

Micro Small Enterprises Sustainability Strategy in Badung Regency with Bayesian Network Analysis of Community-Driven Factors

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ABSTRACT

Micro Small Enterprises (MSE' s) are vital to the Balinese economy, providing substantial benefits to local communities, the economy, and cultural preservation. In Badung Regency, small micro enterprises in the culinary sector have particularly supported the community by meeting daily needs amid pandemic-related restrictions that have led to job losses and workplace closures, prompting many to shift towards the culinary industry. As a result, there has been a notable increase in the number of MSE' s, especially in the culinary sector. However, despite this important role, MSE's are facing challenges as the economy begins to recover. Post-pandemic, many have experienced declines due to various internal and external hurdles and uncertainties. This study aims to conduct a strengths analysis and explore the most suitable scenarios or combinations of scenarios for participatory sustainable management. It seeks to examine the interplay between different components of MSE' s management, particularly within the culinary sector, as well as the external and internal conditions that affect them, along with the complex dynamics between human systems and the environment. Emphasizing the necessity of embracing uncertainty in the development of MSE' s, the study employs Bayesian network analysis as a suitable analytical approach to meet its research goals. Ultimately, the findings underscore that the sustainability of MSE' s, particularly in the culinary sector of Badung Regency, is influenced by factors such as community support, purchasing behavior, and partnerships.

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1. Introduction

Micro, Small, Enterprises (MSE's) are crucial to the Balinese economy, offering substantial benefits to local communities, the economy, and cultural preservation. It is essential for MSEs to embrace sustainable business practices that safeguard the environment, uphold cultural heritage, and strengthen the local economy. The significance of ensuring the sustainability of MSEs can be summarized as follows: (1) they significantly contribute to regional income (GRDP); (2) they create job opportunities, which helps reduce unemployment; and (3) they play a vital role in helping communities endure during the pandemic. (Noviati, 2022)

In the realm of MSE sustainability, both internal and external factors play a crucial role. Internal factors encompass elements such as human resources, financial management, technical and operational capabilities, as well as market dynamics and marketing strategies. Conversely, external factors include government policies, social conditions, and environmental considerations. (Prasetyo, 2023)

Sustainability in Culinary MSE's also entails an environmentally friendly approach, where aspects like the use of eco-friendly raw materials and effective waste management are vital in achieving sustainability objectives. On the other hand, external factors such as supportive government initiatives and public environmental awareness can significantly influence MSE sustainability.

Furthermore, internal elements like employee skills and knowledge, along with the capital and technology available to MSE's, can impact long-term sustainability. By considering these internal and external factors, entrepreneurs can formulate effective strategies to meet sustainability goals and reinforce their market position.

One type of Micro Small Enterprises (MSE's) is the culinary business, which plays a vital role in the local economy. During the COVID-19 pandemic, culinary businesses encountered significant challenges. However, many have not only survived but also thrived by adopting effective strategies and innovations.

Lim(2020) the COVID-19 pandemic has necessitated innovative strategies among culinary businesses to ensure survival and adapt to changing consumer behaviors.

MSE's in the culinary sector present numerous opportunities for entrepreneurs to innovate and cater to the needs of local consumers and tourists alike.

(Claudya et al.,2022) Culinary tourism plays a crucial role in attracting visitors to Badung Regency, enhancing their overall experience by showcasing the rich flavors and traditions of Balinese cuisine. By integrating local culinary experiences into tourism strategies, Badung Regency can further enhance its appeal and promote cultural preservation among visitors.

Badung Regency, situated in Bali Province, is recognized as a major tourism and culinary hub on the Island of the Gods. The culinary landscape in Badung is diverse, featuring a variety of food types and restaurant concepts that attract both locals and tourists. Observations by the Badung Regency government during the pandemic revealed notable growth in the culinary industry, particularly in terms of quantity and innovation. Several key factors and trends contributed to this development during the pandemic, including:

1. **Business Model Adaptation.** Many culinary businesses transitioned to delivery and takeaway services to accommodate restrictions on dine-in dining, prioritizing food delivery to customers' homes. Additionally, partnerships with online platforms, such as Gojek, Grab, and local delivery services, have enabled culinary businesses to reach a broader customer base.
2. **Menu and Product Innovation.** Culinary businesses introduced family meal packages designed for gatherings as a practical solution for social restrictions. There was also a rise in healthy and immune-boosting food options to meet the growing health concerns of consumers.
3. **Technological Adoption.** Online ordering systems have become increasingly common, allowing customers to conveniently order food from home. Contactless payment

systems were also implemented to minimize physical interaction and enhance security.

4. Digital Marketing and Communication. Culinary businesses leveraged digital promotions through social media, email marketing, and online campaigns to maintain connection with customers and inform them about new offers and updates. Additionally, transparency regarding safety measures and health protocols has been crucial in building customer trust.

Following the COVID-19 pandemic, Badung Regency experienced a decline in both the number of culinary businesses and MSE's overall. In the post-pandemic context, MSEs in Bali face multifaceted challenges and opportunities that affect their long-term sustainability. The pandemic caused substantial disruptions, including revenue losses, capital depletion, and interruptions in supply chains. Concurrently, shifts in consumer behavior such as the increased adoption of digital platforms, heightened attention to health and safety standards, and a preference for sustainable and locally sourced products necessitate strategic adaptation. Post-pandemic recovery efforts, supported by government initiatives, digitalization programs, and community-driven economic revitalization, provide new avenues for resilience and growth. The gradual resurgence of tourism further presents opportunities for MSE's to engage both domestic and international markets. To ensure sustainable recovery, MSE's must enhance financial literacy, adopt technological innovations, diversify market strategies, and integrate environmentally and culturally sustainable practices. Such measures are critical not only for short-term resilience but also for the long-term competitiveness and cultural preservation of the Balinese economy.

This downturn was driven by various factors that impacted all economic sectors, including an economic and financial crisis that led to reduced income, challenges in accessing financing, business closures, intensified competition, and shifts in consumer behavior and operational practices.

Given these circumstances, the sustainability of culinary businesses in Badung Regency remains uncertain, with the specific variables influencing this sustainability not yet fully understood. This study seeks to test various factors that may determine the sustainability of culinary businesses in the region. The goal is to identify effective sustainability strategies and analyze the challenges encountered in implementing these practices while exploring opportunities to enhance the sustainability of culinary enterprises in Badung Regency.

Previous research on the sustainability of culinary MSE's in Badung Regency has not sufficiently addressed the complex interactions and uncertainties in decision-making related to managing these businesses. By utilizing Bayesian network analysis, this study aims to capture this complexity, marking a pioneering effort to assess sustainability in Badung Regency.

From the scenario outlined above, two primary issues regarding sustainability strategies in Badung Regency emerge:

1. How can the sustainability of MSE's in the culinary sector be maintained in light of uncertainties, particularly given the strong inclination of Badung residents to prioritize tourism over entrepreneurship?
2. What are the complex interactions and uncertainties among the variables that influence the sustainability of MSE's in the culinary sector of Badung Regency?

This article builds upon two previous studies conducted by researchers that examined the changing landscape of sustainability for MSE's in the culinary sector. Both studies employed the Multipol framework, a prospective analysis technique focused on identifying and evaluating different actions, criteria, and policies for scenario development. However, recognizing the lack of completeness and specificity in the scenarios identified previously, this study applies the Bayesian network method, which provides a visual representation of the scenario development process to understand the shifts occurring within culinary MSE's. The structure of this paper consists of five sections. Following the introduction, Section 2 presents a literature review. Section 3 outlines the research location, materials, and methodologies employed in the study. Section 4 discusses the research results, and Section 5 offers conclusions.

2. Literature Review

To assess the factors influencing the sustainability of Culinary Micro and Small Enterprises (MSE's) in Badung Regency, we first need to identify key variables that affect the management of sustainable Culinary MSE's. Following the approach of Cain (2001), we utilize the Bayesian Network (BN) framework to identify these variables. Within this framework, variables are determined through the interaction of the following elements: objectives, interventions, extra effect variables, implementation factors, regulating factors, and intermediate elements. The way these interact elements is illustrated in the diagram referenced from Cain (2001). (Figure 3)

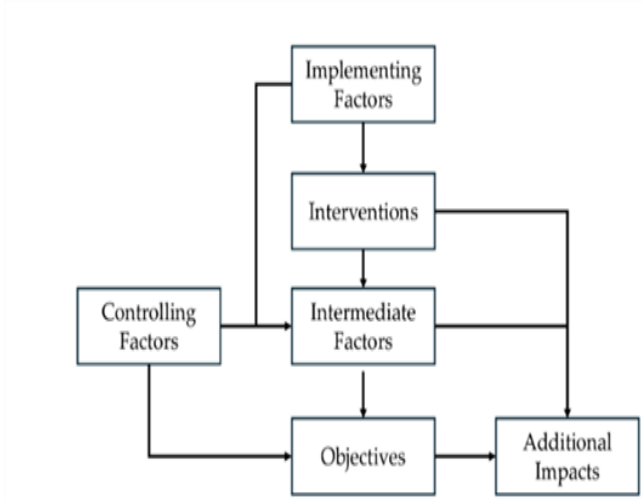


Figure 1. Interaction of BN Variables (Source: Cain, 2001)

Data for this study was gathered through focus group discussions held in the Kuta area of Badung Regency in May 2024. The discussions included twenty participants chosen from various developing Micro and Small Enterprises (MSEs) in the Kuta region (Table 1). Participants represented a diverse group comprising MSE stakeholders from each sub-district, policymakers, training institutions, banking representatives, and academics. Selection criteria for participants included their active engagement in the development and management of

MSEs, their interest in business advancement, and their knowledge of entrepreneurs and the state of MSE development, particularly in the culinary sector within each sub-district of Badung Regency.

Table 1. Participants of Focus Group Discussion

Participant	Number of Persons	Role
Department of Micro & Small Enterprises	One person	Empowerment and Coaching
Department of Industry & Manpower	One person	Development of the Industrial Sector and Increasing the Capacity & Competence of the Workforce
Planning & Development Agency	One person	Short and long-term Development Planning
Micro & Small Enterprises Players	Eight persons	Sharing experiences in running business about business management, challenges and business conditions
Academics	Four persons	Providing relevant insights & information related to the challenges & conditions of MSE's in general
Training Institutions	One person	Providing training in increasing the competitiveness of MSE's
Banking (People's Business Credit)	One person	Financing and mentoring MSE's
Regional Research & Innovation Agency	One person	Supporting & strengthening the MSE's sector in adapting to change & encouraging local economic growth

The focus group discussion (FGD) seeks to identify the key variables influencing the sustainability of culinary MSMEs across each sub-district in Badung Regency, as well as to outline the structure of the Bayesian Network (BN). Figure 4 illustrates the data collection process. In line with the BN framework, variables are sourced from two primary channels: existing secondary data (from prior research and publications) and input from stakeholders involved in the FGD. For this purpose, stakeholders are categorized into two groups. Their feedback is then integrated to establish a network structure agreed upon by the FGD

participants. This integration process includes repeated verification and consensus building to enhance the stability of the network, as shown by the cross-reversal arrows. After reaching a consensus on the BN structure, participants develop a Conditional Probability Table (CPT). The researcher employs this CPT to conduct result analyses using the GeNIe Bayesian 4.1 network software.

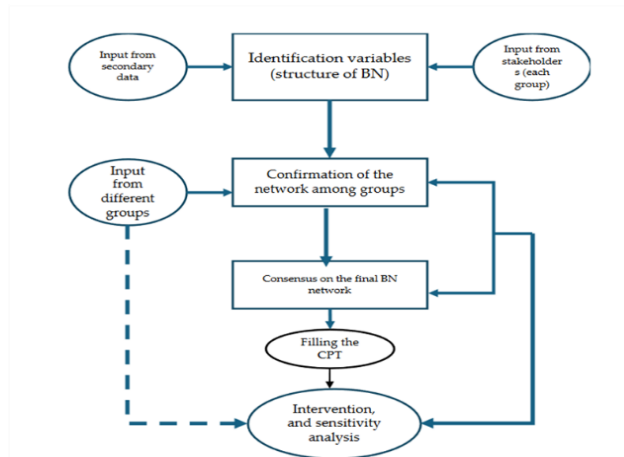


Figure 2. FGD Stages and BN Structure Data Collection (Adapted from Ariyani and Fauzi, 2024)

In this study, participants were invited to modify or add factors based on their insights into managing culinary businesses, utilizing the variable categories established by the Cain system (see Table 2, column 1). After reaching a consensus on the factors, each group then examined the organization or relationships among those factors (Table 2, column 2) and assessed the likelihood of each variable, as explained in Table 2, column 3. The final stage of the focused group discussion aimed to achieve agreement or confirmation on the organized and final likelihoods. The factors listed in Table 2 reflect the collective understanding of the focus group regarding the sustainability of micro and small businesses within the culinary sector in Badung Regency

Table 2. Node variables and measurement

Informant	Node Variable	Measurement
Objective	Sustainability of MSE's	Low, Medium, High
	Price	Low, Medium, High
Intervention	Partnership	Yes, No
Intermediate Factor	Community Purchase	Low, Medium, High
	Product Quality	Low, Medium, High
Controlling factor	Skill	Low, Medium, High
	Land availability	Large, Medium, Small
Implementation	Community Support	Yes, No
Factors	Economic Scale	Low, Medium, High
Additional impact	Competitors	Low, Medium, High
	Product Variation	Low, Medium, High

This study utilized a variety of measurement scales, ranging from discrete categories, like "Yes" and "No," to interval scales, such as "Low," "Medium," and "High." An exception was geographic location, which was defined by the actual land location. For instance, Community Support was recorded as a binary response of "Yes" or "No," reflecting stakeholders' perceptions of the Land Location rather than its size. Likewise, stakeholder engagement was evaluated using a binary scale of "Yes" or "No," providing a quantifiable measure of engagement without a numerical scale. The identification variables included input from secondary data, stakeholder contributions from partnerships, network validation among groups, and consensus on the final Bayesian Network (BN) structure. The intervention process involved conducting sensitivity analysis, though completing the Conditional Probability Tables (CPT) proved challenging. The main focus was on determining stakeholder engagement rather than measuring the extent of that engagement.

3. Research Methods

This study utilizes Bayesian Networks (BN) to identify the factors affecting the sustainability of Micro, Small Enterprises (MSE's) in the culinary sector within Badung Regency. BN is an effective approach for tackling complex issues characterized by uncertainty across variables such as skill, product variation, funding, training, creative ideas, production quality, community purchases, land, and community support. These factors demonstrate the strengths of Bayesian Networks in identifying critical influences. (Jeremey, 2020)

While the application of Bayesian Networks is growing in the culinary MSE's sector, they are used more for analyzing growth within a marketing framework rather than directly supporting the development of culinary MSE's. A key aspect of employing Bayesian Networks is understanding the relationship between skills perception, training, creative ideas, and funding, which together influence product variation(Choi et al., 2013). These networks facilitate an in-depth analysis and prediction of MSE's growth. A key aspect of employing Bayesian Networks is understanding the relationship between skills perception, training, creative ideas, and funding, which together influence product variation. This application of Bayesian Networks is crucial for determining the sustainability factors impacting culinary MSE's.

Bayesian Networks can be visualized as graphical representations that demonstrate causal relationships between factors along with their conditional probabilities. This representation effectively addresses complex problems by merging probabilistic strategies with the clarity of charts that encode these causal links. They can also illustrate conditions among factors, provide concise determinations of joint probability distributions, and depict intricate interactions and causal relationships between variables, expressed through their individual probability densities and conditions as defined by a Conditional Probability Table (CPT). This data can be gathered from observational studies, expert insights, or predictions based on bottom-up modeling results. Bayesian Networks serve as a robust modeling tool, having been successfully applied to various real-world challenges, including business performance. In this study, BNs are employed to identify key factors influencing the success of culinary MSE's and analyze their impacts as a foundation for developing economically viable and competitive enterprises. Bayesian Networks consist of two main components: a qualitative aspect represented by a directed acyclic graph (DAG) that illustrates the relationships among variables, and a quantitative aspect encompassing the probabilities of those variables in the form of a Conditional Probability Table. Figure 2 illustrates the basic structure of a BN, which includes six variables.

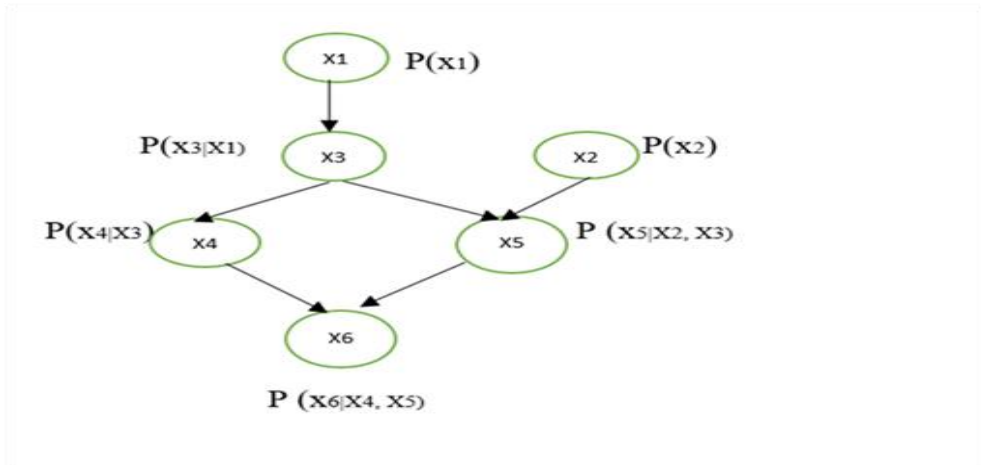


Figure 3. Example of Bayesian Network Structure (Source: Ariyani & Fauzi, 2024)

In Figure 2, the arrow going out from x_1 to x_3 , for example, shows that the probability of being in x_3 depends on the outcome of node x_1 . Similarly, the probability of being in x_5 depends on the outcomes of nodes x_2 and x_3 . The variables x_1 and x_2 are known as the parent variables, and the variables x_3 , x_4 , x_5 , and x_6 are the child variables. Mathematically, the directed acyclic graph (DAG) for variable x_5 , for example, is written as:

$$Pr(x_5) = Pr(x_5 | x_3, x_2) Pr(x_3) Pr(x_2) \quad (1)$$

For a network containing n variables, the probability of a complete BN structure is calculated through the joint probability distribution as written:

$$Pr(X_1, X_2, \dots, X_n) = \prod_{i=1}^n Pr(X_i | \psi_i) \quad (2)$$

$Pr(X_1, X_2, \dots, X_n)$ is the full joint probability distribution, and ψ_i is the parent of node i . (Ariyani and Fauzi, 2024)

One of the key advantages of Bayesian Networks (BN) is their ability to simulate changes in input variables in response to different output levels, often referred to as "what if" scenarios. For instance, policymakers can easily evaluate potential policy interventions by adjusting inputs and examining the resulting impacts on network structures. Additionally, the causal relationships represented in Bayesian Belief Networks (BBNs) are straightforward to comprehend, and incorporating new variables is a seamless process. The network structures are visually appealing and effective for illustrating intervention theories and testing them against real-world data. Beyond these benefits, BNs excel at managing uncertainty in a probabilistic framework, making them especially useful for analysis in management contexts, particularly in situations with limited data.

4. Results

Strength Analysis

The BN structure representing the prior probability for the sustainability of MSE's in the culinary sector is illustrated in Figure 6. As shown in Figure 6, with the current CPT values of 30:70 for land availability, 65:35 for community support, 70:30 for training, 80:20 for funds aimed at enhancing product quality, and 75:25 for partnership involvement as implementing nodes,

there is a resulting opportunity for the sustainability level of micro small culinary businesses at 35%.

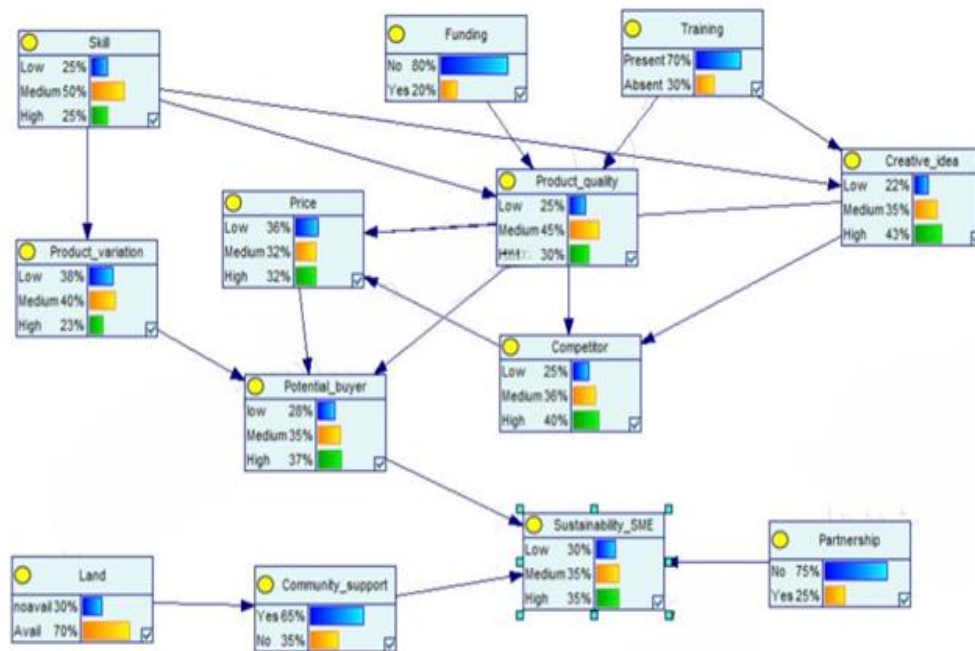


Figure 4. BN Structure with Prior Probability.

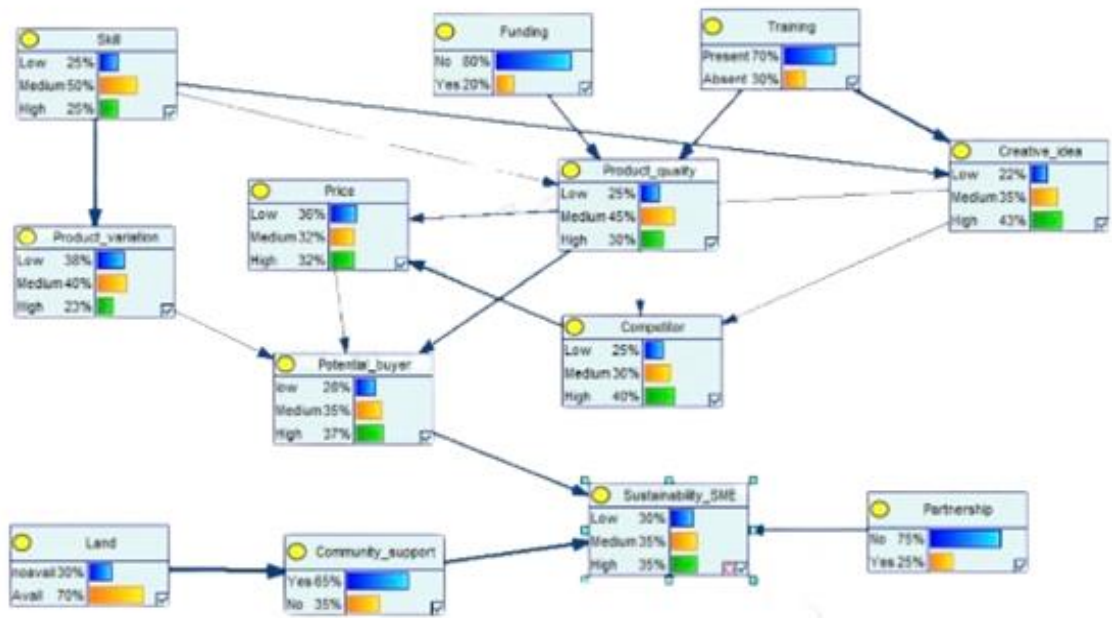
The next phase in the analysis of Bayesian networks involves identifying the relationships among variables within the network structure. GeNie employs an influence diagram for strength analysis, which helps us comprehend the potential cause-and-effect dynamics between variables. In this context, the width of the arcs symbolizes the strength of connections between parent and child nodes.

Figure 6 illustrates the strength of influence within the Bayesian network structure of culinary MSMEs, where the thickness of the arrows indicates the level of influence. As depicted in Figure 7, the arc thickness reflects the impact of training provided to MSE participants, particularly in the culinary sector. This training directly enhances skill levels, enabling workers and business managers to generate innovative ideas and effectively compete in the market.

Funding plays a crucial role in enhancing product quality, which can lead to increased selling prices and greater opportunities to attract potential buyers, ultimately boosting company profits. Adequate funding allows companies to offer more comprehensive or improved training sessions, thereby enhancing skills and production quality and facilitating investments in superior technology or raw materials that directly elevate product quality.

Both Funds and Training are vital for improving production quality. Additionally, the availability of land, supported by community backing, significantly impacts the sustainability of culinary MSE's. Partnerships that provide financial support, such as low-interest people's business credit (KUR) from banks, also play a critical role in sustaining culinary MSE's. Factors like land availability, potential buyers, community support, and partnerships directly influence

business sustainability. This conclusion is supported by the average Euclidean distance values shown in Table 3.



Notes: Bold Arrows indicate strong influence variables
Toward sustainability of SME

Figure 5. The influence of BN structural strength on culinary MSE’s businesses

Table 3. Score of Strength Influence between Parent and Child Node in the BN Structure.

Table. Parent–Child Variables with Average and Maximum Values

Parent	Child	Average	Maximum
Land	Community support	0.500	0.500
Skill	Product Variations	0.379	0.500
Training	Creative idea	0.345	0.436
Community support	MSE's Sustainability	0.304	0.400
Skill	Creative idea	0.282	0.529
Product Quality	Community/ Potential buyer	0.249	0.500
Partnership	MSE's Sustainability	0.248	0.361
Competitor	Price	0.242	0.600
Training	Product Quality	0.227	0.458
Community/ Potential buyer	MSE's Sustainability	0.225	0.361
Funds	Product Quality	0.224	0.361
Skill	Product Quality	0.194	0.436
Price	Community/ Potential buyer	0.159	0.265
Creative idea	Competitor	0.150	0.276
Creative idea	Price	0.146	0.361
Product Variations	Community/ Potential buyer	0.123	0.265
Product Quality	Price	0.123	0.361
Product Quality	Competitor	0.081	0.081

With a standard score of 0.5 and an extreme score of 0.5, Community Support related to Business Location has the most substantial impact, as demonstrated in Table 3. Following this, skills that enable product variations hold a score of 0.3, with a maximum of 0.5. Additionally, the impact of training on creative ideas shows an average score of 0.345 and a maximum of 0.436.

Community support significantly influences Business Location and the sustainability of culinary MSEs, averaging 0.3 with a peak score of 0.4.

Land is crucial for the development of culinary MSEs, particularly because Community support is essential for selecting a strategic business location. Most enterprises in the region are small micro-scale businesses with limited skills, underscoring the need for skilled human resources to produce a variety of high-quality products for business growth. Furthermore, diverse product offerings require training to foster creative ideas. A lack of access to training and skills development hampers MSE's' ability to introduce product variations that necessitate specialized techniques or knowledge, posing a significant challenge as limited understanding in product and technological

innovation can impede MSE's from creating new and appealing products relevant to the market. In this context, partnerships with the government are crucial to alleviate the financial burdens faced by MSE's operators, reduce dependency on bank loans, and simplify complicated loan procedures. Skills are the second most vital aspect for Culinary MSE's in Badung Regency, as they are essential for producing varied products. Culinary skills and expertise are imperative for developing new, creative, and innovative offerings.

Strong skills enable MSE's to experiment with various ingredients, cooking techniques, and presentations, leading to a broader range of products that attract consumers. Well-developed skills enhance an MSE's ability to follow and adapt to shifting market trends, allowing for the introduction of new menus that cater to evolving consumer preferences, such as healthy options, plant-based dishes, or unique flavor combinations. Furthermore, proficient skills empower MSE's to produce a diverse array of high-quality products. In the long run, offering a variety of products backed by qualified skills is crucial for sustaining the culinary MSEs in Badung Regency.

Training plays a vital role in enhancing creative ideas and production quality, enabling these businesses to compete effectively and command higher prices for quality products that appeal to potential buyers, ultimately leading to profitability key to the sustainability of MSE's in the culinary sector. Micro and small business training is essential for improving creative ideas, product quality, market competitiveness, pricing strategies, and attracting customers. These elements collectively bolster the sustainability of MSE's businesses, especially in the competitive landscape of Badung Regency.

Effective training contributes to making micro and small culinary businesses more adaptive, innovative, and resilient, thereby increasing their chances for survival and growth. Partnerships are also necessary for business operators to ensure the sustainability of culinary enterprises, enabling them to compete effectively and achieve higher prices for profitability. Furthermore, training is critical for ensuring good production quality, which directly impacts community interest and the sustainability of MSE's in the culinary field. Conversely, a lack of funding and skills adversely affects product quality, leading to reduced prices and lower consumer interest. Additionally, a deficiency in creative ideas can hinder competition and result in fewer product variations, limiting choices for consumers and leading to price drops due to poor production quality.

One of the advantages of Bayesian systems is their ability to conduct situational analysis or what-if scenarios. The goal is to determine how certain factors of interest will change if specific variables are modified. Adjustments in these factors lead to corresponding changes in the posterior probabilities of those variables. In focus group discussions (FGD), business stakeholders expressed interest in understanding how five key factors potential buyers, community support, partnerships, sustainability, and land interact.

For example, what if we conducted the scenario by treating certain influential nodes as evidence? In this case, we observe the sustainability of micro and small culinary businesses shifting from a posterior probability of 35%. If we set the variables tested in these scenarios to a posterior probability of 100%, the sustainability of MSE's is altered, with training marked as "yes," land availability rated as high, skills assessed as "low," community support rated as "high," and partnerships categorized as "high." These outcomes are illustrated in Figure 8, reflecting a combination of the five scenarios, and the changes in scenario are presented in Table 4.

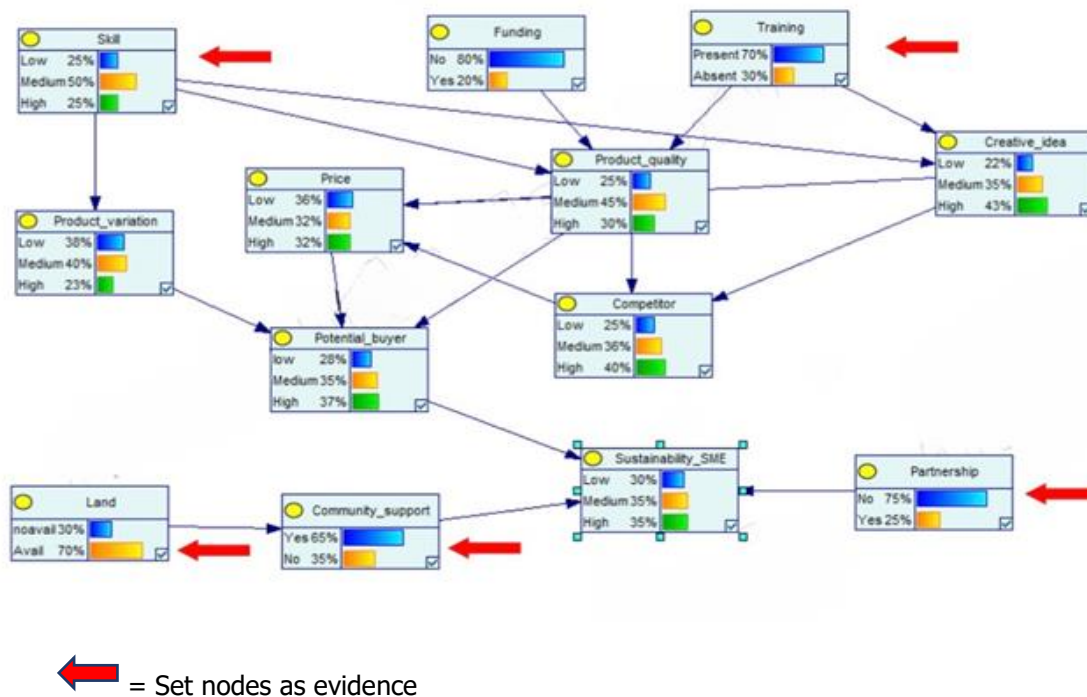


Figure 6. BN Structure with Mixed Evidence Variable Scenario

Table 4: Variation in Posterior Probability under Various Circumstances

		Scenario (Evidence)					
		Training	Land	Skill	Com. Support	Partnership	Mixed
Variable	Prior						
Probability							
Potential buyer (Low)	25%	70%	70%	25%	70%	75%	62%
Community support (Yes)	65%	35%	38%	36%	43%	52%	41%
Partnership (Yes)	25%	0%	3%	1%	8%	17%	6%
Sustainability (High)	35%	35%	38%	36%	43%	52%	65%

Table 5. Difference in Posterior Probability with Different Scenarios.

Variabel	Prior Probability (%)	Posterior Probability	Posterior Probability in UMK	Change
Training	70	100	35%	0%
Land Availability	70	100	38%	3%
Skill	25	100	36%	1%
Community Support	65	100	43%	8%
Partnership	75	100	52%	17%

As shown in Table 5, the provision of training ("yes") of 70% has no change in the increase or decrease in the probability of Micro Small culinary business which is still 35% then with the availability of land of 70%, the probability of Micro Small culinary business changes to 38% making the probability of the business increase to 3% but and with the availability of skills 25% makes the probability change into 36% which only increases the level of profitability of the business to 1% then with the support of the community of 65% makes the probability of change to 43% increase by 8% and with the existence of partnerships of 75% makes the probability of business high to 52% increase by 17%.

The scenario involving the provision of training by 35% does not change the probability of MSE's by 35% so there is no change, land supply of 38% increases the probability of MSEs by 3% then the skills possessed by MSE's actors 36% give the probability of MSEs by only 1% where with the support of the Community it has a positive impact by increasing the possibility of profit by 8%. Then with the scenario of partnership support, the probability of MSEs will be more productive by 17% and increment the plausibility of diminishing contamination and expanding maintainability by 46% and 40% individually, while keeping the plausibility of benefit unaltered from the base level. Possibly way better outcomes can be accomplished by combining the five scenarios. In this combined situation, the execution of smaller scale Little culinary trade maintainability is up to 17%. This likelihood is essentially higher than that watched when each situation is run freely.

Sensitivity Analysis

One of the primary benefits of Bayesian systems is their capability to perform sensitivity analysis on target nodes in relation to changes in evidence. In this study, we conducted a sensitivity analysis to determine which nodes or factors were most impacted by shifts in the probability of sustainability for micro-small businesses in the culinary sector. Sustainability was selected as the target node, while the other factors served as evidence nodes. In Figure 9, we consider financial incentives ("yes"), organizational affiliation ("yes"), and low skills ("low") as evidence. GeNie employs color-coded graphs and tornado diagrams to assess the sensitivity of these factors. The color intensity of a node reflects its sensitivity level, with darker shades indicating higher sensitivity. Figure 9 displays the structure of the Bayesian network, highlighting sensitive nodes. Key nodes—potential conflicts, contamination, and productivity are marked in red, illustrating their significant influence on the likelihood of sustainability.

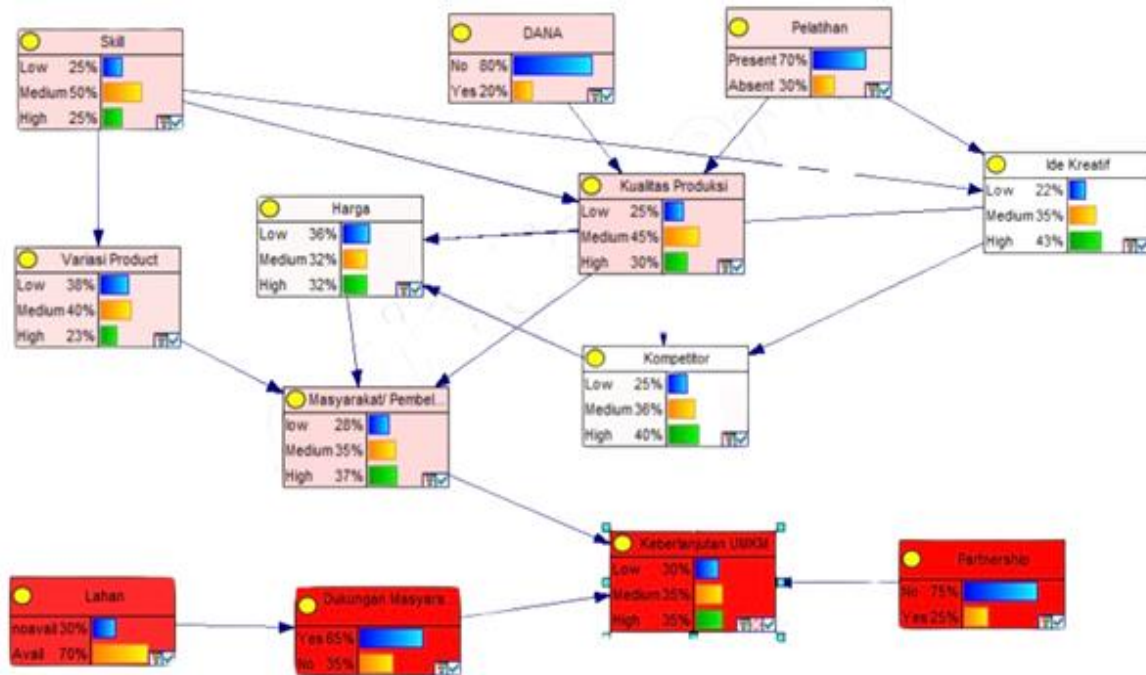


Figure 7. BN with sensitive nodes (marked in red)

Figure 10 displays a tornado chart illustrating the sensitivity analysis for the sustainability of culinary micro and small businesses in Badung Regency. Table 5 details the variations in the net impact of the selected factors (soft factors) when the scale hubs of organization, community support, and potential buyers are considered. The horizontal axis of the chart represents the absolute change in the likelihood of sustainability. The length of each bar indicates the extent of a specific factor's influence on the target variable, which in this case is the sustainability of micro and small culinary businesses. The color variations within the chart denote the direction of change in the target variable, with green indicating positive changes and red signifying negative changes.

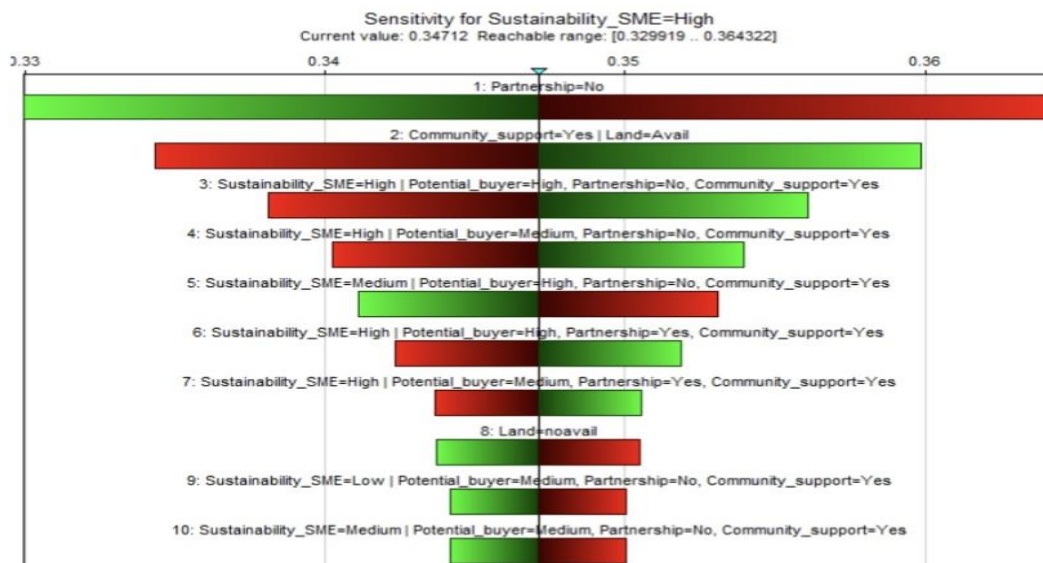


Figure 8. Sensitivity Analysis of Sustainability Level as Target Using Tornado Diagram.

As shown in Figure 10, organization, community support, and potential buyers significantly impact the level of sustainability. A strong organization can foster collaborations that benefit all parties, enabling micro small enterprises (MSE's) to grow more rapidly and stably, thereby enhancing their sustainability prospects. Community support, particularly from local networks, contributes to business development, as it cultivates customer loyalty, a crucial element for long-term sustainability. When communities back MSE's, they are more inclined to opt for local products, which helps sustain and even boost the revenue of culinary MSE's.

Furthermore, this support fosters a positive reputation that can attract additional customers and business partners. Potential buyers are equally vital for business sustainability, with the ability to open doors to both local and international markets. By appealing to new buyers, MSE's can increase sales, innovate, and adapt to evolving market trends, all of which are essential for enduring sustainability. The remaining bars in the tornado diagram in Figure 9 illustrate the interplay between partnerships, community support, and buyers, which are also sensitive to changes in sustainability levels, as previously described in the influence diagram.

6. Conclusion

Culinary Micro Small Enterprises (MSE's) play a crucial role in the economy of Badung Regency, a renowned tourism hub with significant culinary potential. These MSMEs offer a diverse array of food and beverage options, from traditional Balinese dishes to modern cuisine designed for both local and international tourists. The COVID-19 pandemic dramatically impacted the tourism sector, compelling industry participants to adapt and implement innovative strategies to survive in a challenging environment. During this time, culinary MSE's became vital to the economic resilience of the Badung community, especially as hotel, restaurant, and tourist attraction closures affected many.

Unfortunately, as the economy began to recover post-pandemic, the culinary MSE sector was largely overlooked, with many individuals returning to their former jobs. Only a few businesses managed to endure, facing internal and external challenges that deterred them from continuing.

Recognizing the essential role culinary MSEs play in job creation, income generation, and poverty alleviation highlights the need for a new perspective that integrates sustainable practices across social, environmental, and economic dimensions. This approach must also navigate complex interactions and uncertainties, requiring effective strategies to assure the long-term viability of culinary MSE's.

This study employs Bayesian networks to illustrate that a variety of scenarios can inspire creative solutions for product variations and quality, particularly among micro and small-scale operations. Partnerships are pivotal in enhancing business growth and community support, which can stimulate potential buyers' interest, thereby influencing business sustainability. Through collaboration, culinary micro and small businesses can not only survive but thrive in a competitive marketplace. The research indicates that a supportive community can facilitate the resilience and growth of these enterprises, which play a significant role in the local and national economy. Identifying, attracting, and retaining potential customers is key for ensuring long-term survival and success of culinary MSE's, the primary source of income for many in the sector.

The study underscores the potential of Bayesian networks as a valuable analytical tool and acknowledges areas requiring further research. Enhancing the existing model involves incorporating additional variables that impact the sustainability of culinary MSE's. Transitioning to a dynamic Bayesian network allows for time series data integration, enabling the evaluation of sustainability and market trends, which are essential for MSE's in the culinary industry to adapt continuously. It is recommended that Bayesian network probabilities be combined with policy scenario modeling to assess policy impacts on outcomes. Stakeholders can then devise targeted strategies to bolster MSE's sustainability. This integrated approach fosters a comprehensive understanding of the system while emphasizing the need for improved data collection to model the interactions between policies, micro-small businesses, and community support effectively. Additionally, advanced analytical techniques are necessary to translate findings into actionable strategies. Ultimately, this study contributes to a deeper understanding of the internal and external barriers faced by culinary MSEs, paving the way for the development of strategies that promote sustainable business practices.

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