. The derived weights reflect the judgments of a limited group of experts and remain sensitive to variations in pairwise comparisons. Nevertheless, sensitivity checks indicate that, although the exact numerical values may shift under alternative weighting schemes, policy coordination and SME support consistently remain among the leading priorities across scenarios. This suggests that, within the limitations of the dataset, the identified leverage points are reasonably robust.

With this hierarchical structure, strategic decision-making is expected to be more targeted, measurable, and participatory. The policy formulation process also considers actual field conditions, the limitations faced by small-scale entrepreneurs, and the local economic potential that can be optimized through a circular economy approach. The hierarchical structure of the Analytical Hierarchy Process (AHP) developed in this study is presented in Figure 3.

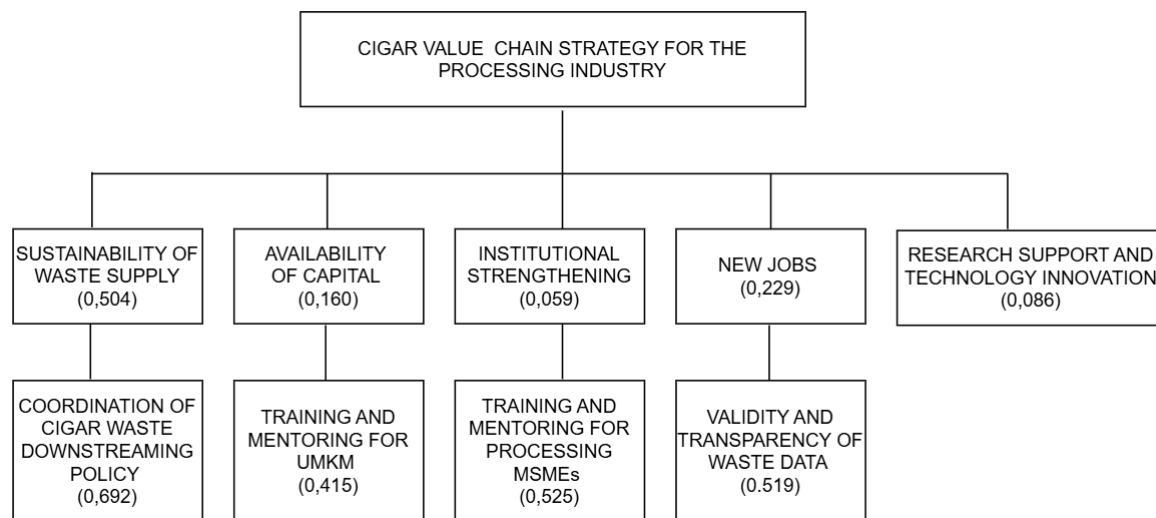


Figure 3. Hierarchical Structure of the Analytical Hierarchy Process (AHP).

4. Managerial and Policy Implications (Re-Focused)

From a managerial perspective, the findings suggest that individual SMEs will face difficulties upgrading their operations if broader coordination and information problems remain unresolved. Practical steps may include:

- developing a shared digital registry of cigar-waste types, volumes, and basic quality indicators;
- piloting a small-scale coordination forum where factories, SMEs, and local agencies can experiment with supply contracts and pricing rules;
- linking technical training programs to concrete upgrading pathways (e.g., diversification into fertilizer granules or bio-based inputs), rather than generic capacity-building.

These proposals are not presented as ready-made solutions, but rather as scenarios for local experimentation that could be further refined and evaluated through subsequent research and policy dialogue, as outlined in Table 7.

Table 7. Weight values of policy criteria toward the goal.

Value Chain Strategy Criteria	Weight
Sustainability of waste supply	0.504
Availability of capital	0.160
Institutional strengthening	0.059
Creation of new jobs	0.229
Support for research and technological innovation	0.086

4.1. Relationship between Policy Alternatives and Policy Criteria

Table 8 shows the relationship between the applicable policy alternatives and each policy criterion. The numerical weights indicate the extent of influence that each alternative has on a given criterion within the cigar waste management strategy.

Table 8. Weight values of policy alternatives toward policy criteria.

Policy Criteria (Weight)	Incentive Regulations (0.095)	Policy Coordination (0.692)	Data Validity (0.229)	SME Assistance (0.249)
Sustainability of Waste Supply (0.504)	0.068	0.692	0.177	0.123
Availability of Capital (0.160)	0.147	0.134	0.305	0.415
Institutional Strengthening (0.059)	0.086	0.128	0.207	0.525
Creation of New Jobs (0.229)	0.099	0.086	0.519	0.296
Support for Research and Technological Innovation (0.086)	0.153	0.206	0.563	0.078

4.2. Explanation of the Relationship between Alternatives and Criteria:

The weight table illustrates the strategic link between policy criteria in the development of the cigar waste value chain and the available policy alternatives. Each weight value reflects the degree of contribution or alignment of an alternative in achieving the objectives of each criterion. The higher the weight, the greater the influence or relevance of the alternative in supporting the respective criterion.

4.2.1. Sustainability of Waste Supply (0.504)

The highest-weighted alternative is Policy Coordination for Cigar Waste Downstreaming (0.692), indicating that supply consistency is strongly influenced by stakeholder synchronization efforts, cross-sector regulations, and integrated planning in cigar waste management. Other alternatives, such as data validity (0.177) and incentive regulations (0.068), while important, have less direct impact on ensuring the overall continuity of waste supply.

4.2.2. Availability of Capital (0.160)

The top alternative is SME Assistance (0.415), showing that capital provision for waste processors is closely tied to SMEs' ability to access and manage financing. Data validity (0.305) also plays a significant role in strengthening investor or financial institution confidence through transparent information.

4.2.3. Institutional Strengthening (0.059)

Under this criterion, Training and Assistance for Waste-Processing SMEs (0.525) holds the dominant weight, suggesting that institutional capacity building is more effectively achieved through skills enhancement and direct technical mentoring, rather than mere policy adjustments.

4.2.4. Creation of New Jobs (0.229)

The highest-weighted alternative is Data Validity and Transparency (0.519), indicating that credible and accessible data serve as the basis for adaptive and needs-based workforce planning. Reliable data supports more precise production and investment planning, thereby creating opportunities for new job generation.

4.2.5. Support for Research and Technological Innovation (0.086)

Again, Data Validity and Transparency (0.563) emerges as the dominant alternative, suggesting that research and innovation are heavily dependent on accurate baseline data. Without valid information, the development of effective waste processing technologies will be difficult to achieve.

4.3. Managerial Implications

Based on the AHP analysis of policy strategies for the cigar waste value chain, the policy criterion with the highest weight is the sustainability of waste supply, with policy coordination for downstreaming as the main strategic alternative. The primary issues in cigar waste management are the suboptimal enforcement of regulations and weak inter-agency coordination, which reduce supply chain efficiency and waste utilization.

In this regard, strengthening human resources through training, institutional support, and continuous assistance is essential for building a sustainable cigar waste management system, in line with Sartika (2024), who emphasizes the strategic role of human resource management in supporting organizational sustainability

through economic, social, and environmental integration. In this context, strong downstreaming policies must be supported by well-planned and applicable managerial actions not limited to regulatory formulation but also extending to technical implementation in the field. The following managerial mechanisms are recommended for building a sustainable cigar waste management system:

1. Building Financial Strength

All policy alternatives require financial backing. Strengthening capital is therefore fundamental. A Cigar Industry-Based Microfinance Institution (MFI) should be established as a financing solution for waste-processing SMEs.

Steps to implement this include:

- (a) Organizing SME actors and cooperatives to become founding members.
- (b) Developing a legal and administrative framework for the MFI.
- (c) Preparing an integrated business plan in coordination with the Cooperative Office and Financial Services Authority (OJK).

Establishing Strong Institutions

Inter-agency coordination is key to strengthening the cigar waste processing value chain. Local government, industry associations, universities, and SMEs should collaborate to design an institutional roadmap defining each party's role, function, and commitment. Recommended institutional strengthening actions include:

- (a) Establishing a Cigar Waste Downstreaming Forum (FHLC) as a strategic communication platform.
- (b) Formulating regulations for collaboration between large industries and SMEs in waste supply.
- (c) Conducting human resource training based on innovative waste processing technologies.

2. Upgrading Technology and Business Models

Upgrading refers to modernizing production systems and diversifying cigar waste-based products. This is crucial for sustaining SME operations and ensuring raw material efficiency. Strategic steps include:

- (a) Implementing a digital waste quality classification system.
- (b) Developing derivative products such as organic fertilizers, bioenergy, waste-based SKT, and eco-friendly paper packaging.
- (c) Establishing integrated processing units in villages using a Teaching Factory (Tefa) model.

3. Creating Economic Protection Schemes for SMEs

During the transition period of policy implementation and waste distribution system restructuring, alternative economic activities should be provided for affected entrepreneurs. For example, if waste supply from cigar industries decreases, SMEs could temporarily shift to processing agricultural waste or other natural fiber-based products. Local governments can also promote:

- (a) Development of waste-industry-based educational tourism (industry tours).
- (b) Certification for micro-enterprises processing waste to access training and low-interest credit.

4. Value Chain Data Estimation and Updating

Accurate data is critical for determining policy direction. Regular data audits should be conducted regarding:

- (a) Volume and types of cigar waste generated.
- (b) SMEs' processing capacity and market potential of processed products.
- (c) Estimates of Maximum Sustainable Utilization (MSU) and Maximum Economic Yield (MEY) for waste processing systems.
- (d) The use of digital dashboards or locally developed application-based information systems can make this process more transparent and real-time.

A shared commitment among local governments, industry players, educational institutions, and communities is essential to implementing these mechanisms. With synergistic coordination and data-driven implementation, an efficient, sustainable, and competitive cigar waste value chain management system can be achieved.

5. Limitations & Policy Implications

5.1. Limitations (Strengthened)

This study has several important limitations that must be acknowledged explicitly. First, the number of respondents is small and purposively selected, which is appropriate for expert-based ISM–AHP modelling but does not allow for statistical generalization to the broader population of tobacco-sector actors in Jember. Second, several quantitative estimates—such as waste utilization rates and cost differentials—are based partly on self-reported data and company records that could not always be independently verified. Third, the analysis is confined to a single regency and a particular configuration of industries and institutions; other tobacco regions may display different patterns of actor relationships, regulatory pressures, and market dynamics. These constraints imply that the findings should be interpreted as an exploratory diagnosis and a starting point for further, more extensive empirical work, rather than as definitive evidence.

5.2. Policy Implications (More Cautious)

Within these limits, the study still offers useful indications for policy and practice. Three areas appear particularly promising for local experimentation:

Table 9 shows three key priority areas for advancing cigar-waste downstreaming in a more structured and sustainable manner, namely institutional coordination, microfinance support, and digital data development. In terms of institutional coordination, the establishment of a pilot Cigar Waste Downstreaming Forum is expected to reduce stakeholder fragmentation and foster a clearer understanding of roles and constraints across agencies, factories, SMEs, and research institutions. This intervention appears highly feasible when linked to existing coordination platforms and supported by dedicated funding. In the financial dimension, a cooperative-based microfinance mechanism is proposed to address working-capital limitations among waste-processing SMEs. Although this scheme has the potential to significantly expand financial access, its implementation requires careful risk assessment and regulatory alignment. Meanwhile, the development of an open-access digital inventory of cigar-waste volumes, types, and locations is expected to improve transparency and planning efficiency. However, this initiative depends on sustained technical support and consistent industry participation in data provision. Collectively, these proposed actions indicate that an effective downstreaming strategy must be supported by institutional synergy, adaptive financing mechanisms, and robust data systems. These initiatives should be implemented gradually and accompanied by monitoring arrangements that assess not only economic outcomes but also social inclusion and environmental performance.

Table 9. Priority areas, proposed actions, expected impacts, and feasibility considerations for cigar-waste downstreaming development.

Priority Area	Proposed Action	Expected Impact	Feasibility Considerations
Institutional Coordination	Pilot a Cigar Waste Downstreaming Forum involving key agencies, factories, SMEs, and research institutions	Reduces fragmentation, improves mutual understanding of roles and constraints	High, if linked to existing coordination platforms and supported by earmarked resources (e.g., tobacco excise funds)
Microfinance Mechanism	Design a cooperative-based microfinance scheme tailored to waste-processing SMEs	Expands access to working capital for small processors	Moderate; requires risk assessment, regulatory alignment, and financial-sector engagement
Digital Data Platform	Develop a simple, open-access inventory of cigar-waste volumes, types, and locations	Enhances transparency and supports planning by both public and private actors	Moderate; needs technical support and sustained data input from industry

6. Conclusions

This study has examined the value chain of cigar-waste utilization in Jember Regency with a focus on its potential role as an alternative raw material for the hand-rolled kretek cigarette (SKT) industry. By combining activity-based value chain mapping with ISM and AHP, the analysis has shown that underutilization of cigar waste is primarily rooted in institutional and coordination challenges rather than

in the absence of technical processing options. Institutional performance and cross-agency coordination emerge as key system drivers, while SME needs, supply continuity, and data transparency occupy highly interdependent positions in the constraint structure.

The prioritization exercise suggests that policy coordination, SME support, and improved information systems are perceived by local stakeholders as the most relevant strategic levers for upgrading the cigar-waste value chain. These findings do not provide universal recipes, but they do offer a structured account of how actors in one tobacco-producing region view the obstacles and opportunities associated with circular economy initiatives. Future research could expand the empirical base by incorporating longitudinal data, comparative case studies from other regions, and more detailed economic modelling of alternative policy scenarios.

Author Contributions

N.D.W. contributed to the conceptualization of the study, development of the research framework, methodology design, supervision of the overall project, interpretation of results, and preparation of the original draft of the manuscript. D.K. contributed to data collection, data curation, field investigation, validation of findings, and manuscript review. D.K.W. contributed to investigation, visualization of the research results, organization of supporting data, and manuscript review and editing. A.W.W.A. contributed to methodology refinement, formal analysis, validation of the analytical results, interpretation of data, visualization, and critical review of the manuscript. F.E.A.P. contributed to data curation, field investigation, validation, and manuscript review and editing. All authors have read and agreed to the published version of the manuscript.

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Conflicts of Interest

The authors declare no conflict of interest.

Use of AI and AI-Assisted Technologies

No AI tools or services were utilized in the preparation of this paper. The manuscript reflects the original ideas, academic judgment, and collaborative scholarly work of the author team. All conceptual development, analysis, interpretation, and writing were carried out independently by the authors, who remain fully responsible for the content of the manuscript.

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