# ANALYSIS OF RAW MATERIAL SUPPLY CHAIN RISK IN HEALTHY FOOD CATERING BUSINESS USING FMEA
## (Analisis Risiko Rantai Pasok Bahan Baku Pada Usaha Katering Manakan Sehat Menggunakan FMEA)

By:
**Hanifatus Sahro[1]**
[1]Agribusiness Department, Faculty of Agriculture, University of Widya Gama Malang
Corresponding Author: hanifatus@widyagama.ac.id

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**ABSTRACT**

The sustainability of healthy food catering businesses largely depends on the availability of fresh, high-quality, and consistent organic raw materials. However, the supply chain of these raw materials often encounters risks such as limited numbers of suppliers, unstable product quality, and delivery delays. This study aims to analyze supply chain risks of raw materials in healthy food catering businesses in Malang City using the Failure Mode and Effect Analysis (FMEA) method. Primary data were collected through interviews with business owners and procurement staff, as well as questionnaires assessing the severity, occurrence, and detection of risks. The findings reveal that the highest-priority risk is the limited availability of organic raw materials (RPN = 315), followed by variations in raw material quality (RPN = 288) and delivery delays (RPN = 210). This study provides practical contributions by recommending the diversification of organic farmer partners, the implementation of quality standards in procurement, and the strengthening of distribution coordination to ensure the sustainability of healthy food catering businesses.

**Keywords:**
Supply chain, raw materials, risk, FMEA, healthy food.

**ABSTRAK**

Keberlanjutan usaha katering makanan sehat sangat bergantung pada ketersediaan bahan baku organik yang segar, berkualitas tinggi, dan konsisten. Namun, rantai pasok bahan baku ini sering menghadapi risiko seperti terbatasnya jumlah pemasok, kualitas produk yang tidak stabil, dan keterlambatan pengiriman. Penelitian ini bertujuan untuk menganalisis risiko rantai pasok bahan baku pada usaha katering makanan sehat di Kota Malang menggunakan metode Failure Mode and Effect Analysis (FMEA). Data primer dikumpulkan melalui wawancara dengan pemilik usaha dan staf pengadaan, serta kuesioner yang menilai tingkat keparahan, kejadian, dan deteksi risiko. Temuan penelitian mengungkapkan bahwa risiko dengan prioritas tertinggi adalah terbatasnya ketersediaan bahan baku organik (RPN = 315), diikuti oleh variasi kualitas bahan baku (RPN = 288) dan keterlambatan pengiriman (RPN = 210). Penelitian ini memberikan kontribusi praktis dengan merekomendasikan diversifikasi mitra petani organik, penerapan standar kualitas dalam pengadaan, dan penguatan koordinasi distribusi untuk memastikan keberlanjutan usaha katering makanan sehat.

Kata kunci: rantai pasok, bahan mentah, risiko, FMEA, makanan sehat

## INTRODUCTION

Global public awareness of the importance of maintaining health has increased significantly over the past two decades. This phenomenon is driven by the rising prevalence of non-communicable diseases such as obesity, diabetes, hypertension, and cardiovascular diseases, many of which are caused by unhealthy dietary patterns. The World Health Organization (WHO, 2020) reported that more than 70% of annual global deaths are attributed to non-communicable diseases, with one of the major risk factors being high-calorie diets that are low in fiber and rich in additives. This condition has prompted a paradigm shift in food choices, moving beyond taste and price considerations toward aspects of nutrition, safety, and environmental sustainability (Hur & Jang, 2015).

In Indonesia, this awareness has become more evident, particularly in the aftermath of the Covid-19 pandemic. The global health crisis heightened public concern about immunity and long-term quality of life. Wachyuni & Wiweka (2020) revealed that the pandemic altered Indonesian consumption patterns toward healthier choices, one of which is the growing demand for organic food and healthy products. This behavioral change has created significant opportunities for businesses in the food sector to offer products that are natural, pesticide-free, and rich in nutrients (Yolanda & Fatikhah, 2024).

Malang City, as one of the education and tourism hubs in East Java, has also experienced the impact of these shifting consumption trends. Its large population of students, young professionals, and urban communities positions Malang as a promising market for healthy food businesses. One emerging enterprise in this context is *Catering Healthy Food*, which offers a variety of menu options ranging from salads, juices, smoothies, to healthy family catering packages. Since its establishment in 2019, this business has witnessed growing demand, particularly during the pandemic when delivery services became the primary choice due to social restrictions.

Nevertheless, like other food-based enterprises, this catering business faces risks, particularly in the supply chain of raw materials. As a business upholding the *fresh and organic* principle, the quality of raw materials is a key determinant of product success (Rizkitania et al., 2022). Supply chain risks can arise from various factors, including limited numbers of organic farmer partners, fluctuating prices of organic vegetables, inconsistent product quality, and distribution delays caused by logistical or weather constraints. If these risks are not properly managed, they may directly affect customer satisfaction, brand reputation, and business sustainability.

The supply chain in the healthy food industry possesses characteristics distinct from the broader food industry. Healthy food products are required to use fresh ingredients without preservatives, resulting in relatively short shelf lives (Muttaqin, 2024). This necessitates a stable and consistent supply of raw materials in terms of both quality and quantity.

According to Chopra & Meindl (2001) the food supply chain consists of networks of suppliers, producers, distributors, and end consumers. At each stage, risks may occur that disrupt the smooth flow of goods, information, and finance. In the context of organic food, the greatest risks lie in the procurement stage. Not all farmers are able to meet organic standards, limited land reduces supply capacity, and dependence on climatic conditions makes production vulnerable to fluctuations.

For micro, small, and medium enterprises (MSMEs) such as healthy food catering, supply chain risks become even more complex due to limited capital, restricted storage infrastructure, and high dependence on local suppliers. For example, even a one-day delay in the delivery of organic vegetables may disrupt production processes and cause losses, as products cannot be processed on schedule. Therefore, supply chain risk management becomes a critical aspect that requires serious attention.

Research on risk management in healthy food businesses has been widely conducted, albeit with varying focuses. Latifa (2018) studied risk aspects in the healthy diet catering business *Dapur Menthik* in Yogyakarta and found that the primary risk was consumer demand fluctuation. Amalina (2015) analyzed factors influencing organic vegetable consumption in Malang City, concluding that limited supply and higher prices were the main obstacles. Maralis & Triyono (2019) emphasized the

importance of risk management in sustaining small and medium enterprises. An international study by Anggrahini et al. (2015) also demonstrated that fresh produce supply chains are highly risky, particularly in terms of quality and distribution. However, most of these studies remain general in scope and have not specifically mapped raw material supply chain risks in the context of healthy food MSMEs in Indonesia.

Accordingly, there is a research gap that needs to be addressed, namely how to identify, evaluate, and prioritize raw material supply chain risks in healthy food businesses using a systematic analytical method. This study adopts the Failure Mode and Effect Analysis (FMEA) method, a quantitative approach commonly used to identify potential failures in a system. According to Stamatis (2003) FMEA assesses risks based on three main parameters: severity, occurrence, and detection. These values are then multiplied to generate the Risk Priority Number (RPN), which serves as the basis for prioritizing risk management.

The application of FMEA in this study offers two advantages. First, the method provides a structured assessment of various potential risks within the supply chain. Second, FMEA enables small businesses to identify critical risks without requiring highly complex data, making it practical and applicable for MSME contexts.

This study makes two main contributions. Theoretically, it enriches the risk management literature by applying FMEA in the context of healthy food MSMEs in Indonesia. Most previous studies have focused on consumer aspects or general operational risks, whereas this study highlights raw material supply chains as the core of business sustainability. Practically, the findings are expected to offer concrete recommendations for entrepreneurs, such as diversifying organic farmer partners, implementing raw material quality standards, and improving distribution systems. Thus, this study benefits not only academics but also business practitioners and policymakers supporting the development of healthy food MSMEs in Indonesia.

## METHODS

This study using a quantitative descriptive design with the Failure Mode and Effect Analysis (FMEA) approach. A descriptive design was selected because the study aimed to systematically describe the raw material supply chain risks faced by healthy food catering businesses in Malang City. The quantitative approach was applied to obtain numerical measurements of severity, occurrence, and detection levels for each potential risk (Vazdani et al., 2017).

The choice of FMEA was deliberate. In risk management literature, various analytical techniques are available, such as the Risk Matrix, House of Risk (HOR), Analytical Hierarchy Process (AHP), and Monte Carlo Simulation. However, for this research context focusing on micro, small, and medium enterprises (MSMEs) with limited data, FMEA was deemed more suitable due to several advantages: Simplicity and structure, making it applicable for entrepreneurs with non-technical managerial backgrounds; Risk prioritization through the Risk Priority Number (RPN) without requiring complex mathematical models; Flexibility, as it can be applied across multiple sectors, from manufacturing to services, including healthy food businesses; Practicality for MSMEs, since it does not demand advanced software and can be conducted using basic qualitative and quantitative data from interviews and questionnaires (Sharma & Srivastava, 2018; Wu et al., 2021). Thus, the research design was developed to generate findings that are both practically applicable and academically relevant.

Penelitian dilakukan di UMKM catering healthy food, sebuah usaha katering makanan sehat yang berlokasi di Jl. Andromeda No. 11, Tlogomas, Kota Malang. Lokasi ini dipilih secara sengaja (*purposive sampling*) dengan pertimbangan: usaha ini telah beroperasi sejak 2019 dan memiliki pengalaman menghadapi dinamika permintaan konsumen; Produk yang dihasilkan sepenuhnya berbasis bahan organik, sehingga sangat relevan dengan fokus penelitian tentang supply chain bahan baku; Pemilik usaha dan karyawan bersedia memberikan akses informasi terkait operasional rantai pasok.

The study was conducted at *UMKM Catering Healthy Food*, a healthy food catering enterprise located at Jl. Andromeda No. 11, Tlogomas, Malang City. This site was selected using purposive

sampling based on the following considerations: The business has been operating since 2019 and has experience in managing dynamic consumer demand; Its products are entirely organic-based, making it highly relevant to the study's focus on raw material supply chain risks; The owner and employees were willing to provide access to supply chain operational data.

The research population comprised all stakeholders involved in the procurement of organic raw materials, including the business owner, production and logistics staff, and partner farmers supplying organic vegetables.

The sample was determined using purposive sampling based on their role in the supply chain:

1. The business owner, as the key informant with knowledge of supply chain management strategies.
2. Three production and logistics employees, as supporting respondents familiar with procurement and distribution operations.
3. Five partner organic farmers, as external stakeholders contributing to raw material availability.

In total, nine respondents were directly involved in interviews and questionnaires. This number was considered sufficient given the case study approach, which emphasizes analytical depth rather than statistical generalization.

Two types of data were collected primary and secondary data. Primary data with Semi-structured interviews with the business owner and employees to explore supply chain risks, past experiences, and existing mitigation strategies; Likert-scale questionnaires distributed to employees and partner farmers to evaluate potential risks in terms of severity, occurrence, and detection; also Direct observation of raw material reception, quality control, and storage processes.

Secondary data collected by internal documents, such as raw material purchase records, production reports, and delivery delay logs; also relevant academic literature and prior studies on healthy food supply chain risks.

The main instrument was the FMEA questionnaire sheet, consisting of three evaluation components (Lipol & Haq, 2011):

- **Severity (S):** The degree of seriousness of the failure, rated on a 1–10 scale (1 = negligible impact, 10 = severe impact on business sustainability).
- **Occurrence (O):** The likelihood of risk occurrence, rated on a 1–10 scale (1 = rare, 10 = almost certain).
- **Detection (D):** The ability of the system to detect risks before they cause adverse effects, rated on a 1–10 scale (1 = easily detectable, 10 = very difficult to detect).

Data were analyzed using the following FMEA steps:

1. **Risk Identification:** All potential raw material supply chain risks were identified through interviews and observations, categorized into quantity limitations, raw material quality, and distribution/logistics.
2. **Risk Assessment:** Each risk was scored based on severity, occurrence, and detection, using a 1–10 scale.
3. **Risk Priority Number (RPN) Calculation:** The RPN for each risk was calculated using the formula:

$$RPN=S\times O\times D \quad (1)$$

   RPN values ranged from 1 to 1000, with higher values indicating higher priority for mitigation.
4. **Risk Prioritization:** Risks were ranked from highest to lowest RPN. The three risks with the highest RPN were determined as the primary focus for mitigation strategies.

## RESULT AND DISCUSSION

### Supply Chain Risk Identification

Based on interviews with the business owner, employees, and partner farmers, the raw material supply chain of *Dailee Healthy Club* was found to face three main categories of risks:

1. Availability Risk, including the limited number of organic farmer partners; high dependence of organic vegetable production on seasonal and weather conditions; and insufficient supply capacity during peak demand periods.
2. Quality Risk, referring to inconsistent implementation of organic standards among farmers; frequent quality variations such as differences in size, color, and freshness; and high perishability of raw materials without preservatives, which requires fast distribution.
3. Distribution Risk, including delivery delays from farmers due to weather or logistical issues; limited transportation infrastructure, particularly when sourcing from rural areas; and relatively high shipping costs that reduce profit margins.

Respondents evaluated these risks using the FMEA instrument by assigning scores for severity (S), occurrence (O), and detection (D). These scores were used to calculate the Risk Priority Number (RPN) and determine priority levels.

Table 1. FMEA Results of Raw Material Supply Chain Risks

| Risiko | S | O | D | RPN | Ranking |
|---|---|---|---|---|---|
| Limited organic raw materials | 9 | 7 | 5 | 315 | 1 |
| Variations in raw material quality | 8 | 6 | 6 | 288 | 2 |
| Delays in raw material delivery | 7 | 6 | 5 | 210 | 3 |

The findings indicate that limited availability of organic raw materials poses the highest-priority risk with an RPN of 315.

### Interpretation of Results

### Risk of Limited Organic Raw Materials

The results show that limited organic raw materials represent the most critical risk, consistent with literature highlighting that one of the main challenges of organic food supply chains in developing countries is the limited number and capacity of organic farmers (Amalina, 2015; Trienekens & Zuurbier, 2008). In the Greater Malang region, organic farmers remain relatively scarce, and organic certification is costly and complex, discouraging many farmers from adopting organic farming despite growing consumer demand. Consequently, healthy food enterprises face difficulties in ensuring supply continuity.

This limitation is further exacerbated by external factors such as weather, water availability, and soil fertility. Extreme rainy seasons reduce yields, while prolonged droughts lower productivity. As such, organic supply chains are more vulnerable than conventional ones Anggrahini et al. (2015). For catering businesses, limited raw materials cause two main impacts: disrupted production schedules when promised menus cannot be fulfilled on time, and increased costs when sourcing from alternative suppliers at higher prices.

From a managerial perspective, diversifying suppliers is key. Healthy food caterers need to expand cooperation with more organic farmers, even beyond Malang, and establish long-term contractual partnerships to secure both quality and quantity of supply.

### Risk of Raw Material Quality Variation

The second most critical risk concerns raw material quality variation. In the healthy food business, raw material quality is a central attribute of consumer satisfaction. Variations arise because farmers apply different cultivation standards, some inconsistently using organic fertilizers. This

inconsistency directly impacts consumer perceptions, as healthy food customers are highly sensitive to freshness, cleanliness, size, and appearance. Even slight quality declines may result in complaints and reduced loyalty.

Latifa (2018) found that diet catering customers have high expectations of quality consistency. Similarly, Total Quality Management (TQM) theory emphasizes quality consistency as a key factor in food service success. International research by Trienekens & Zuurbier (2008) also highlights the necessity of strict quality standards in organic supply chains.

In this case, quality variations occur due to the absence of standardized procurement guidelines and insufficient quality checks at the raw material intake stage. To address this, structured quality control procedures must be implemented, such as standard inspections for color, texture, size, and freshness. This not only improves product consistency but also builds long-term consumer trust.

**Risk of Delivery Delays**

Delivery delays rank third in the analysis. Although its RPN is lower than the other two risks, delays still have significant implications due to the perishable nature of organic products. Delayed deliveries reduce freshness, which contradicts the core principle of healthy food businesses.

The main causes of delays include weather conditions, transportation access from farming areas, and inadequate logistics infrastructure. Christopher (2022) emphasizes that on-time delivery is a key performance indicator in fresh food supply chains. For catering services, delays lead to reduced product quality and disrupted production schedules, ultimately lowering customer satisfaction.

Practical solutions include collaboration with more reliable local logistics providers and the introduction of limited buffer stocks using cold storage facilities to preserve certain raw materials.

This study supports and extends previous research. It aligns with Amalina (2015), who identified organic supply limitations in Malang as a primary risk; with Latifa (2018), who emphasized the importance of product quality; and with Anggrahini et al. (2015), who highlighted the vulnerability of fresh produce supply chains to external factors.

The novelty of this study lies in its focus on organic raw material supply chains rather than general operational risks. Moreover, by applying FMEA, it provides a quantitative prioritization of risks, a method rarely used in the context of Indonesian healthy food MSMEs. The study also underscores the critical issue of limited farmer partners, which has been underexplored in prior literature.

**Managerial Implications**

Based on the findings, several strategic implications can be drawn for healthy food entrepreneurs:

1. **Short-term strategies:** Enforce stricter raw material inspections, increase communication with partner farmers to monitor supply, and adopt flexible delivery schedules to anticipate weather-related disruptions.
2. **Medium-term strategies:** Diversify suppliers by engaging new farmers, provide training on organic farming standards, and invest in cold storage facilities to maintain quality.
3. **Long-term strategies:** Establish long-term contracts with farmer partners, develop farmer communities as core suppliers, and leverage digital technology (e.g., supply chain tracking applications) to monitor operations.

Despite offering comprehensive insights, this study has certain limitations. First, FMEA assessments rely heavily on respondent perceptions, introducing potential subjectivity bias. Second, as a single case study, the results cannot be generalized directly to all healthy food enterprises.

## CONCLUSION

This study aimed to identify and evaluate raw material supply chain risks in healthy food catering businesses in Malang City using the Failure Mode and Effect Analysis (FMEA) method. As outlined in the introduction, supply chain risks were expected to be critical factors influencing the sustainability of healthy food enterprises. The findings confirmed this expectation, as the FMEA

analysis revealed that the limited availability of organic raw materials constitutes the highest-priority risk, followed by variations in raw material quality and delivery delays.

These results indicate that the sustainability of healthy food businesses is highly dependent on effective raw material supply management. Therefore, mitigation strategies should include diversifying partnerships with organic farmers, implementing procurement quality standards, strengthening distribution systems, and establishing mutually beneficial long-term contracts between entrepreneurs and farmers. Such efforts will not only reduce potential losses but also enhance customer satisfaction and loyalty.

The scope for further development of this research is substantial. First, FMEA can be combined with other approaches such as the House of Risk (HOR) or the Analytical Hierarchy Process (AHP) to generate a more comprehensive risk analysis, including inter-risk relationships. Second, future research could broaden the scope by examining healthy catering businesses in other cities, thereby enabling generalization of findings and cross-regional comparisons. Third, integrating consumer perspectives would provide insights into how raw material risks affect service quality perceptions and customer loyalty.

In conclusion, this study contributes both academically and practically. Academically, it enriches the risk management literature by applying FMEA within the context of healthy food MSMEs. Practically, it offers actionable recommendations for entrepreneurs and policymakers. The findings are expected to serve as a foundation for more adaptive and sustainable risk management strategies, ensuring that healthy food businesses continue to thrive amid dynamic consumer demand and ongoing supply chain challenges.

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