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Supply Chain Risk Management for Native Chicken in Taliwang Chicken Culinary Businesses in Mataram City: An Integrated FMEA–AHP Approach

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Novelty: This study identifies the supply chain risks of native chicken for the development of Taliwang chicken culinary by applying Failure Mode and Effects Analysis-Analytical Hierarchy Process analysis.

ABSTRACT

Taliwang chicken is a traditional culinary icon of Lombok, Indonesia, and its supply chain, involving farmers, collectors, and restaurants, faces significant operational vulnerabilities. This study maps the native chicken supply chain using SCOR, identifies failure modes using FMEA, and determines risk priorities using AHP based on survey data from 58 respondents. The supply chain operates linearly from producers to restaurants. Integrating FMEA and AHP identifies price and market risks as the most dominant category (weight: 0.42), with live chicken price fluctuations ranking as the top-priority risk (weighted RPN: 161.28), followed by limited DOC supply, disease mortality, intermediary reliance, and low institutional support. Conclusion: Supply chain stability depends heavily on mitigating price volatility and securing stable inputs.

Contribution to Sustainable Development Goals (SDGs):

SDG 2: Zero Hunger

SDG 8: Decent Work and Economic Growth

SDG 9: Industry, Innovation and Infrastructure

SDG 11: Sustainable Cities and Communities

SDG 12: Responsible Consumption and Production

1. INTRODUCTION

1.1. Research Background

The native chicken farming sector represents an important component of the agribusiness system in West Nusa Tenggara Province, serving not only as a source of livelihood for rural communities but also as a major supplier of raw materials for traditional culinary industries. The native chicken population is

projected to reach 5.303.821 in 2025, a 4% increase from 5.118.430 in 2024. During the same period, the tourism sector is also growing rapidly. In March 2026, the number of domestic tourist visits to West Nusa Tenggara reached 1.393.460, a 34.64% increase compared to the previous month [1]. This growth is expected to increase demand for regional culinary products, particularly Ayam Taliwang, one of the province's most distinctive traditional dishes. Consequently, maintaining a reliable supply of native chickens has become increasingly



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important to support production continuity and the sustainability of the regional culinary industry.

The culinary industry's dependence on the continuity of supply, quality, and suitability of native chicken characteristics indicates potential vulnerabilities and gaps in the supply chain, both in terms of raw material availability, quality, continuity, and coordination between actors. In order to systematically identify and prioritize supply chain risks, this study uses Failure Mode and Effect Analysis (FMEA) by assessing the dimensions of occurrence, severity, and detection to determine the risk priority level through the Weighted Risk Priority Number (WRPN) [2].

The conventional FMEA approach has limitations because it assumes equal importance among the criteria of Severity, Occurrence, and Detection, and relies heavily on expert judgment, which can introduce subjectivity into risk prioritization. Integrating FMEA with multi-criteria decision-making methods, such as the Analytic Hierarchy Process (AHP), provides a more objective and reliable framework for assigning criterion weights and enhances the robustness of risk evaluation. [3].

The AHP method employs pairwise comparison among criteria and sub criteria to derive more accurate and measurable priority weights based on judgments from relevant stakeholders and experts. Pairwise comparisons in converting qualitative assessments into quantitative values, ensure that more critical aspects receive proportionally greater weight [3]. Combining FMEA with AHP enables the weighting of risk criteria according to their relative importance, thereby producing a more robust and reliable prioritization of mitigation actions than the conventional RPN approach alone [4].

Comprehensive research that integrates risk analysis along the supply chain from upstream to downstream, and explicitly links the assessment to the operational needs of the Ayam Taliwang culinary industry using a combined FMEA and AHP framework is still limited, namely: (1) Research related to the free-range chicken supply chain includes studies examining a supply chain involving various interacting actors, where integration among participants remains a significant challenge for the development of a sustainable free-range chicken supply chain [5], (2) Research examining the poultry supply chain highlights exposure to environmental and socio-economic pressures that can reduce production quality and quantity while increasing operational costs [6], and (3) Research on the performance of the free-range chicken supply chain still faces several challenges, particularly limited transportation infrastructure, weak market linkages, and price volatility [7].

Based on the description above, it is necessary to conduct research with the title: Supply Chain Risk Management of Free Range Chicken in the Taliwang Chicken Culinary Business in Mataram City: Integrated FMEA-AHP Approach with the objectives of: (1) mapping the supply chain with SCOR, (2) identifying vulnerabilities and failure modes with FMEA, and (3) determining risk priorities with AHP.

1.2. Literature Review

Supply chain risk management (SCRM) has become a crucial component of modern agri-food systems, as agricultural supply chains are highly vulnerable to biological, environmental, market, and logistical uncertainties [8];[9]. Furthermore, effective risk management requires the systematic identification, assessment, prioritization, and mitigation of risks throughout the supply chain.

Supply chain risks in agri-food systems arise from internal operational activities (production, procurement, logistics, and inventory management) as well as external environmental factors such as climate change, market uncertainty, disease outbreaks, and policy changes. In an effort to enhance resilience and ensure business continuity, integrated supply chain risk management is essential [9]; [10].

Recent studies indicate that supply chain disruptions can rapidly propagate from upstream production to downstream distribution, thereby affecting operational performance, product availability, and long-term business sustainability. Current supply chain risk assessments should integrate qualitative expert assessments with quantitative analysis methods to enhance decision-making under conditions of uncertainty [11]; [12].

Failure Mode and Effects Analysis (FMEA) is one of the most widely used proactive risk assessment techniques for identifying, evaluating, and prioritizing potential failures in complex operational systems. The method systematically assesses each potential failure mode using three evaluation criteria, namely Severity (S), Occurrence (O), and Detection (D). These three criteria are combined to calculate the Risk Priority Number (RPN), enabling decision-makers to rank potential risks by criticality and determine appropriate mitigation priorities [12]; [13].

Conventional FMEA has several methodological limitations. The traditional RPN assumes that Severity, Occurrence, and Detection contribute equally to risk prioritization, even though their relative importance often varies depending on the operational context. The assessment process relies heavily on expert judgment, leading to subjectivity and potential inconsistencies in risk rankings. Moreover, the conventional RPN does not fully reflect the interdependencies between failure modes, which may diminish its effectiveness within complex supply chain systems [12];[14]

Analytical Hierarchy Process (AHP) is one of the most widely used multi-criteria decision-making (MCDM) methods for determining the relative importance of evaluation criteria through pairwise comparisons [3]. AHP has been widely applied in supply chain management, risk assessment, and sustainable decision-making. Integrating AHP with FMEA enables a more robust, transparent, and context-sensitive prioritization of risks, while its combination with complementary MCDM techniques further enhances the reliability and consistency of mitigation decision-making in complex systems [15].

Within supply chain risk management, AHP provides a more objective mechanism for assigning weights to Severity, Occurrence, and Detection based on stakeholder perceptions and operational priorities. Rather than assuming equal contributions of each criterion, AHP recognizes that some dimensions may exert greater influence on overall supply chain performance. This characteristic significantly improves the reliability of risk prioritization, particularly in agri-food supply chains where biological, economic, and institutional factors interact simultaneously. In the integrated framework, FMEA is employed to identify potential failure modes and estimate their associated risks, whereas AHP is used to determine the relative importance of the evaluation criteria through pairwise comparisons. This combination improves the accuracy of risk prioritisation by incorporating stakeholder preferences and reducing the bias associated with equal weighting assumptions among Severity, Occurrence, and Detection criteria [14]; [16]

Several empirical studies have demonstrated that integrating FMEA with AHP provides more reliable risk prioritisation than conventional FMEA alone. FMEA criteria weighting using AHP significantly improves the consistency of supplier risk evaluation in a complex supply chain environment [16]. An integrated FMEA–AHP approach was used to assess operational risks in the food supply chain and reported that the method resulted in stronger mitigation priorities by considering both risk severity and decision-maker preferences [14]. These findings support the application of an integrated FMEA–AHP framework in a study evaluating risks within the free-range chicken supply chain that meet the culinary requirements for Taliwang chicken.

1.3. Research Objective

This study examines supply chain risk management for native chicken within the context of the Taliwang chicken culinary business in Mataram City, covering activities ranging from procurement, supply, and receiving to the availability of raw materials for production. The research focuses on identifying and prioritizing risks using an integrated FMEA-AHP approach to support supply continuity, operational efficiency, and supply chain resilience.

2. MATERIALS AND METHODS

2.1. Study Area.

This research was conducted in two locations representing upstream and downstream of the supply chain: Mataram City (as the central market and culinary centre) and Teruwai Village, Pujut District, Central Lombok Regency (as the production area for native chicken supplying Mataram Chicken Taliwang businesses).

2.2. Respondents and Sampling.

A total of 58 respondents were selected through purposive sampling based on the following inclusion criteria: active involvement in the native chicken supply chain for at least 1 year and direct participation in production, aggregation, or culinary processing activities. The respondents comprised 33 native chicken farmers, 4 collectors/wholesalers, and 21 owners or managers of Taliwang chicken culinary businesses. This sampling approach ensures that the data encompasses all key stakeholders across the supply chain, from upstream production to downstream end users. The study was conducted between April and May 2026 in Mataram City, West Nusa Tenggara Province, Indonesia, covering key native chicken producing areas that supply the of Taliwang chicken culinary industry: Teruwai Village (Pujut District, Central Lombok Regency) and the Lingsar and Narmada Districts (West Lombok Regency).

The study locations were selected purposively because these areas represent the primary production and distribution centers of native chickens supplying Chicken Taliwang restaurants in Mataram City. This study employs a hybrid method combining FMEA and AHP. Conventional FMEA assigns equal weight to Severity (S), Occurrence (O), and Detection (D), which can lead to bias; AHP addresses this limitation by establishing objective weights through pairwise comparisons, thereby enabling more accurate risk prioritization.

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2.2.1. FMEA Procedure.

Determining risk levels using the FMEA analysis method [14] with the following indicators:

- Risk identification: Summarizing all potential failure methods, causes, and impacts at each stage of the supply chain.
- Severity assessment (S): Assessing the seriousness of the impact if a failure occurs (scale 1–10).
- Occurrence likelihood assessment (O): Estimating the likelihood of a failure occurring (scale 1–10).
- Detection likelihood assessment (D): Evaluating the probability of detecting a failure before it impacts the system (scale 1–10).

Calculating the Risk Priority Number (RPN) uses the formula:

$$RPN = S \times O \times D$$

2.2.2. AHP Procedure.

The AHP method is applied to determine the level of accuracy of failure risk, based on standard principles [3] with the following procedures:

- Hierarchy construction: Establishing a decision hierarchy: primary objective → criteria → sub-criteria/failure modes.
- Pairwise comparison: Compare each pair of elements using Saaty's 1–9 scale to construct an assessment matrix.
- Matrix normalization: Normalize the values in each column so that the sum is 1.
- Eigenvector calculation: Calculate the priority weights of the normalized matrix.
- Consistency testing is performed by calculating the Consistency Ratio (CR), which is defined as the ratio of the Consistency Index (CI) to the Random Index (RI), using the formula:

$$CR = CI / RI$$

Description: CI = Consistency Index, RI = Random Index table value. A $CR \leq 0.10$ indicates acceptable consistency.

2.2.3. Weighted RPN (WRPN)

The final risk ranking was obtained by multiplying the original RPN values by the AHP-derived weights for S, O, D, and each failure mode, yielding the Weighted Risk Priority Number (WRPN).

3. RESULT AND DISCUSSION

3.1. Native Chicken Supply Chain Structure

The research results show that the local chicken supply chain serving the Chicken Taliwang culinary business in Mataram City follows a four-level flow: Farmers in Teruwai Village, collectors in Batujai, wholesalers in Mataram City, and Chicken Taliwang restaurants and consumers. Farmers practice a semi-intensive rearing system, with chicken farming primarily as a secondary livelihood alongside agricultural labour. The average farming experience among respondents is 12 years, indicating long-standing involvement but limited intensification. Chickens are harvested once they reach market-standard weight and are

sold directly to local collectors. Collectors act as the sole intermediaries connecting the scattered farmers with larger wholesalers based in Mataram City, who then distribute the chickens to Chicken Taliwang restaurants throughout the city. This structure demonstrates a linear flow that relies on intermediaries with minimal direct linkages between producers and end users.

3.2. Supply Chain Risk Identification

Supply chain risks are classified into four main categories that encompass the entire chain: production risks (disease outbreaks, high mortality rates, and delays in day-old chick supply); distribution risks (delayed deliveries, mismatch between supply and demand, high dependence on small-scale traders); price and market risks (live chicken price volatility, fluctuations in restaurant demand, competition from broilers/roosters); and institutional risks (inadequate government support, lack of formal marketing partnerships, and asymmetry in market information).

3.3. FMEA Analysis

The results of the FMEA assessment, including the Severity (S), Occurrence (O), Detection (D), and Risk Priority Number (RPN) corresponding to each supply chain risk are presented in Table 1.

Table 1. Severity, Occurrence, Detection, and RPN Values

Risk Item	S	O	D	RPN
Live chicken price fluctuation	8	8	6	384
Dependence on collectors/intermediaries	8	7	6	336
Limited supply of day old chicks (DOC)	7	7	6	294
Mortality due to disease	8	6	5	240
Low institutional/government support	6	7	5	210

Description: S= Severity; O= Occurrence; D= Detection dan RPN= Risk Priority Number

The research results (Table 1) indicate that fluctuations in live chicken prices rank highest, with an RPN value of 384. This reflects the perception that price changes have a significant impact ($S = 8$), occur frequently ($O = 8$), and are difficult to predict ($D = 6$). Price instability directly reduces income certainty for farmers and compels restaurant owners to adjust menu prices or compromise on raw material quality, thereby threatening the viability of businesses in both the upstream and downstream sectors. Price fluctuations in the poultry supply chain are heavily influenced by supply-demand imbalances, market uncertainty, and weak coordination mechanisms among supply chain actors [17].

The second highest priority is dependence on collectors (RPN = 336). A high severity score ($S = 8$) indicates that any disruption from collectors can halt supply entirely, while a moderate occurrence score ($O = 7$) shows that such imbalances are common. The low detection capability ($D = 6$) stems from the absence of alternative marketing channels for most farmers. This condition creates unequal bargaining power, where collectors often determine purchase prices unilaterally. Fragmented relationships, limited information, and weak connectivity between actors can increase social and operational risks in the

agribusiness supply chain [16]. Limited DOC supply ranks third (RPN = 294). Constraints in the availability of quality chicks limit production expansion and cause supply gaps during peak tourist seasons. The combination of moderate severity and high frequency shows that seed supply remains a persistent bottleneck, worsened by limited local hatchery capacity and long procurement lead times.

Mortality due to disease (RPN = 240) presents high severity ($S = 8$) but lower occurrence and detection scores, implying that outbreaks are devastating when they happen but are less frequent and somewhat predictable through routine monitoring. Nevertheless, low biosecurity practices among small-scale farms keep this risk at a critical level.

Finally, low institutional support (RPN = 210) ranks lowest under the conventional FMEA approach but remains strategically important for the long-term sustainability of the supply chain. Although its immediate operational impact appears less severe, limited extension services, inadequate financial support, weak farmer organizations, and the absence of formal marketing partnerships reduce the adaptive capacity and resilience of supply chain actors. These findings highlight the limitations of the conventional RPN approach, which assumes equal importance among evaluation criteria. Therefore, incorporating the Analytical Hierarchy Process (AHP) enables the relative importance of institutional factors to be adequately represented, resulting in more reliable and context-sensitive risk prioritization [16]; [18]

3.4. AHP Analysis: Weighting of Risk Categories

The Analytical Hierarchy Process (AHP) was applied to derive relative priority weights for the four main risk categories, based on structured pairwise comparisons by respondents and key informants across the supply chain. The resulting weights are presented in Table 2.

Table 2. Priority Weights of Risk Categories

Risk Category	Priority Weight	CR	CR Standard
Price and Market Risks	0.42	0.08	<0.10
Production Risks	0.29		
Distribution Risks	0.18		
Institutional Risks	0.11		

Description: CR= Consistency Ratio

Table 2 above shows that the value of 0.42 reflects that price fluctuations, changes in market demand and price instability have a significant impact on the supply chain. This value confirms that the pairwise comparison judgments are logically consistent and statistically acceptable, ensuring the reliability of the derived priority weights. The weighting results indicate that Price and Market Risks are perceived as the most critical dimensions, accounting for 42% of the total decision weight. This dominant position reflects that price volatility and demand uncertainty directly determine the economic viability of all actors: farmers face unpredictable revenue, intermediaries bear margin risk, and restaurant operators struggle to maintain cost stability and menu pricing. This finding is consistent with recent evidence indicating that market-related uncertainties, particularly price volatility and market instability, substantially affect supply chain resilience by disrupting production planning, procurement decisions, and market coordination among supply chain actors. Such risks are

especially critical in small-scale agri-food systems where market fluctuations rapidly propagate throughout the supply chain [8]; [19]

Production Risks rank second most important, with a weight of 0.29. This underscores the fundamental dependence of the entire chain on consistent output quality and volume from upstream producers. Challenges such as disease outbreaks mortality and unreliable chick supply can rapidly propagate downstream creating shortages and cost spikes, consistent with the high severity scores recorded in the FMEA assessment. Distribution Risks obtained a weight of 0.18, indicating that while logistical and dependency issues are significant, they are viewed as secondary to market and production fundamentals. Nevertheless, the concentration of supply through a small number of collectors amplifies these risks, making them structurally relevant even if ranked lower in overall priority.

Finally, Institutional Risks recorded the lowest weight at 0.11. This does not imply unimportance; rather, it suggests that respondents priorities immediate operational and economic concerns over long-term systemic factors in their current assessment. However, recent studies emphasize that weak institutional coordination, limited policy support, and insufficient collaboration among supply chain actors are fundamental drivers of production, pricing, and distribution vulnerabilities in agri-food supply chains.

Table 2 shows that the obtained Consistency Ratio (CR) is 0.08, which is below the 0.10 consistency tolerance threshold commonly used in the Analytical Hierarchy Process (AHP). This value indicates that the level of inconsistency in the respondents' assessments remains within an acceptable range, demonstrating that the pairwise comparisons are logically consistent in representing the relative importance of the criteria and alternatives being evaluated.

Consequently, integrating AHP-derived weights into the FMEA framework enables a more balanced and context-sensitive prioritization of risks, which is reflected in the subsequent WRPN analysis presented in Table 3.

Table 3. Integrated Results: Weighted Risk Priority Number

Risk Item	RPN	AHP Weigh	WRPN	Rank
Live chicken price fluctuation	384	0.42	161.28	1
Limited DOC supply	294	0.29	85.26	2
Mortality due to disease	240	0.29	69.60	3
Dependence on collectors	336	0.18	60.48	4
Low institutional support	210	0.11	23.10	5

Description: WRPN = Weighted Risk Priority Number

The integrated ranking provides a more realistic hierarchy aligned with systemic impact. Price volatility remains the leading threat, as it directly affects revenue certainty for all actors. Limited DOC supply and disease-related mortality emerged as high-priority risks, reflecting their fundamental role in maintaining production continuity and ensuring a stable supply of native chickens. Although dependence on intermediaries ranked lower, it remains a structurally important risk because it amplifies

the impacts of production disruptions and price volatility throughout the supply chain. These findings support previous studies demonstrating that integrating FMEA with the Analytical Hierarchy Process (AHP) improves the accuracy of risk prioritization by overcoming the equal-weight assumption of conventional Risk Priority Number (RPN) calculations and incorporating the relative importance of evaluation criteria into the decision-making process [18]; [20]

This study has several limitations. It involved 58 respondents along the Teruwai–Batujaí–Mataram route; consequently, the limited sample size and geographical scope may affect the generalizability of the findings to other regions. The use of the FMEA–AHP method also entails a degree of subjectivity, as assessments are based on respondents' experiences and perceptions. However, the consistency of the assessments was verified using AHP, yielding acceptable results. In addition, this study used a cross-sectional design, so it cannot yet describe changes in risk over time. Further research is recommended to involve larger samples and areas and use longitudinal data to strengthen the validation of results and evaluate the effectiveness of mitigation strategies on an ongoing basis.

3.5. Mitigation Strategies for Sustainable Supply Chains

Implementing an integrated supply chain management system to improve supply continuity, product quality, and distribution efficiency of native chickens.

4. CONCLUSION

- The native chicken supply chain follows a linear flow from producers to small collectors, large collectors, and finally to the Taliwang chicken culinary business.
- The FMEA-AHP analysis indicates that live chicken price fluctuation is the new highest-priority risk, followed by reliance on middlemen, limited supply of day-old chicks (DOC), livestock mortality due to disease, and weak institutional support.

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