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Multiaspect Sustainability Analysis of Household-Scale Coconut Sugar Enterprises in Besan Village, Klungkung

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ABSTRACT

Keyboard: Agribusiness; MSA; Sustainability; MSMEs; Digitalization

Abstrak

Coconut sugar production represents a vital component of the rural economic structure in Besan Village, Dawan District, Klungkung Regency. However, the sustainability of this household-based enterprise faces multifaceted challenges related to economic, social, environmental, institutional, and technological aspects. This study aims to assess the current sustainability status, identify the most influential attributes, and formulate improvement scenarios for household-scale coconut sugar enterprises. A mixed-methods approach was employed, utilizing primary data collected through questionnaires distributed to 15 key informants, supported by relevant secondary data. The data were analyzed using the Multiaspect Sustainability Analysis (MSA) method.

The application of MSA in this study offers a holistic evaluative framework for assessing the sustainability of small-scale, local agro-industries—an approach that has rarely been applied to traditional production systems such as coconut sugar. The results show that the current sustainability level falls into the low category, with a score of 44.56. Sensitive attributes include environmental pollution, financial record-keeping, social security, access to financing, and digital marketing adoption. The first improvement scenario raised the score to 70.51, indicating a sustainable status, while the second scenario achieved 88.47, categorized as very sustainable.

These findings provide empirical foundations for policy formulation and development strategies to strengthen the long-term sustainability of household-based coconut sugar enterprises in rural areas.

INTRODUCTION

Household-based coconut sugar enterprises continue to serve as a vital component of traditional agroindustry, maintaining their relevance amidst the ongoing modernization of national food systems (Ariesa, 2012). In Indonesia, coconut sugar plays a strategic role as both a staple food product and a primary source of livelihood for rural communities. Research conducted by (Kusumadewi et al., 2022) indicates that the coconut sugar industry contributes the highest proportion to household income among members of the KWT Sari Kelapa women's farmer group in Besan Village, Dawan District, Klungkung Regency. Besan Village in Dawan District, Klungkung Regency, is recognized as one of the primary centers of coconut sugar production in Bali, with 134 farmers recorded in 2025 (Data Kepala Desa, 2025). The abundant availability of coconut sap supports the development of this agroindustry as an integral component of the local agribusiness system.

Previous studies have demonstrated the significant contribution of the coconut sugar agroindustry to household income. (Prasetiyo et al., 2018) found that processing coconut sap into coconut sugar generates an average monthly income of IDR 560,089. (Saleh, 2014) in his research in Tulo'a Village, Bone Bolango Regency, reported a Revenue-to-Cost (R/C) ratio of 2.12, indicating the economic feasibility of this enterprise. Similarly, Ramadani & Br, (2017) concluded that coconut sugar MSMEs in Sumberingin Village, Blitar Regency, operate efficiently and are viable for continued development. In Besan Village, (Kusumadewi et al., 2022) reaffirmed that the coconut sugar industry is the leading contributor to household income for members of KWT Sari Kelapa.

Despite its importance, the sustainability of coconut sugar enterprises in Besan Village faces several challenges. From an economic perspective, business operators have yet to implement systematic financial record-keeping, making it difficult to evaluate performance and support sound decision-making. Socioculturally, the absence of social security protections for workers increases the risk of occupational hazards, which has led to a decline in the number of coconut sap tappers. Ecologically, the use of firewood as fuel contributes to environmental degradation. Furthermore, the lack of digital marketing efforts hinders efforts to enhance brand awareness for Besan's coconut sugar products. Institutionally, limited access to financing presents a major barrier to sustainable enterprise development.

Previous studies have assessed the sustainability of commodity-based enterprises using various methods, such as Multi-Dimensional Scaling (MDS) (Khuswati, Pudjiastuti, & Sumarno, 2022) and SWOT analysis (Putra Adnyana, Panjaitan, Astiti, & Hipi, 2020). However, these approaches often address only specific aspects in isolation and have yet to integrate the five dimensions of sustainability, ecological, economic, sociocultural, institutional, and technological, within a unified framework. In this context, the Multi-Aspect Sustainability Analysis (MSA) method stands out for its ability to evaluate sustainability holistically and systematically, offering a comprehensive picture of enterprise conditions (Firmansyah, 2022).

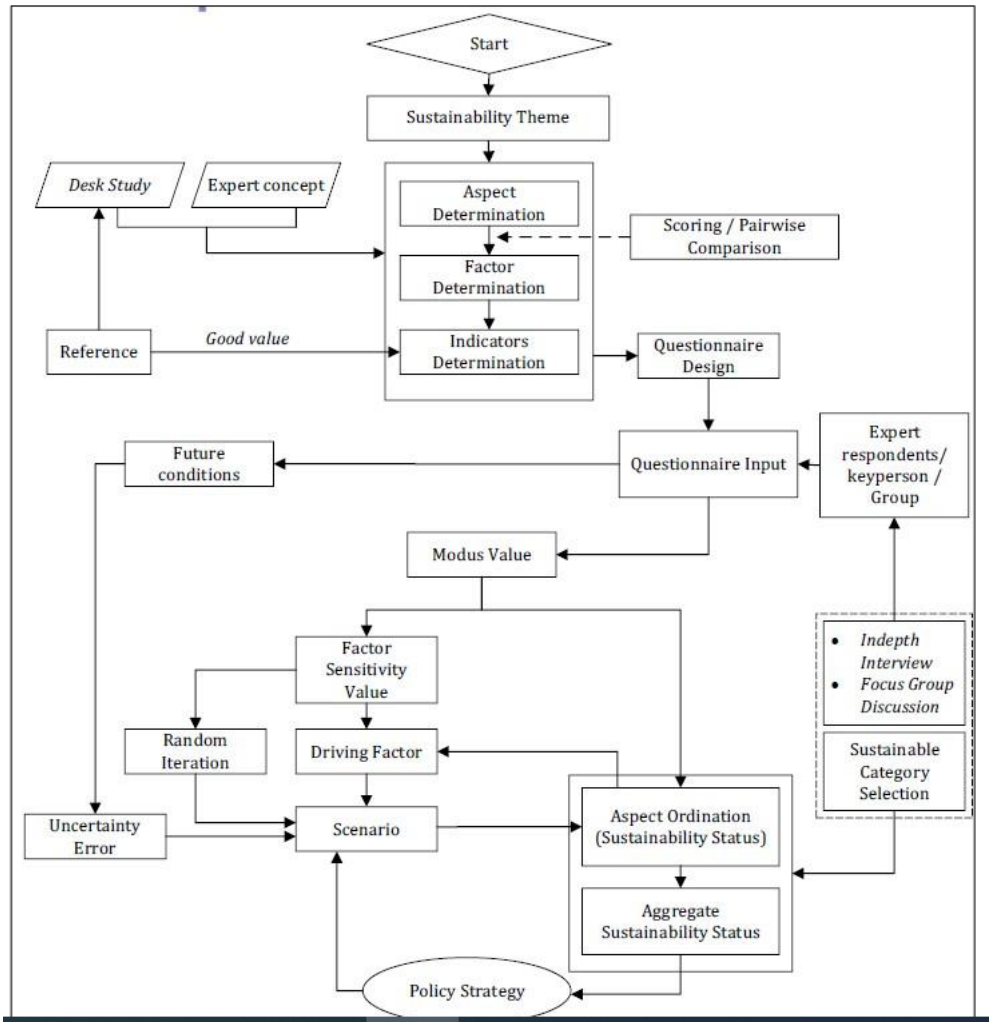
Accordingly, this study aims to contribute to scholarly discourse through the application of the MSA method to household enterprises based on local commodities. This area remains underrepresented in academic research. It also seeks to identify the most sensitive attributes affecting sustainability and to formulate development scenarios that are aligned with local conditions. The specific objectives of this study are: 1) to analyze the sustainability status of coconut sugar enterprises in Besan Village, Dawan District, Klungkung Regency; 2) to identify the sensitive attributes influencing the sustainability of coconut sugar enterprises in Besan Village, Dawan District, Klungkung Regency; and 3) to develop effective scenario-based recommendations to enhance the sustainability status of these enterprises.

Through this approach, the study is expected to provide tangible contributions to the ongoing efforts to sustain coconut sugar enterprises in Besan Village and to serve as a reference for future policy development and empowerment programs.

RESEARCH METHODS

This study employs a descriptive quantitative approach with a case study focused on household-based coconut sugar enterprises in Besan Village, Dawan District, Klungkung Regency, Bali Province. Data collection involved 15 key informants representing diverse backgrounds, including coconut sugar producers, representatives from relevant government agencies, and MSME facilitators, forming a heterogeneous group. This number is considered sufficient to represent the actual field conditions, as the diversity of informants enables the collection of in-depth and comprehensive information on the sustainability of coconut sugar enterprises in Besan Village. This aligns with the principles of qualitative research, which prioritize the depth of data over its quantity (Guest et al., 2006). Key informants were selected purposively, taking into account their knowledge, experience, and strategic roles within the value chain. To reduce perceptual bias, data triangulation was conducted through interviews, observations, focus group discussions (FGDs), and validation of official documents. Secondary data were gathered from various documented sources, including official government reports, data from Statistics Indonesia (BPS), and relevant academic and policy literature. The sustainability of coconut sugar enterprises in Besan Village was examined across five dimensions and 44 attributes. These attributes were determined through literature review and consultations with experts and local stakeholders, thereby enhancing the research's validity.

Data analysis was conducted using the Multi-Aspect Sustainability Analysis (MSA) method, operated through ExSimpro software, a methodological innovation derived from the enhanced RAPFISH technique (Firmansyah, 2022). MSA is a rapid assessment tool that integrates both quantitative and qualitative information to measure and map sustainability status based on predetermined aspect-indicators. In a broader context, Cinelli et al. (2024) classify MSA as part of the Multi-Criteria Decision Analysis (MCDA) framework, which has been extensively applied in sustainability studies related to the food and agribusiness sectors. MCDA, including MSA within it, is regarded as an effective approach to addressing the complexity of interactions among economic, social, environmental, and institutional dimensions. Furthermore, this method allows for the integration of local wisdom and scientific considerations into a unified and structured assessment system. The analysis yields several key parameters, including overall (aggregate) sustainability scores, aspect-specific sustainability values, future sustainability projections, key driving factors, levels of uncertainty, and recommended policy scenarios. The detailed steps of the analysis are illustrated in the figure below:



Source: Firmansyah (2022)

Figure 1 Conceptual Framework of the Multi-Aspect Sustainability Analysis (MSA) Approach

Each factor is assessed using an ordinal scale, which is then normalized into a sustainability index ranging from 0 to 100. These index scores are subsequently classified into four levels of sustainability, as shown in the following table:

Table 1
Sustainability Criteria for Coconut Sugar Enterprises

Value	Status Sustainability
0-25	Unsustainable
>25-50	Low Sustainable
>50-75	Sustainable
>75-100	Very Sustainable

Source: Firmansyah (2022).

According to Firmansyah (2022), the classification of sustainability status into four categories is considered an ideal approach in MSA-based studies, as it allows for a proportional distinction between negative extremes, transitional phases, and positive sustainability outcomes.

The identification of the most influential (sensitive) attributes was conducted through a combination of leverage analysis, sensitivity simulations, and substantive

evaluation across sustainability dimensions. An attribute is categorized as sensitive when it possesses a high leverage score, reflecting its significant contribution to changes in the sustainability index value. In addition, sensitivity testing using random simulation techniques (Monte Carlo) was conducted to evaluate the stability of results in the presence of attribute value variations. Attributes demonstrating a substantial effect on modal values, with deviations within the tolerance range, less than ±0.5 for the index and less than ±10% for sustainability status, are considered key determinants. These determinations were further examined through uncertainty analysis and evaluated for both theoretical and practical relevance across the five sustainability dimensions: economic, sociocultural, ecological, technological, and institutional (Firmansyah, 2022; Sutrisno et al., 2019). Consequently, sensitive attributes are prioritized in the formulation of policies and strategies to enhance sustainability.

Scenario simulations were conducted as part of the extended MSA analysis to measure the impact of improving sensitive attributes on the sustainability of household-based coconut sugar enterprises. In MSA, scenarios can be developed based on sustainability status values and leverage factors identified through analysis (Paulus et al., 2023). This study adopts a tiered scenario approach with two categories: Scenario 1, representing moderate improvement of sensitive attributes, and Scenario 2, reflecting optimal enhancement of these attributes. Scenario 1 involves improvements to 15 of the most sensitive attributes, while Scenario 2 addresses 18 sensitive attributes. The values of these attributes were adjusted to their ideal category and re-analyzed using ExSimpro software. Simulation results were compared with actual index scores to strategically assess the potential for improvement.

RESULTS AND DISCUSSION

1. Sustainability Value and Status

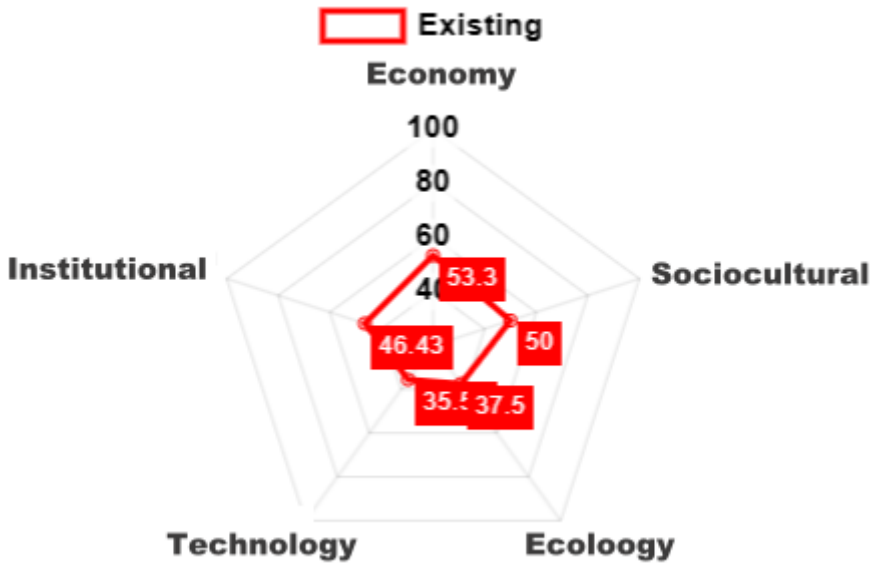
The sustainability status of coconut sugar enterprises in Besan Village was assessed across five key dimensions: ecology, economy, sociocultural, institutional, and technology. Within these dimensions, several attributes were identified, measured, weighted, and analyzed using the Multi-Aspect Sustainability Analysis (MSA) method. The results of the sustainability status analysis are presented in the following table:

Table 2
Sustainability Status Score

No	Aspect	Existing Condition
(1)	(2)	(3)
1.	Economy	53.3
2.	Sociocultural	50
3.	Ecology	37.5
4.	Technology	35.57
5.	Institutional	46.43
Average		44.56
Sustainability Status		*Low Sustainable*

Source: Primary Data Processed (2025)

As shown in Table 2, the average sustainability score for coconut sugar enterprises in Besan Village is 44.56, which falls within the low sustainable category. A graphical representation of the sustainability status for each aspect is presented below.



Source: Processed Primary Data (2025)

Figure 2

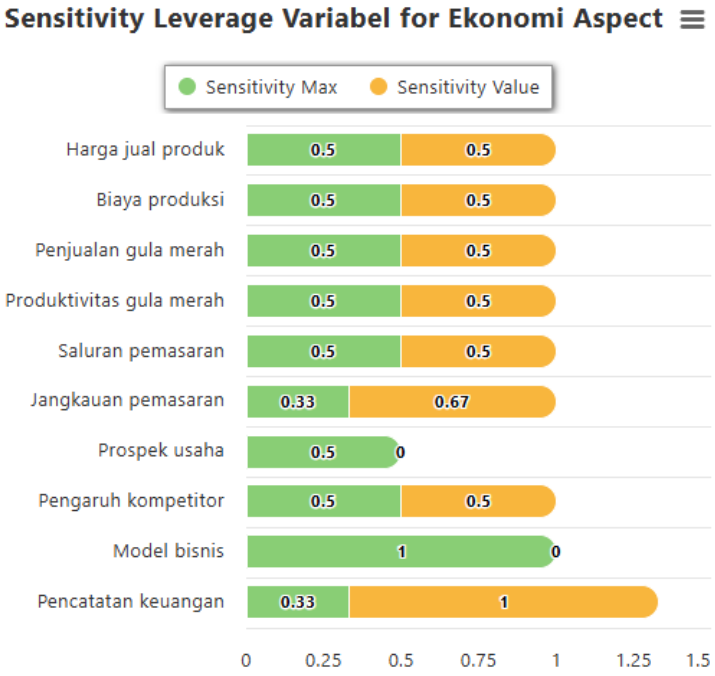
Graph of Field Sustainability Status (Existing Conditions)

Based on the table and figure above, the economic aspect scored the highest with a value of 53.3, placing it in the sustainable category. The technological aspect received the lowest score of 35.57, falling into the less sustainable category. Other aspects also classified as less sustainable include the sociocultural aspect (50.0), ecological aspect (37.5), and institutional aspect (46.43). These findings align with previous studies on smallholder coffee farming in Silo District, Jember, which also identified ecology, technology, and institutional dimensions as the least sustainable. Such similarities indicate that challenges in the ecological and technological dimensions are not unique to a specific enterprise type but are common across various small-scale agribusiness ventures. Therefore, targeted improvements are necessary, such as enhancing business actors' capacity to utilize appropriate technologies, improving waste management, and promoting environmentally friendly practices. Support from government agencies, partner institutions, and collaboration among entrepreneurs will play a crucial role in building a more sustainable business system in the future.

2. Sensitive Attributes

Sensitive attributes are identified through the calculation of variable sensitivity leverage within each aspect. The results of the sensitivity leverage analysis for each aspect of the sustainability of coconut sugar enterprises in Besan Village, Dawan District, are presented in the figures below:

Sensitive Attributes in Economic Aspect

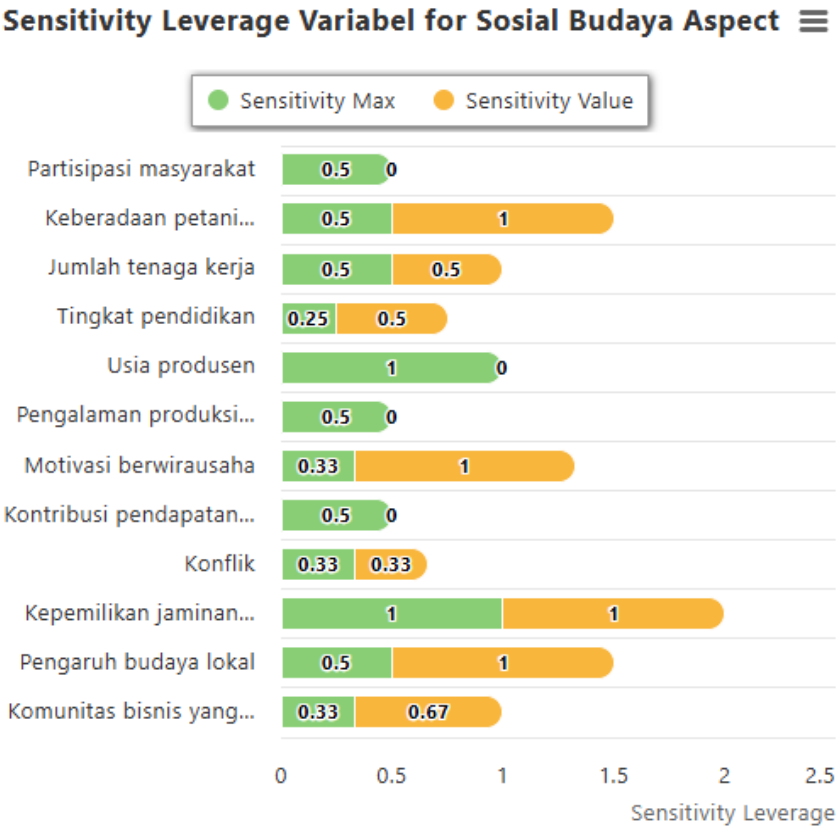


Source: Processed Primary Data (2025)

Figure 3
Sensitivity Leverage in Economic Aspect

Based on the results of the sensitivity leverage analysis for variables within the economic aspect, financial record-keeping is identified as the most sensitive indicator in the economic sustainability of coconut sugar enterprises in Besan Village. Most producers lack adequate understanding of the importance of basic financial documentation, including an unawareness of calculating the Cost of Goods Manufactured (COGM), recording operational expenses, and separating household and business finances. This condition reflects weak managerial capacity, particularly in financial management, which has direct implications for business continuity. These findings align with prior studies by Permatasari et al., (2023) and Mulyani, Nurhayaty, & Miharja, (2019), which highlighted the low financial literacy among MSME actors, characterized by limited training, a habit of recording transactions from memory, and mixing personal and business assets. The distinctiveness of this study lies in identifying the direct impact of inadequate financial record-keeping on coconut sugar producers' access to formal financing such as the People's Business Credit (KUR), as emphasized by Nisya & Firdaus, (2023). Therefore, financial record-keeping serves not only as an administrative obligation but also as a strategic element underpinning the economic sustainability of coconut sugar enterprises.

Sensitive Attributes in the Socio-Cultural Aspect



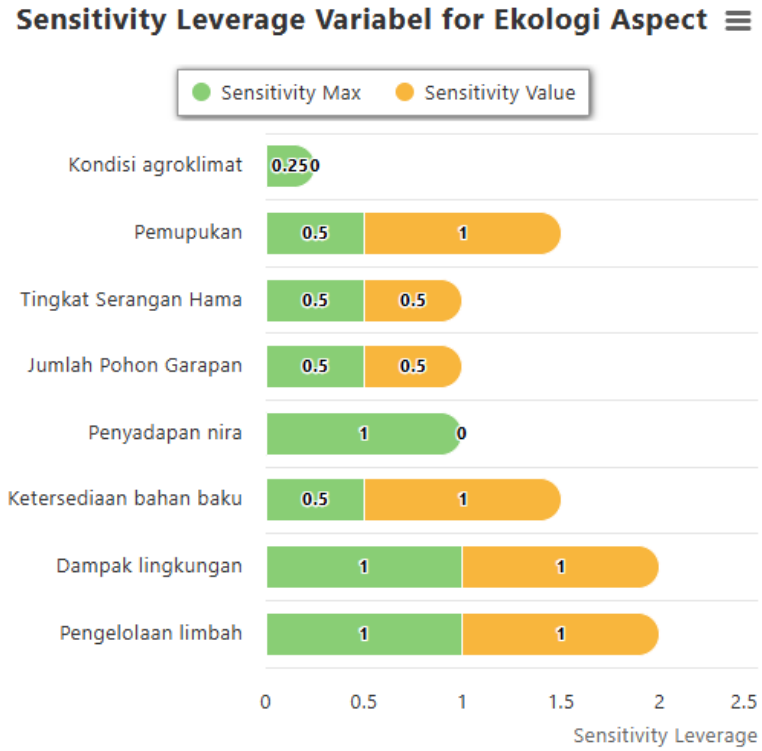
Source: Processed Primary Data (2025)

Figure 4

Sensitivity Leverage in the Sociocultural Aspect

The results of the sensitivity leverage analysis reveal that the attribute of social security ownership, measured through participation in the Workers Social Security Program (BPJS Ketenagakerjaan), is the most sensitive variable in the socio-cultural aspect of coconut sugar enterprise sustainability in Besan Village. Information from village authorities and women farmers' groups (KWT) indicates that limited understanding and confusion between the Workers and Health Social Security programs are the primary causes. Law No. 24 of 2011 mandates all workers, including those in the informal sector, to enroll in this program. The absence of social security increases vulnerability to occupational risks and economic pressures, such as income loss due to workplace accidents (Azis, et al., 2024). Support for social security programs has been proven to have a positive influence on business continuity, as noted in research by (Hasanah, 2020), which found that low participation in social security led to a decline in active coconut sap tappers and disrupted sap supply. Thus, the attribute of social security ownership is a crucial element in the socio-cultural dimension, as it directly relates to the sustainability of the sap tapping profession and the stability of the local coconut sugar enterprise system.

Sensitive Attributes in the Ecological Aspect



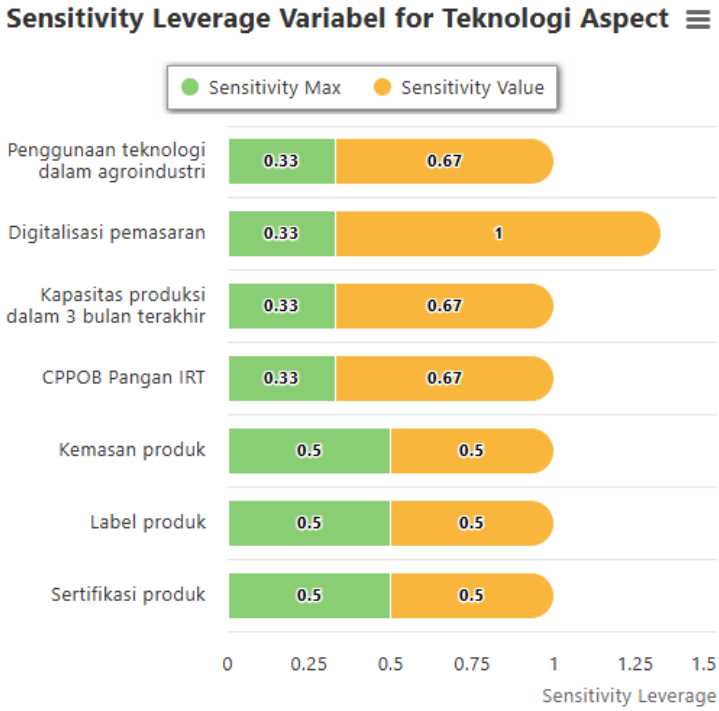
Source: Processed Primary Data (2025)

Figure 5

Sensitivity Leverage in the Ecological Aspect

According to the sensitivity leverage analysis in the ecological aspect using the Multi-Aspect Sustainability Analysis (MSA) approach, environmental impact is identified as the most vulnerable attribute affecting the sustainability of coconut sugar enterprises in Besan Village. This attribute is evaluated through the type of energy used in the coconut sap boiling process, where field observations reveal that the majority of producers still rely on firewood. Continuous use of firewood for boiling poses risks of deforestation, environmental degradation, and increased greenhouse gas emissions. This practice contradicts the principles of the Sustainable Development Goals (SDGs), particularly Goals 12 and 13. These findings are consistent with the study by Nugroho et al. (2024), which indicated that the use of conventional fuels in rural MSME sectors exerts significant pressure on the environment. Additionally, the ecological impacts of poorly managed solid and liquid waste can reduce soil and water quality, directly affecting the productivity of coconut trees. (Prasetyo et al, 2019) also emphasized that negligence in environmental aspects not only reduces business competitiveness but also increases the risk of regulatory sanctions and erosion of consumer trust. Therefore, transitioning toward clean and environmentally friendly technology is an urgent necessity in ensuring the holistic sustainability of coconut sugar enterprises.

Sensitive Attributes in the Technological Aspect



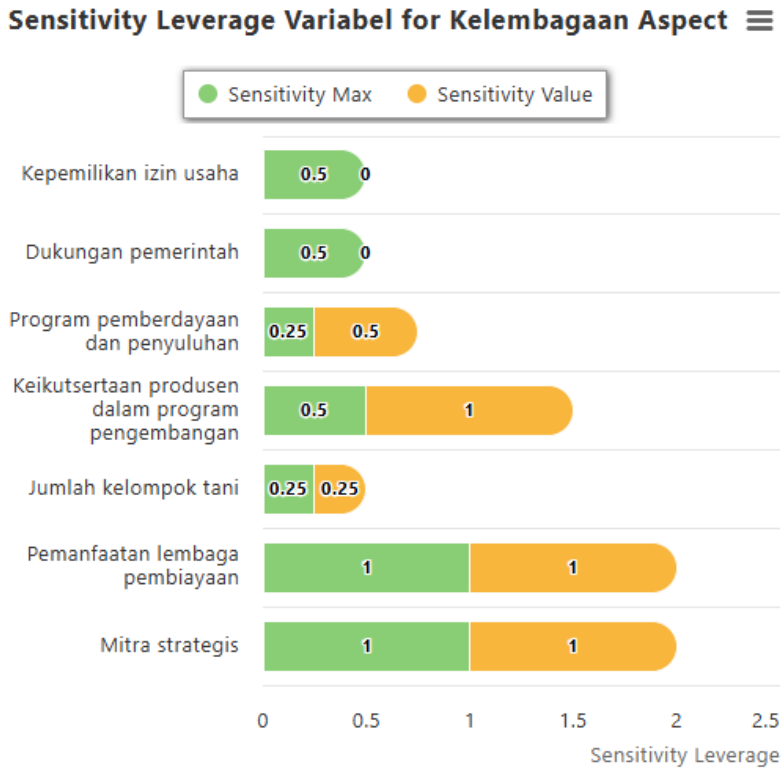
Source: Processed Primary Data (2025)

Figure 6

Sensitive Attributes in the Technological Aspect

The analytical findings indicate that digital marketing represents the most critical element influencing the technological sustainability of coconut sugar enterprises in Besan Village. This aligns with the study by (Wafa et al., 2024) which asserts that digital marketing plays a vital role in assisting micro, small, and medium enterprises (MSMEs) in adapting to shifting consumer behavior and enhancing operational efficiency through expanded market reach. Based on data and focus group discussions (FGDs), it was revealed that the majority of producers lack adequate understanding and have not yet implemented digital marketing strategies, continuing instead to rely on traditional methods. This condition results in limited market reach and low brand awareness of Besan Village's signature coconut sugar products. These findings are consistent with research conducted by Universitas Teknokrat Indonesia (2024), which emphasized that MSMEs' capacity to adopt digital technology, particularly in marketing strategies, is a key determinant of business sustainability amidst changing consumption patterns. On the other hand, weaknesses in digitalization have exacerbated the market position of Besan's coconut sugar products due to the proliferation of counterfeit products. This underscores the critical importance of digital marketing strategies not only in building brand awareness but also in protecting product authenticity, as explained by Mokoagow et.al., 2025. Furthermore, digital transformation also contributes to greater efficiency in production processes and operational management. Therefore, the adoption of digitalization is no longer merely a strategic option but a pressing necessity for MSMEs to remain adaptive and competitive in today's dynamic digital marketplace.

Sensitive Attributes in the Institutional Aspect



Source: Processed Primary Data (2025)

Figure 7

Sensitive Attributes in the Institutional Aspect

Based on the analysis, the utilization of financial institutions emerges as the dominant factor influencing the institutional sustainability of coconut sugar enterprises in Besan Village. The results of the FGD show that most producers still rely on informal financing sources such as family loans or community savings groups (arisan) and have not yet accessed funding programs offered by formal financial institutions. This finding aligns with the study by Mualim Hasibuan, (2024) which revealed that limited access to formal financing compels MSMEs to operate predominantly within the informal sector, relying heavily on informal financial sources. This issue is further supported by data from the Bali Provincial Office of Cooperatives and MSMEs (2023), indicating that the distribution of credit remains concentrated among formal-sector MSMEs, while most MSMEs in Bali still fall into the informal category. Low financial literacy, a lack of supporting business documentation, and complex administrative procedures are identified as primary barriers that prevent artisans from accessing formal financing, an issue echoed by multiple studies. Access to formal financing has a direct impact on producers' ability to adopt technology, obtain product certifications, and withstand market fluctuations. These findings are consistent with research by Muharoma (2024), which highlights the importance of financial literacy in MSME financial management, identifying low literacy as a key barrier to accessing formal financing and, ultimately, affecting business sustainability. Hence, improving access to formal financial institutions is crucial to strengthening the institutional structure and long-term viability of coconut sugar enterprises in the region.
These sensitive attributes will then be scenario-based to analyze the level of improvement in the sustainability status of the brown sugar business in Besan Village.

3. Scenarios for Improving Sustainability Status

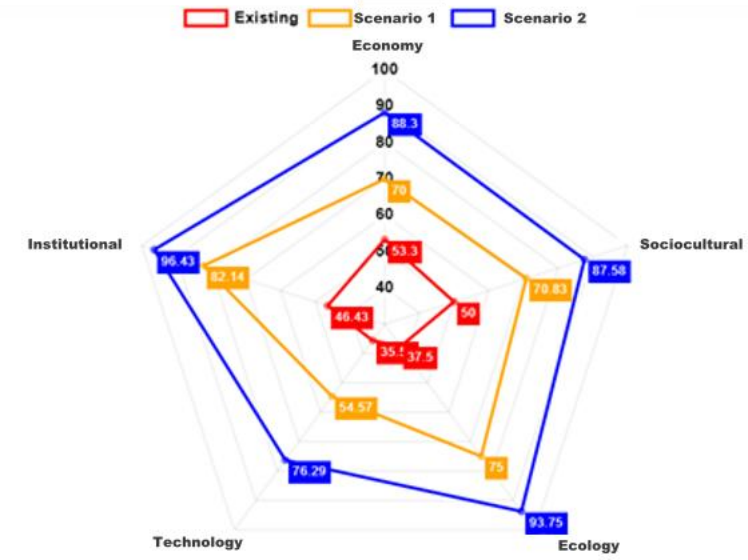
Sustainability enhancement scenarios are designed to ensure that all sustainability aspects—ecological, economic, socio-cultural, institutional, and technological—are optimally and equitably managed. The most sensitive attributes are incorporated into the sustainability analysis of coconut sugar enterprises in Besan Village, Dawan District, using two scenarios and three driving factors. Scenario 1 simulates improvements in 15 prioritized sensitive attributes within sustainability aspects, while Scenario 2 simulates improvements in an extended set of 18 prioritized attributes. The results of these sustainability improvement scenarios for coconut sugar enterprises in Besan Village, Dawan District, Klungkung Regency, are presented in Table 3:

Table 3
Sustainability Values Based on Scenario Simulation

No.	Aspek	*Existing*	Skenario 1	Skenario 2
(1)	(2)	(3)	(4)	(5)
1	Ekonomi	53,3	70	88,3
2	Sosial Budaya	50	70,83	87,58
3	Ekologi	37,5	75	93,75
4	Teknologi	35,57	54,57	76,29
5	Kelembagaan	46,43	82,14	96,43
Total *Average*		44,56	70,51	88,47
Status *Sustainability*		*Low Sustainable*	*Sustainable*	*Very Sustainable*

Source: Processed Primary Data (2025)

Based on Table 3, it can be concluded that the sustainability status of coconut sugar enterprises in Besan Village, Dawan District, has improved from a current condition of low sustainability to sustainable under Scenario 1 and very sustainable under Scenario 2. A comparative visualization of the improvement in sustainability status is illustrated through the sustainability graph in Figure 3.



Source: Processed Primary Data (2025)
Figure 8
Sustainability Graph Scenario

Based on Figure 4, the sustainability graph illustrates a comparison between two scenarios across five sustainability dimensions: ecological, economic, socio-cultural, institutional, and technological. The red color represents the existing condition, orange denotes Scenario 1, and blue indicates Scenario 2. The sustainability graph reveals that Scenario 2 achieves the highest scores across all dimensions, thereby representing the most optimal option for enhancing sustainability compared to the other scenarios. Drawing from Table 3 and Figure 4, it is evident that the sustainability status of coconut sugar enterprises in Besan Village, Dawan District, Klungkung Regency, improved from 44.56 (low sustainable) to 70.51 (sustainable) under Scenario 1. Under Scenario 2, the sustainability status further increased to 88.47 (very sustainable).

The prioritization of these scenarios was developed as a strategic effort to optimize each sustainability aspect in the coconut sugar industry in Besan Village. According to (Firmansyah, 2022), the effectiveness of Scenario 2 must be demonstrated by values that are at least twice as high as those of Scenario 1. If the ratio of ΔS2S/ΔS1S exceeds 2, Scenario 2 is considered more effective for improving the targeted aspect. Conversely, if ΔS2S/ΔS1S < 2, Scenario 1 is deemed more feasible and practical to implement for improving that aspect (Paulus et al., 2023). The prioritization of sustainability scenarios for each aspect is presented in Table 4:

Table 4
Sustainability Scenario Prioritization

Aspek	ΔS1S	ΔS2S	ΔS2S/ ΔS1S
(1)	(2)	(3)	(4)
Ekonomi	16,7	35	2,1
Sosial Budaya	20,83	37,58	1,8
Ekologi	37,5	56,25	1,5
Teknologi	19	40,72	2,14
Kelembagaan	35,71	50	1,4
Average Scenario Priority			1,79

Source: Processed Primary Data (2025)

Based on the scenario simulation results in Table 4, the average ratio between Scenario 2 and Scenario 1 compared to the existing condition is 1.79. This finding suggests that Scenario 1 is more effective in enhancing the sustainability of coconut sugar enterprises in Besan Village when compared to Scenario 2. Thus, Scenario 1 is recommended as the preferred policy direction for sustainability improvement efforts.

CONCLUSION

This study reveals that the sustainability status of household-scale coconut sugar enterprises in Besan Village falls within the low sustainable category. The technological aspect is identified as the weakest dimension of sustainability, primarily due to low scores in the digital marketing attribute. Most entrepreneurs lack sufficient understanding and implementation of digital marketing strategies, resulting in weak brand awareness of Dawan's signature coconut sugar products. This highlights the critical importance of digital marketing for MSMEs in enhancing product competitiveness.

Sensitive attributes across all aspects, such as environmental impact, access to social security, utilization of financial institutions, and financial recordkeeping, also significantly affect the long-term sustainability of coconut sugar enterprises. Recognizing these attributes allows policymakers and business actors to more effectively manage the critical elements that determine the success of coconut sugar businesses.

Scenario 1 is recommended as the most appropriate development approach for coconut sugar enterprises in Besan Village, as it is grounded in robust empirical analysis (Table 4) and aligned with the actual conditions and needs of producers. Additionally, this scenario corresponds with government policy directions and available funding opportunities. It is expected that this strategy will enhance business actor participation and reduce resistance during implementation.

From a methodological perspective, this study expands the application of the Multi-aspect Sustainability Analysis (MSA) approach within the context of household-scale agro-industries in local communities. The method has proven effective in identifying key influencing factors and formulating comprehensive scenario simulations. Therefore, the MSA approach holds potential as a reference for designing locally based agribusiness policy strategies. These findings also contribute to the academic discourse on agribusiness sustainability, particularly by emphasizing the need for synergy across the economic, ecological, socio-cultural, technological, and institutional dimensions to foster resilient and sustainable MSMEs

RECOMMENDATIONS

Based on the simulation results, Scenario 1 is the most realistic option for short-term implementation. Initial interventions should focus on the five most sensitive attributes across each sustainability aspect, as these play a strategic role in enhancing the sustainability of coconut sugar enterprises.

In the technological domain, local governments and support institutions are advised to develop training programs focused on the use of digital marketing platforms, especially those integrated with community-based marketplaces (e.g., village-owned enterprises or BUMDes platforms). To support these initiatives, intensive assistance from PLUT-KUMKM Klungkung Regency is essential, considering that regional product development is one of the agency's ten core services. PLUT's involvement is expected to strengthen training processes, facilitate legal compliance, and expand market access, thereby enabling the development of coconut sugar enterprises in Besan Village to proceed in a more directed and sustainable manner.

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