OPEN ACCESS
Advances in Animal and Veterinary Sciences
Research Article

Comprehensive Analysis of Supply Chain Risk in the Goat Milk Industry in East Java: Scor-FMEA Approach

Asmaul Khusna[1], Mujtahidah Anggriani Ummul Muzayyanah[2], Tri Anggraeni Kusumastuti[2], Ahmad Romadhoni Surya Putra[2]

[1]Study Program of Doctor in Animal Science, Faculty of Animal Science, Universitas Gadjah Mada, Jl. Fauna No. 3 Bulaksumur, Yogyakarta, Indonesia; [2]Department of Livestock Socioeconomics, Faculty of Animal Science, Universitas Gadjah Mada, Jl. Fauna No. 3 Bulaksumur, Yogyakarta, Indonesia.

Abstract | The goat milk industry in East Java is an important sector for the local economy dominated by small businesses with complex supply chains. The goat milk industry in East Java faces many supply chain risks that have the potential to disrupt the operation and efficiency of the supply chain. The objective of this study is to conduct a comprehensive risk analysis on the goat milk supply chain in East Java and formulate mitigations. This study is a qualitative and quantitative research. The research was conducted in three major goat milk producing regions in East Java: Lumajang, Malang, and Banyuwangi. Data were collected through interviews with 173 dairy goat farms, 27 intermediaries, and 7 dairy company representatives. Potential failures were found using the SCOR matrix. FMEA was then used to assess and analyze risks, considering the frequency of occurrence (O), severity (S), and detectability (D) of each failure. The higher the calculated RPN value, the more likely the failure is to occur. The identification results show that the 3 risks with the highest values are fluctuating milk prices, milk quality not in accordance with physicochemical quality, and packaging leakage during delivery. The results of risk mitigation analysis using AHP found that the priority risk mitigation is by training and improving the competence of supply chain actors with a score of 0,365 and a consistency value of 0,04.

Keywords | East java, Goat milk, Risk analysis, Supply chain

Received | June 10, 2024; **Accepted** | October 09, 2024; **Published** | January 10, 2025
***Correspondence** | Mujtahidah Anggriani Ummul Muzayyanah, Department of Livestock Socioeconomics, Faculty of Animal Science, Universitas Gadjah Mada, Jl. Fauna No. 3 Bulaksumur, Yogyakarta, Indonesia; **Email:** m_anggriani_um@ugm.ac.id
Citation | Khusna A, Muzayyanah MAU, Kusumastuti TA, Putra ARS (2025). Comprehensive analysis of supply chain risk in the goat milk industry in east java: Scor-fmea approach. Adv. Anim. Vet. Sci. 12(2): 217-230.
DOI | https://dx.doi.org/10.17582/journal.aavs/2025/12.2.217.230
ISSN (Online) | 2307-8316; **ISSN (Print)** | 2309-3331

INTRODUCTION

The goat milk industry has grown and expanded significantly in recent years (Miller and Lu, 2019; Popescu *et al*., 2021; Sumarmono, 2022). Goat milk is increasingly recognized for its nutritional advantages over cow's milk, especially in terms of digestibility and health benefits. Studies have shown that goat milk contains a good protein profile, including A2 β-casein protein and medium-chain fatty acids, which are associated with better digestion and lower allergic reactions in infants (Bahbah *et al*., 2022; Mal *et al*., 2018). Goat milk has been associated with a variety of

health benefits, including prevention of obesity and insulin resistance, as shown in animal studies (Delgadillo-Puga *et al*., 2020) In addition, its unique biochemical composition allows it to play a role in managing gastrointestinal disorders, making it a valuable product in health-focused markets (Carvalho *et al*., 2012). This growing awareness has led to an increased demand for goat milk products in various markets, including Europe and North America, where consumers are looking for alternatives to cow's milk due to lactose intolerance or allergies (Huda *et al*., 2023; Jung *et al*., 2016). The goat milk market is also growing in Asian countries, including Indonesia, which is expected to experience significant growth until 2030. This provides a positive outlook for the goat milk industry in this country (Zhang *et al*., 2022). Evidence of an increase in the number of dairy goats being raised in Indonesia indicates that interest and investment in the dairy goat business is increasing. Milk production in Indonesia is expected to grow by 0.25% until 2028 (Cahyo *et al*., 2022). East Java is one of the provinces in Indonesia with the second highest goat milk production. East Java contributes 30% of the total milk production in Indonesia. The goat milk industry in East Java has become an important sector that contributes to the local economy and the nutritional needs of the population (Miller and Lu, 2019; Santoso and Suman, 2023). The goat milk industry in this region is mostly composed of small-scale farms and small and medium enterprises (Maesya and Rusdiana, 2018). Health implications, functional properties and contributions to the local economy aspect increase the attractiveness of goat milk in the supply chain, as health-conscious consumers are more likely to seek products that offer functional benefits.

The goat milk industry in East Java involves several links, forming a long and complex supply chain (Hikmah *et al*., 2023). The goat milk supply chain starts from milk production on farms, the milk collection process, the milk distribution process to processing, the processing of milk into processed products, until it reaches consumers. The flow of the fresh milk supply chain in East Java is generally influenced by differences in quality, the chain members involved in it, and the rules of the game or systems built between stakeholders. In practice, the flow of the goat milk supply chain experiences many risks that have the potential to disrupt operations and affect the efficiency of the supply chain (Bode and Wagner, 2015).

Dairy goat farming in East Java has a uniqueness that reflects local adaptation to social, economic, and environmental conditions. One of its characteristics is that management is still widely carried out traditionally, although there are efforts to increase productivity through training and the application of modern management (Sumarmono, 2022). The existence of dairy goats, especially the Peranakan Ettawah and Senduro goats, is important in meeting the community's animal protein needs. These goats are known to have good milk production potential. However, challenges in health and reproductive management are still problems that must be overcome (Fatmawati *et al*., 2022). Most dairy goat farmers in East Java still consider natural mating to be better than artificial insemination. The quality of dairy goat milk in East Java is also a concern, especially related to microbiology and factors that affect production. Research shows that raw goat milk is often considered more nutritious (Putri *et al*., 2021). Limited market infrastructure makes it difficult for farmers to reach a wider market and get better prices for their products (Nguyen *et al*., 2023).

Risks that occur in the supply chain are factors that hinder operations in the supply chain. Risk cannot be eliminated completely but can be minimized by carrying out appropriate risk management. Group risk management strategies into four groups, namely risk avoidance, risk reduction, risk transfer and risk retention (Giannakis and Papadopoulos, 2016). Risk must be controlled because otherwise, there will be a chance of problems with the supply of materials resulting in financial losses. Existing research has focused on supply chain risk management in various industries, including manufacturing (Ganji *et al*., 2017; Pham *et al*., 2023; Shenoi *et al*., 2018), food (Khan *et al*., 2019; Lestari *et al*., 2021; Tran, 2018) and technology (Hove-Sibanda *et al*., 2021; Warsi *et al*., 2020). These studies concentrate on improving supply chain efficiency, developing risk management measures, and increasing resilience. Certain businesses, such as the East Java goat milk industry, have received relatively little investigation. Existing research often focuses on basic supply chain risk management principles, which may not adequately capture the unique circumstances and issues in certain locations, such as East Java. Thus, a specific supply chain risk management study is needed in the East Java goat milk business.

The resulting risk analysis is expected to help the decision-making process that can be carried out by actors involved in the supply chain in determining risk management actions based on the results of the risk assessment. This study includes risks shown in each supply chain process, the results of risk measurement and assessment, then finding mitigation efforts. Identification of risks in each process from the farm unit to the finished product, is analyzed based on literature studies and then confirmed by direct observation in the field and confirmation with experts. After the identified risks are obtained from the entire process, the supply chain risk evaluation is continued. In this process, a risk assessment is carried out for each risk in each supply chain activity.

This study proposes to use the SCOR (Supply Chain Operations Reference) model and the FMEA (Failure Modes and Effects Analysis) method as tools for risk identification

in the goat milk supply chain. To determine risk mitigation strategies, the AHP (Analytical Hierarchy Process) analysis method is used. The SCOR model provides a structured framework to identify and improve supply chain performance by examining key processes such as plan, source, make, deliver, and return (Ayyıldız and Gümüş, 2020; Hidayati and Pulansari, 2023). On the other hand, FMEA is a systematic approach to identify potential failure points in these processes, propagate their impact, prioritize them based on severity, and implement preventive measures (Wu and Hsiao, 2021). Meanwhile, AHP is a systematic and structured decision-making method, which allows decision-makers to evaluate various alternatives based on predefined criteria (Agustine *et al*., 2023). Using AHP, risks can be prioritized based on predefined criteria. This helps in determining which risks should be addressed first, so that resources can be allocated efficiently to mitigate the most significant risks (Yusrianafi and Dahdah, 2021).

MATERIALS AND METHODS

This study was conducted in three districts that are centers of dairy goat farming in East Java Province, Indonesia, namely Lumajang Regency, Malang Regency, and Banyuwangi Regency. These three districts are centers of dairy goat farming and have the highest milk production in East Java. According to data from the East Java Provincial Agriculture Service, Lumajang Regency has 40% goat milk production, Banyuwangi 25%, Malang Regency 25% of the total goat milk in East Java. Activities in the goat milk supply chain in East Java consist of several stages, the first is activities at the dairy goat farm level, the second is activities at middleman, the third is activities at milk processing factories, and the last is activities that include trade in processed milk products. The most processed goat's milk in East Java is pasteurized goat's milk and powdered milk (Sumarmono, 2022). The risk analysis in this research focuses on the supply chain of the two goat milk products. All processes that occur in each chain can be seen in Figure 1.

Figure 1 shows the main actors in the goat milk supply chain: dairy goat farms, intermediaries, and goat milk processing companies. Representatives from each actor were informed and introduced to the purpose of the study. It was also stated that their participation was voluntary, and all information would be kept confidential. After agreeing to participate in the study, respondents were interviewed to confirm and comment on potential errors in their operations. After that, they provided us with field data on the occurrence and detection of each identified failure. In addition to interviews, the research team also conducted observations and surveys in the study area. Respondents were selected using a purposive sampling method, with the provision that they had been running a business for at least 5 years and had at least 5 lactating dairy goats. Meanwhile, the criteria for selecting respondents for intermediaries were having experience as a collector for at least 1 year and the amount of milk collected was at least 200 liters/month. The criteria for milk factories were having experience in the goat milk processing industry for 1 year and producing processed goat milk products at least 500 liters/month. The number of respondents who met the requirements was 207 people spread across 3 sub-districts, namely in Lumajang Regency 85 dairy goat farms, 13 collectors, and 2 milk factories. Respondents from Malang Regency consisted of 35 dairy goat farms, 8 collectors, and 4 milk factories. Finally, respondents from Banyuwangi Regency consisted of 53 dairy goat farms, 6 collectors, and 1 milk factory. In the formulation of risk mitigation, we added respondents from the government in each district as policy makers.

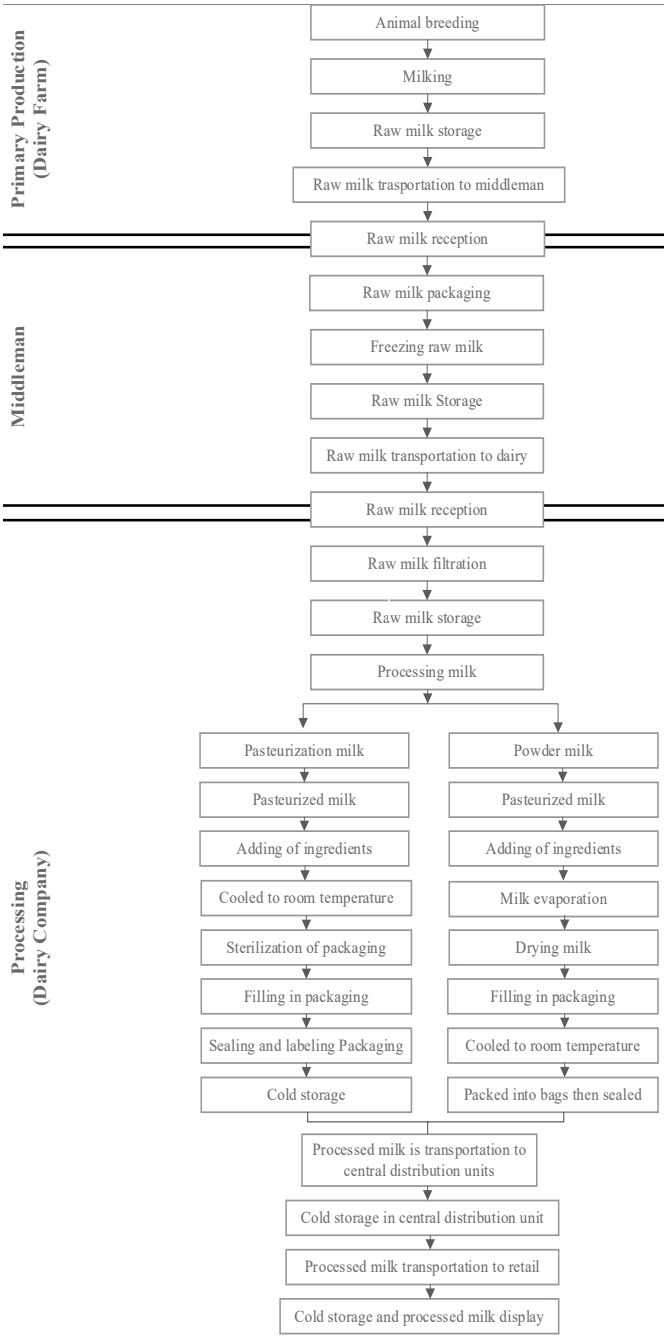

Figure 1: Goat milk supply chain flow diagram in East Java.

Table 1: Scale of severity, occurrence and detection.

Scale	Severity	Occurrence	Detection
10	The effects are very dangerous	Almost always happens	No one is able to detect the cause of failure and subsequent failure mode
9	The effect is very high	Very often	Very little ability to detect the cause of failure and subsequent failure mode
8	The effect is high	Often	Little ability to detect the cause of failure and subsequent failure mode
7	The effect is quite high	Often enough	Very low ability to detect the cause of failure and subsequent failure mode
6	The effect is moderate	A little often	Low ability to detect the cause of failure and subsequent failure mode
5	The effect is low	Seldom	Medium ability to detect the cause of failure and subsequent failure mode
4	The effect is very low	A little rare	Quite high ability to detect the cause of failure and subsequent failure mode
3	The effect is small	Quite rare	High ability to detect the cause of failure and subsequent failure mode
2	The effect is very small	Very rarely	Very high ability to detect the cause of failure and subsequent failure mode
1	No effect	Almost never happens	Almost certain ability to detect the cause of failure and subsequent failure mode

Data Analysis

Identify potential failures that occur in each activity in the goat milk supply chain related to food safety and food quality. Identification is carried out using the SCOR (supply chain operation reference) matrix reference. The risk list was created as a reference model for supply chain operations into five processes, namely Plan, Source, Make, Delivery and Return. FMEA analysis is applied for risk assessment and analysis (Giannakis and Papadopoulos, 2016; Wu and Hsiao, 2021). For this purpose, values of the frequency of occurrence for each failure (O), the seriousness of the failure (S) and the probability of detection of the failure (D) are required. In the first stage, the level of failure seriousness (S) is given a value from 1 to 10. The highest S value is defined as a very serious failure. Depending on the probability of occurrence, each failure is assigned an O value in the range from 1 to 10. The highest O value represents the greatest probability of the failure occurring (Table 1). The D value was also evaluated in this study, as shown in Table 1. The higher the D value means failure is difficult to detect. The risk score is calculated based on data obtained from interviewing respondents in the field. These components allow us to know the risk priority of identified failures by calculating the RPN (Risk Priority Number) value (Zandi *et al*., 2020). The formula for calculating the RPN value is:

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

The higher the calculated RPN value means the higher the risk of identified failure. The maximum RPN value that can be obtained is 1000. The RPN value is divided into 3 categories, the first is the high-risk category if the RPN value is >100, the second is the medium risk category if the RPN value ranges between 35 – 100, the third is the low-risk category with the RPN value <35 (Geng *et al*., 2023; Schuller *et al*., 2017).

The prioritization of goat milk supply chain risk mitigation strategies in East Java requires a mapping with the AHP method to explain the interrelationships between criteria in formulating risk mitigation strategies. AHP is a measurement theory that uses pairwise comparisons and relies on expert judgment using a priority scale. This analysis is included in the multicriteria decision analysis (MCDA) tool. Respondents were selected based on strict qualifications regarding position, education, and experience. There is no general stipulation on the number of participants to be taken. Studies using AHP use the opinions of stakeholders (experts); therefore, a smaller number of respondents than the statistical approach is possible. The determination of alternative prioritization of the level of importance of the strategies for the formulation of prioritized goat milk supply chain risk mitigation strategies in East Java was carried out with the AHP method using expert choice 11 software. If the consistency ratio value is below 0,1, this indicates that the assessment made by the respondents is consistent (Agustine *et al*., 2023). The stages of the AHP analysis method are (1) formulating the problem using a hierarchy, (2) compiling a matrix of individual opinions from each expert, (3) comparing between elements, namely comparison between criteria and comparison between alternative risk mitigation options, and (4) compiling a combined opinion matrix from each expert.

RESULTS AND DISCUSSION

Risk Analysis

Risk analysis begins with the risk identification process, looking for critical values or critical activities in the supply chain, which can be processes, systems and production activities. The next step is to identify sources of variation that present a major or high impact. Then the final step is to identify the overall risk value. This underlies that when you want to mitigate a problem, the process with the highest risk becomes a priority. After conducting interviews with experts and operators in the field, the risks studied were focused on risks in supply chain management, resulting in

a list of 24 risks that could potentially arise in the farmer's supply chain, 15 risks in the collector's supply chain, 24 risks in the goat's milk processing industry. Based on the SCOR reference, the risk list was created as a reference model for supply chain operations into five processes, namely plan, source, make, delivery and return.

Dairy Goat Farm Subsystem

The distribution of risks that occur in the goat milk supply chain for farmers is seen based on the five SCOR processes can be seen in Table 2. In terms of quantity, the largest potential risks are in the Source process (41.7%), Make (25%), Plan (16.7%), Deliver (12.5%), and Return (4.1%). Based on the risk category from the results of the risk score calculation in Table 2, there are 3 risks that fall into the high category (RPN> 100), 18 risks that fall into the medium category (RPN 35-100), and 3 risks that fall into the low category (RPN <35). Several risks that fall into the high-risk category need attention to reduce the possibility and impact of failure (Daneshvar *et al*., 2020). The risk with the highest score is in the make process, namely milk purchased at a low price with a score of 175. The price of goat milk at the farmer level in East Java has fluctuated. Fluctuations in goat milk prices are greatly influenced by market demand and consumer preferences (Miller and Lu, 2019; Tsakali *et al*., 2019). Raw milk prices fall when there is an oversupply from farmers. When raw milk prices are low due to oversupply, farmers in East Java anticipate this by breeding lactating goat (drying lactating goat), this is one step in implementing smart farming practices (Belanche *et al*., 2019). Lack of access to accurate market information is also a limiting factor. Many farmers in East Java do not have sufficient knowledge of market prices and consumer demand, making it difficult for them to compete with other, more informed farmers. Research shows that farmers who have access to market information tend to get better prices, while farmers who do not have such access are often forced to sell products at lower prices (Wadjdi and Ali, 2023). This shows the importance of extension and training for farmers to improve their knowledge of the market.

The second risk of failure is in the planning process, namely inappropriate lactation period planning with a score of 112. Inappropriate lactation period planning in dairy goat farms in East Java often occurs due to the lack of ability of farmers in East Java in reproductive management which has an impact on the amount of fluctuating fresh milk production. Most goat farmers in East Java still do natural mating rather than artificial insemination. Traditional preferences that are still strong among farmers also influence their decision to use natural mating. Many farmers have been using this method for a long time and feel comfortable with it. They believe that natural mating is more effective or safer than artificial insemination, although studies have shown that artificial insemination can increase reproductive efficiency and milk productivity (Alhuur *et al*., 2022; Mulatmi *et al*., 2016). A comprehensive understanding of reproductive management is essential for farmers to achieve optimal milk production, cost effectiveness, and overall sustainability of their operations (Bewley *et al*., 2017).

The third rank is in the Make process with a risk of failure, namely low milk quality with a score of 105. Low milk quality results in milk being rejected by dairy companies. Low milk quality is caused by low feed quality (Hasanah *et al*., 2023). Green fodder is the main component in the diet of dairy goats. Farmers in East Java often rely on local grass and other green plants available around the pen. However, the quality and quantity of this green fodder can vary depending on the season and location. Research shows that many farmers do not pay attention to the optimal nutritional needs of goats, so that feeding is often not in accordance with the basal needs of livestock (Khasanah *et al*., 2023). This can affect the health, productivity and quality of goat milk. Farmers in East Java often add concentrate to increase energy and protein intake, especially during lactation. However, the management of providing this concentrate is often not standardized, and many farmers still use traditional methods in determining the amount and frequency of feeding (Mahanani *et al*., 2023). Lack of livestock knowledge in milking management, barn sanitation and improper post-harvest handling of milk can also affect milk quality (Júnior *et al*., 2018). In East Java, milking is still done traditionally using hands, so the consistency of farmers in maintaining personal hygiene before milking is very important. Milk storage containers use plastic bottles, it is very rare to find milk cans on dairy goat farms in East Java. The use of plastic bottles as storage containers makes the risk of milk contamination very high, because plastic containers cannot be sterilized using hot water (Pisestyani *et al*., 2021).

Middleman Subsystem

The distribution of risks that occur in the goat milk supply chain in the collector subsystem based on the five SCOR processes can be seen in Table 3. In terms of quantity, the largest potential risks are in Source (26.6%), Make (26.6%), Deliver (26.6%), Return (13.3%) and Plan (6.7%). Based on the risk category from the results of the risk score calculation in Table 3, there are 2 risks of failure in the high category (RPN> 100), 3 risks in the medium category (RPN 35-100), and 10 risks in the low category (RPN <35). The risk with the highest score is in the source process, namely the fluctuating price of milk with a score of 168. Price fluctuations that occur in the goat milk supply chain in East Java are caused by the demand for goat milk which varies depending on the season, consumption trends, and community preferences. For example, during the month of Ramadan or holidays, the demand for goat milk tends to increase, but at other times, demand can decrease drastically

Table 2: FMEA analysis of the goat milk supply chain at the dairy goat farm.

SCOR models	Failure Mode	Effect	Potential causes	S	O	D	RPN
Plan	Planning the lactation period for livestock is not appropriate	The amount of milk production cannot be ascertained	Lack of farmer ability in goat reproduction management No recording was done	4	7	4	112
	Inappropriate planning of feed requirements	Animal feed needs are not met	Lack of farmer ability in feed management	3	6	3	54
	Inappropriate planning of mating time for livestock	Irregular pregnancy in livestock	Lack of farmer ability in goat reproduction management	4	6	4	96
	Milk production planning is not appropriate	There is an excess supply or lack of milk supply	Lack of breeders' ability to read market opportunities	4	6	4	96
Source	Low quality of feed ingredients	Livestock experience malnutrition Low milk production Low milk quality	Improper handling of feed ingredients Farmers' lack of knowledge regarding the nutritional content of feed ingredients	2	7	3	42
	Lack of forage	Low milk production	Effect of the dry season The location of the cage is in the city	3	7	3	63
	Lack of concentrate feed	Low milk quality	Farmers lack of understanding about the importance of concentrate feed Limitations of breeders in purchasing concentrates	3	7	3	63
	Lack of drinking water	Low milk production	Effect of the dry season	2	7	3	42
	Sick livestock	Milk production decreases Milk contaminated with antibiotics	Virus spread Poor maintenance management	3	7	3	63
	Transmission of disease to other livestock	The number of sick livestock increases	Lack of implementation of sanitation and biosecurity	3	7	3	63
	Livestock experience heat stress	Livestock appetite decreases Livestock consume a lot of water	Climate change	2	6	3	36
	Cattle fail to mate	Delayed pregnancy	Signs of heat were not detected	4	6	4	96
	Cattle fail to get pregnant	Delayed lactation period	Malnutrition in livestock resulting in low livestock fertility	3	6	4	72
	Cattle die during calving	The number of livestock during the lactation period decreases	Infected with brucellosis bacteria Breech position of the fetus	3	7	3	63
Make	The process of milking the nipples is not optimal	The udder is infected with mastitis	Breeders have not yet mastered proper milking techniques	2	6	3	36
	Milk contaminated with microbes	Spoiled milk Milk collectors reject it	Lack of sanitation during the milking process Milk storage temperature is not appropriate	1	7	3	21
	Milk contaminated with foreign matter	Milk collectors reject it	The milk storage container is open The milking pen is not clean	1	7	3	21
	Milk production decreases	Unable to meet milk deposit targets from collectors/dairy company Farmers' income decreases	Lack of forage Lack of drinking water consumption Livestock experience *heat stress*	2	6	3	36
	Low milk quality	Milk is rejected by collectors/dairy company	Low feed quality Lack of knowledge of good milking management	5	7	3	105
	Milk is bought at a cheap price	Reduced income	Over supply of milk	7	7	7	175
Deliver	Milk spilled during delivery	The amount of milk deposited to collectors has decreased	The milk storage container used is not safe	2	6	3	36

	Milk is not sold out	Milk spoils if stored too long	There is an over supply of milk The amount of milk received is limited by the factory	2	6	3	36
	Milk was damaged during delivery	Milk is rejected by collectors/Dairy Company	The distance traveled is too far	2	6	3	36
Return	Milk does not comply with collector/Dairy Company standards	Milk is rejected	Low milk quality	1	6	3	18

Table 3: FMEA analysis of the goat milk supply chain in the middleman subsystem.

SCOR models	Failure Mode	Effect	Potential causes	S	O	D	RPN
Plans	Planning the amount of milk supply is not appropriate	There are excesses and shortages of milk stock	Lack of records on available milk stock	6	7	3	126
Source	The amount of milk from farmers is small	Lack of milk stock Milk prices increase	Many livestock are entering a dry period	4	6	3	72
	The quality of milk from farmers is low	Milk rejected by dairy company	Lack of checks when receiving milk	5	5	2	50
	There is milk adulteration	Milk rejected by dairy company	Lack of checks when receiving milk	4	6	3	72
	Milk prices fluctuate	Profits are reduced	Excess or deficiency in the amount of milk in the farmer Factories limit production	7	6	4	168
Make	The presence of physicochemical contamination	Milk is rejected by Dairy Company	Lack of checks when receiving milk Regarding animal feed nutrition	2	3	1	6
	The presence of microbiological contamination	Milk is rejected by Dairy Company	Lack of checks when receiving milk Sanitation is less than optimal	1	4	2	8
	Milk was damaged during storage	Milk is rejected by Dairy company	Storage temperature is unstable	3	4	1	12
	Milk storage temperature is unstable	Spoiled milk	The refrigerator is broken	3	4	2	24
Deliver	The milk delivery vehicle is damaged or has an accident on the road	Milk was damaged during delivery	No regular checks are carried out on transport vehicles	2	4	2	16
	The milk was damaged while in transit	Milk rejected by Dairy company	Long delivery time Packaging damaged	2	4	2	16
	Delivery not according to the specified schedule	Consumers/Dairy company are disappointed	Delivery vehicles are damaged or stuck on the road	1	2	2	4
	Packaging leaks during delivery	Spoiled milk Milk rejected by Dairy company	The quality of the packaging materials is not good Handling during transportation was careless	4	4	1	16
Return	Milk quality does not meet Cooperative/Dairy Company standards	Milk is rejected by Dairy company	There is damage to the milk or contamination of the milk	1	3	1	3
	The amount of milk does not match consumer/Dairy Company requests	Consumers/Dairy company are disappointed	Milk supply is low	4	2	2	16

(Sumanto, 2017). This uncertainty in demand causes the price of goat milk to be unstable. Price fluctuations can impact profit margins, leading to low profitability when milk prices are low (Schulte *et al*., 2018) The quality of milk produced by farmers in East Java varies, which also contributes to price fluctuations. Research shows that contaminated or low-quality milk is often sold at a lower price, while high-quality milk can be sold at a better price (Agustina,

2020; Suwito *et al*., 2019). Uncertainty in the quality of milk produced by farmers forces collectors to adjust prices according to the quality received.

The second highest risk of failure is in the planning process, namely the error in planning the number of raw materials needed is not precise with a score of 126. The error in Planning the number of raw materials needed is not precise is due to the lack of accurate data and information regarding the production and demand of goat milk. Many collectors in East Java do not have an adequate information system to monitor the amount of milk available and market demand. This can cause them to make inappropriate decisions about the amount of milk to store or purchase (Seprianto *et al*., 2023). Research shows that the application of information technology in supply chain management can help improve the accuracy of stock planning and reduce the risk of errors (Ismanto *et al*., 2018). In addition, inefficient management in the supply chain can also cause errors in stock planning. In East Java, collectors still use traditional methods in managing milk stocks, which can result in errors in calculating and managing inventory (Nisa and Primandita, 2024). Recording milk stocks is very important because it facilitates effective supply chain management by providing real-time inventory level data, allowing for accurate stock replenishment, reducing the risk of running out or shortages, and optimizing the distribution process (Dineen *et al*., 2018).

Dairy goat company subsystem

The distribution of risks that occur in the goat milk supply chain in the Milk Processing Industry subsystem seen based on the five SCOR processes can be seen in Table 4. In terms of quantity, the largest potential risks are found in the make process (33.3%), source (20.8%), return (16.7%), plan (16.7%), and delivery (12.5%). Based on the risk category from the risk score calculation results in Table 4, there are 7 failure risks classified as high category (RPN> 100), 14 risks with medium category (RPN 35-100), and 3 risks with low category (RPN <35). The risks included in the high-risk category in the Milk Processing Industry subsystem in sequence are in the source process, the quality of milk does not meet physicochemical standards with an RPN score of 160. The quality of milk does not meet physicochemical standards due to the lack of understanding of farmers about sterilization and sanitation of equipment, which causes microbial contamination of milk. Farmers in East Java often rely on local grass and other green plants available around the pen. However, the quality and quantity of this green fodder can vary depending on the season and location. Research shows that many farmers do not pay attention to the best nutritional needs of goats, so that feeding is often not following the basal needs of livestock (Khasanah *et al*., 2023). The physicochemical quality of fresh milk is important in figuring out product quality for various reasons including nutritional and microbiological aspects. The physicochemical quality of milk raw materials greatly affects the success of making dairy products such as cheese and kefir (Król *et al*., 2020).

In the delivery process, namely packaging leakage during delivery with an RPN score of 144. Packaging leakage that occurs during the distribution of processed milk products to retail or to consumers is caused by pressure and shocks during product distribution. The goat milk supply chain in East Java does not yet use adequate vehicles. The vehicles used are open-back cars. processed milk products are arranged and then covered with ice gel in a box made of styrofoam. In addition, packaging leakage is also caused by the lack of quality control on the seal of processed milk product packaging. Leakage of milk packaging is an important risk because it can reduce the quality and safety of milk products. Leaking milk packaging can cause microbial contamination that has the potential to damage the product and even endanger consumer health (Ahmad and Ginantaka, 2018).

In the Make process, the temperature in the cooling process is less than optimal with a score of 120. This unstable cooling temperature is caused by unstable electricity in several areas of East Java, electricity often goes out without notice (Khaqiqi *et al*., 2022). The goat milk processing industry in East Java is dominated by Small and Medium Enterprises (SMEs) so they do not have their own electricity generators. The cooling temperature in the milk supply chain is one of the important risks in the goat milk supply chain, because milk is a product that is very susceptible to microbial growth. Inappropriate temperatures can accelerate the growth of pathogenic and harmful bacteria, which can cause damage to the product (Suharto *et al*., 2021).

In Plane process, the risk of inappropriate raw material planning gets a score of 120. The causes of failure in planning raw materials in the goat milk processing industry in East Java are the fluctuating availability of fresh goat milk and the company's lack of ability to predict consumer demand. The risk of failure in raw material planning is one of the important risks, because the lack or excess of raw materials can reduce the efficiency of the production process. Lack of raw materials can hamper the production process, while excess raw materials can increase storage costs and increase the risk of raw material damage.

In the delivery process, product damage during delivery received an RPN score of 112. The risk of product damage during delivery is in line with the high risk of damage to milk packaging during delivery. Rough handling, such as turning or stacking inappropriate products, can cause physical damage to goat milk packaging, which ultimately affects product quality (Kurniawan and Anggraeni, 2020). Research shows that physical damage to packaging can cause

Table 4: FMEA analysis of the goat milk supply chain in the dairy company subsystem.

SCOR models	Failure Mode	Effect	Potential causes	S	O	D	RPN
Plans	Planning the number of raw materials needed is not precise	Raw materials are lacking	Uncertainty of production quantities	4	6	5	126
	Changes in the number of product orders that are not according to plan	The number of products is less or more	There is a sudden event	3	5	6	90
	Changes in production planning	Less or more raw materials	Lack of ability to read opportunities	3	7	4	84
	Improper production scheduling	Product continuity is disrupted	Lack of ability in production planning	4	5	4	80
Source	The amount of milk supply received is insufficient	Production targets cannot be met	The amount of milk produced by farmers is small	6	9	2	108
	Milk quality does not meet physico-chemical standards	Cannot proceed to the next process	Regarding animal feed nutrition Lack of checks when receiving milk	4	9	4	160
	Milk prices fluctuate	Production costs increase	Regarding the amount of milk produced by farmers	6	4	3	72
	There is antibiotic and aflatoxin contamination in milk	Cannot proceed to the next process	Relating to livestock health, contamination of supply sources Lack of checks when receiving milk	2	8	5	80
	There is microbiological contamination in milk	Cannot proceed to the next process	Sanitation is less than optimal Lack of checks when receiving milk	1	8	4	32
Make	Milk pasteurization temperature is too low or too high	If the temperature is lower it causes increased microbial growth If the temperature is too high it causes the nutrients in the milk to be damaged	Lack of control over the heating process	2	7	3	42
	Food additives do not meet standards	Product quality is not up to standard	Commonly used food additives are not available	5	7	2	70
	The temperature in the cooling process is not optimal	Microbiological contamination, the growth of pathogenic and non-pathogenic bacteria, reduces product quality	The cooling machine is damaged	6	5	4	120
	Risk of seal leakage in cup and bottle packaging	Microbiological contamination	The bottle seal closure is not optimal	4	8	3	96
	Seal leak in cup packaging	Microbiological contamination	The cap position is not appropriate	4	7	3	84
	Inappropriate storage temperature	Microbiological contamination	The cooling machine is damaged	4	9	3	108
	Storage area is not clean	Microbiological contamination	Sanitation is not carried out regularly	3	7	3	63
	Errors in stock recording	Information for production planning is invalid Products that are nearing their expiration date cannot be identified	There is no checklist for outgoing and incoming products	5	5	4	100
Deliver	Truck damage during distribution	Delay in product delivery	No regular vehicle maintenance is carried out	3	7	4	84
	Packaging leaks during delivery	Microbiological contamination	Arrangement of products on transport vehicles	5	8	4	144

	Product damage during delivery	Microbiological contamination	Packaging leaks Long delivery time	4	7	4	112
Return	The number of products sent does not match consumer demand	Products rejected by consumers	There was an error in recording the order received	4	5	2	40
	The product specifications sent do not match consumer requests	Products rejected by consumers	There was an error in recording the order received	2	7	2	28
	The product has expired	Wasted product	Stock recording is not carried out	1	9	3	27
	There are defects in the product or packaging	Products rejected by consumers	The product arrangement during delivery was not correct	3	8	2	48

contamination and decreased milk quality, which has an impact on consumer satisfaction (Septiani and Djatna, 2015). Product damage can cause financial losses for producers and distributors. Damaged products cannot be sold, reducing revenue and increasing operational costs (Hidayatuloh *et al*., 2024). In addition, product damage can also damage the company's reputation in the eyes of consumers. If consumers receive products that do not meet quality standards, they may switch to other brands, which negatively impacts the company's market share (Fatima and Billah, 2022).

In the deliver process, product damage during delivery gets an RPN score of 112. The risk of product damage during delivery is in line with the high risk of damage to milk packaging during delivery. Rough handling, such as inappropriate turning or stacking of products, can cause physical damage to goat milk packaging, which ultimately affects product quality (Kurniawan and Anggraeni, 2020). Research shows that physical damage to packaging can lead to contamination and decreased milk quality, which impacts consumer satisfaction (Septiani and Djatna, 2015). Product damage can cause financial losses for producers and distributors. Damaged products cannot be sold, thus reducing revenue and increasing operational costs (Hidayatuloh et al., 2024). In addition, product damage can also damage the company's reputation in the eyes of consumers. If consumers receive products that do not meet quality standards, they may switch to other brands, which negatively affects the company's market share (Aini et al., 2019).

In the make process, the storage temperature is not in accordance with the standard has an RPN score of 108. The storage temperature that does not comply with this standard is caused by unstable electricity in several areas of East Java, electricity often goes out without notice (Khaqiqi *et al*., 2022). The storage temperature of dairy products is a critical point because it can directly affect the quality, safety and shelf life of these products. Inappropriate temperatures can accelerate the growth of microorganisms, which can cause contamination and damage to dairy products (Angelidis *et al*., 2016).

In the sourcing process, the risk of insufficient milk supply received a RPN score of 108. The risk of milk raw material shortages is closely related to improper raw material planning. besides that, the cause of limited fresh milk raw materials is due to the amount of goat milk from farmers fluctuating. The risk of milk raw material shortages is a critical point in the dairy processing industry because it can disrupt the smooth production process and have a significant impact on company performance. First, a shortage of raw materials can lead to a halt in production, which directly results in lost revenue (Chandrahadinata *et al*., 2022).

Risk Mitigation

Risks in the supply chain cannot be completely avoided but can be minimized through proper risk management. Various studies have highlighted the importance of Supply Chain Risk Management (SCRM) in defining, operationalizing and mitigating risks (Ho *et al*., 2015). One of the proposed approaches is to develop and implement appropriate risk management strategies to improve supply chain sustainability and mitigate the negative consequences of risks (Giannakis and Papadopoulos, 2016). The results of the identification and assessment of risks in the livestock sub-sector, collectors and the milk processing industry were each taken 3 risks with the highest score, namely the risk of milk being purchased at low prices / fluctuating milk prices, the risk of leakage of containers, and the risk of milk quality not meeting physicochemical standards. Based on the risks with the highest scores, several risk mitigation alternatives were formulated by confirming directly with expert respondents. Some risk mitigation alternatives that have been formulated through literature studies and discussions with expert respondents are product diversification, training and competency improvement, institutional strengthening, and utilization of innovation and technology. The formulation of risk mitigation alternatives was analyzed using the AHP method to obtain mitigation priorities that would be applied by stakeholders in the goat milk supply chain. The results of AHP processing using Expert choice 11 software obtained weights and priority factors that influence the determination of goat milk supply chain risk mitigation in East Java. The structure of the goat milk sup-

ply chain risk mitigation strategy is presented in Figure 2.

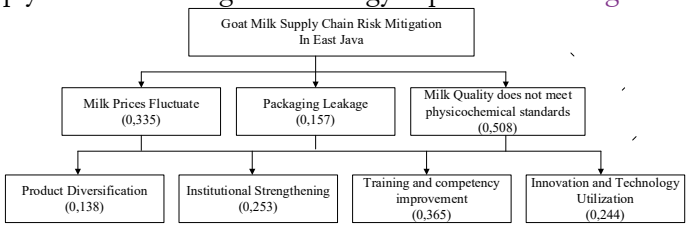

Figure 2: AHP hierarchy structure of goat milk supply chain risk mitigation in east java.

Figure 2 shows that the priority factor in determining risk mitigation for goat milk supply chains in East Java is the factor of milk quality that does not meet physicochemical standards with a score of 0,508 with a consistency value of 0,04. This risk factor has a high weight because goat milk that does not comply with physicochemical quality can have an impact on the nutritional value and attractiveness of the product in the market. Milk quality that is not in accordance with physicochemical standards can reduce consumer satisfaction and potentially reduce market demand, with implications for the income of farmers and the goat milk processing industry in East Java. The risk factor of milk quality not meeting physicochemical standards is due to farmers' lack of understanding of the importance of sterilization and sanitation when milking, and farmers' lack of ability to provide quality feed. Priority risk mitigation that has the highest score according to expert respondents is training and competency improvement with a score of 0,365 and consistency value of 0.04. Appropriate training can improve the knowledge and skills of farmers and the goat milk industry in milking and milk processing. Research shows that a lack of knowledge about hygiene and sanitation practices can lead to milk contamination, potentially posing health risks to consumers (Trimadya *et al*., 2018). Adequate training allows farmers to understand the importance of hygiene in the milking process and milk handling, so that the quality of milk produced can be maintained (Putri *et al*., 2021).

Training and competency improvement can also help mitigate risks associated with fluctuating milk prices caused by changes in the market and consumer demand. With a better understanding of market trends and consumer needs, industry players can adjust their products to meet changing demand, thereby reducing the risk of financial losses due to unsold products (Triyanti and Yusuf, 2016). In addition, training and increasing competence in the use of new technologies and innovations in milk processing can improve product quality and minimize the risk of leaky packaging (Putri *et al*., 2021).

Training and competency improvement can be done by collaborating between the Livestock Service Office of East Java and academics. The first step is to evaluate training needs based on risk factors that have high scores. Some of the recommended trainings for dairy goat farmers are health and reproduction management, formulation and feeding techniques, sterilization and sanitation techniques in the milking process, milking equipment technology training, post-harvest milk handling training from storage, pasteurization and milk packaging. Recommended training for collectors is training on cold chain management to maintain milk quality during distribution, training on utilizing information technology using software for recording transactions, shipping goods and looking for market opportunities, training to conduct effective communication to negotiate prices without harming both parties. The recommended training for the dairy processing industry is training on food safety, training on marketing products effectively through marketplaces and outlets, training related to product branding, and training related to the utilization of information technology. After conducting the training, it is necessary to conduct regular evaluation and mentoring to assess the impact of the training and continue to identify areas that still require improvement. It is expected that with this mitigation, the goat milk supply chain in East Java will become stronger.

CONCLUSIONS AND RECOMMENDATIONS

The results of risk identification using the FMEA approach show that there are 24 risks on dairy farms, 15 risks on intermediary traders, and 24 risks on dairy companies. 3 risks that have the highest RPN value are fluctuating milk prices, milk quality that is not in accordance with physicochemical standards, and packaging leakage during delivery. Based on the three highest risks, 4 risk mitigation alternatives are formulated, namely product diversification, institutional strengthening, training and competency improvement, and utilization of innovation and technology. Based on the results of AHP analysis, the risk mitigation that is prioritized to overcome goat milk supply chain risks in East Java is to conduct training and competency improvement with a score of 0,365 and consistency value of 0.04. Experts that the root of the risks arises due to the lack of competence of the supply chain actors. So far, the dairy goat industry has received less attention from the government, so training programs and competency development in the dairy goat industry are still limited. The government and academics are expected to work together to conduct training and competency improvement on goat milk supply chain actors and continue to conduct regular evaluations and assistance to assess the impact of training and continue to identify areas that still require improvement. It is expected that with this mitigation, the goat milk supply chain in East Java will become stronger. The findings in this study can be used as input for other regional

stakeholders who want to develop the goat milk industry, but still must pay attention to the socio-cultural and environmental conditions of the region. For further research development, it is recommended to focus more on risks related to food safety and food quality in the goat milk supply chain.

ACKNOWLEDGEMENTS

We sincerely thank for Indonesia Endownment Funds for Education (LPDP) and Center for Higher Education Funding (BPPT)

NOVELTY STATEMENT

The novelty in this study is the discovery of important risks that occur in the goat milk supply chain in East Java and the obtaining of priority mitigation to handle these risks.

AUTHOR'S CONTRIBUTIONS

Asmaul Khusna developed the research design, collected and analyzed data, and produced the manuscript. Mujtahidah Anggriani Ummul Muzayyanah examined the data and authored the manuscript. Tri Anggraeni Kusumastuti developed the research equipment and reviewed the manuscript. Ahmad Romadhoni Surya Putra revised the manuscript. All authors were responsible for reviewing and approving the final manuscript.

Conflict of Interests

All authors declare that they have no competing interests.

REFERENCES

Agustina Y (2020). Analisis Pengendalian Mutu Bahan Baku Utama Susu Kambing Bubuk Di Bumi Haijau Yogyakarta. J. Teknosains, 9(2): 127. https://doi.org/10.22146/teknosains.42139

Agustine R, Muzayyanah MAU, Putra ARS, Baliarti E (2023). Utilization of Farmer Priority on Local Beef Cattle Development Strategy in Central Java, Indonesia. Biodiversitas, 24(1): 508-515. https://doi.org/10.13057/biodiv/d240159

Ahmad S, Ginantaka A (2018). Pengaruh Perlakuan Fisik Dan Variasi Produk Second Grade Terhadap Kebocoran Dan Sifat Fisik Pada Produk Industri Susu Dalam Kemasan Botol. J. Agroindustri Halal, 4(1): 10–21. https://doi.org/10.30997/jah.v4i1.1158

Aini Q, Pratama AMP, Yasmin F (2019). Analisis Kinerja Rantai Pasok Dengan Supply Chain Operation Research Dan Analytical Hierarchy Process (Studi Kasus Umkm Tempo Susu Malang). Sebatik, 23(1): 20–27. https://doi.org/10.46984/sebatik.v23i1.439

Alhuur KRG, Setiawan R, Christi RF (2022). Penerapan Teknologi Inseminasi Buatan Pada Ternak Kambing Perah Untuk Percepatan Pemenuhunan Kebutuhan Protein Hewani Masyarakat. Media Kontak Tani Ternak, 4(1): 21. https://doi.org/1024198/mkttv4i1.38216

Angelidis AS, Tsiota S, Pexara A, Govaris A (2016). The Microbiological Quality of Pasteurized Milk Sold by Automatic Vending Machines. Lett. Appl. Microbiol., 62(6): 472–479. https://doi.org/10.1111/lam.12572

Ayyıldız E, Gümüş AT (2020). Interval-Valued Pythagorean Fuzzy AHP Method-Based Supply Chain Performance Evaluation by a New Extension of SCOR Model: SCOR 4.0. Complex Intell. Syst., 7(1): 559–576. https://doi.org/10.1007/s40747-020-00221-9

Bahbah WA, El-Hodhod MA, Salah M, Al-Refaee F, Alturaiki MA, Mousa S, Mehaidib A Al, Ayesh W, El-Bazzar AN, Haddad J, Khashab HY El, Zawahry A El, Hasosah M, Shaaban SY, Vandenplas Y (2022). A Survey to Identify the Current Management of Cow's Milk Disorders and the Role of Goat Milk-Based Formulas in the Middle East and North Africa Region. Nutrients, 14(5): 1067. https://doi.org/10.3390/nu14051067

Belanche A, Martín-García AI, Álvarez JF, Pleguezuelos J, Mantecón ÁR, Yáñez-Ruíz DR (2019). Optimizing Management of Dairy Goat Farms Through Individual Animal Data Interpretation: A Case Study of Smart Farming in Spain. Agric. Syst., 173: 27-38. https://doi.org/10.1016/j.agsy.2019.02.002

Bewley JM, Robertson L, Eckelkamp E (2017). A 100-Year Review: Lactating Dairy Cattle Housing Management. J. Dairy Sci., 100 (12): 10418-10431. https://doi.org/10.3168/jds.2017-13251

Bode C, Wagner SM (2015). Structural Drivers of Upstream Supply Chain Complexity and the Frequency of Supply Chain Disruptions. J. Oper Manag., 36(1): 215–228. https://doi.org/10.1016/j.jom.2014.12.004

Cahyo DN, Muatip K, Syamsi AN, Widodo HS, Ifani M (2022). Analisis Peramalan Produksi Susu Berbagai Ternak Perah Di Indonesia Menggunakan Metode Autoregressive Integrated Moving Average (Arima). ANGON J. Anim. Sci. Technol., 4(3): 310–321. https://doi.org/10.20884/1.angon.2022.4.3.p310-321

Carvalho EB, Maga EA, Quetz J da S, Lima IFN, Magalhães HYF, Rodrigues FAR, Silva AVA, Prata MMG, Cavalcante PA, Havt A, Bertolini M, Bertolini LR, Lima AÂM (2012). Goat Milk with and Without Increased Concentrations of Lysozyme Improves Repair of Intestinal Cell Damage Induced by Enteroaggregative Escherichia Coli. BMC Gastroenterol, 12(1):106. https://doi.org/10.1186/1471-230X-12-106

Chandrahadinata D, Cahyadi U, Gahara MR (2022). Persediaan Bahan Baku Kedelai Dengan Metode EOQ_Dan POQ_Di Pabrik Tahu AS Berkah Putra. J. Kalibrasi, 20(2): 137–146. https://doi.org/10.33364/kalibrasi/v.20-2.1183

Daneshvar S, Yazdi M, Adesina KA (2020). Fuzzy Smart Failure Modes and Effects Analysis to Improve Safety Performance of System: Case Study of an Aircraft Landing System. Qual. Reliab Eng. Int., 36(3): 890-909. https://doi.org/10.1002/qre.2607

Delgadillo-Puga C, Noriega LG, Morales-Romero AM, Nieto-Camacho A, Granados-Portillo O, Rodríguez-López LA, Alemán G, Furuzawa-Carballeda J, Tovar AR, Cisneros-Zevallos L, Torre-Villalvazo I (2020). Goat's Milk Intake Prevents Obesity, Hepatic Steatosis and Insulin Resistance In Mice Fed A High-Fat Diet By Reducing Inflammatory Markers And Increasing Energy Expenditure And

Mitochondrial Content In Skeletal Muscle. Int. J. Mol. Sci., 21(15): 5530. https://doi.org/10.3390/ijms21155530

Dineen M, Delaby L, Gilliland TJ, McCarthy B (2018). Meta-Analysis of the Effect of White Clover Inclusion in Perennial Ryegrass Swards on Milk Production. J. Dairy Sci., 101(2): 1804–1816. https://doi.org/10.3168/jds.2017-12586

Fatima R, Billah UI (2022). Contributors of Brand Switching: The Mediating Role of Brand Image and Customer Satisfaction. JISR manage. Soc. Sci. Econ., 20(2):143-164. https://doi.org/10.31384/jisrmsse/2022.20.2.9

Fatmawati M, Suwanti LT, Mufasirin M, Hambarrukmi W, Sukesi LE, Rofiah R, Novianto E, Wahyutyas BK (2022). A comparative study among dairy goat breeds in Lumajang and Malang (East Java, Indonesia) based on milk organoleptic and milk composition. Biodiversitas, 23(6): 2899-2903. https://doi.org/10.13057/biodiv/d230616

Ganji EN, Shah S, Coutroubis A (2017). Sustainable Supply and Demand Chain Integration Within Global Manufact. Ind.,1807-1811. https://doi.org/ 10.1109/IEEM.2017.8290203

Geng K, He J, Rong S, Jia ZK, zhang xiangxiang, Shi T (2023). FMEA of the Risk Management of Non-Integral-Dosage Drug Dispensing in PIVAS. J. Chin. Pharm. Sci., 33: (7): 597-608. https://doi.org/10.5246/jcps.2024.07.044

Giannakis M, Papadopoulos T (2016). Supply chain sustainability: A risk management approach. Int. J. Prod. Econ., 171: 455–470. https://doi.org/10.1016/j.ijpe.2015.06.032

Hasanah U, Sinamo KN, Desnamrina KC, Siregar GAW, Prayitno HD (2023). Evaluation of Feed Quality for Sustainable Production and Quality of Buffalo Milk in Siborong-Borong Farm. IOP Conf. Ser. Earth. Environ. Sci., 1241: 012141. https//doi.org/10.1088/1755-1315/1241/1/012141

Hidayati A, Pulansari F (2023). Performance Measurement Supply Chain Management (SCM) Using the Supply Chain Operation Reference (SCOR) Method at PT X. Ijiem – Indones. J. Ind. Eng. Manage., 4(2):173. https://doi.org/10.22441/ijiem.v4i2.20506

Hidayatuloh S, Uswatun Kasanah Y, Arini RW (2024). Pengukuran Green Supply Chain Pada UMKM Produsen Ayam Potong Dan Distribusi Ayam Broiler. J INTECH Tek Ind. Univ. Serang Raya, 10(1): 61–69. https://doi.org/10.30656/intech.v10i1.7826

Hikmah L, Chotib M, Munir M (2023). Halal Supply Chain Strategy for Etawa Goat Milk to Increase Sales Volume in Senduro Lumajang Village. J. Syntax Admiration, 4(10): 1-14. https://doi.org/10.46799/jsa.v4i10.745

Ho W, Zheng T, Yıldız H, Talluri S (2015). Supply Chain Risk Management: A Literature Review. Int. J. Prod. Res., 53(16):5031–5069. https://doi.org/10.1080/00207543.2015.1030467

Hove-Sibanda P, Matshidiso M, Igwe PA (2021). Supply Chain Risks, Technological and Digital Challenges Facing Grocery Retailers in South Africa. J. Enterp Communities, 15(2): 228–245. https://doi.org/10.1108/JEC-05-2020-0104

Huda M, Nuraini S, Setyaningrum E, Kanedi M (2023). Effect of Flower Extract of Roselle (Hibiscus Sabdariffa L) on Microbial Quality of Raw Milk of Etawa Goats. GSC boil. Pharm. Sci., 24(1): 022–028. https://doi.org/10.30574/gscbps.2023.24.1.0245

Ismanto SD, Hasbullah H, Kasim A, Azima F, Sayuti K, Rini B, Novizar N, Neswati N, Anggraini T, Indeswari NS (2018). Pelatihan Penanganan Dan Pengolahan Susu Kambing Di Nagari Bukit Batabuh Kabupaten Agam. Logista - Jurnal Ilmiah Pengabdian Kepada Masyarakat, 2(2): 32. https://doi.org/10.25077/logista.2.2.32-39.2018

Jung TH, Yun S, Lee W, Kim JW, Ha HK, Yoo M, Hwang HJ, Jeon WM, Han KS (2016). Hydrolysis by Alcalase Improves Hypoallergenic Properties of Goat Milk Protein. Korean J. Food Sci. Anim. Resour., 36(4): 516–522. https://doi.org/10.5851/kosfa.2016.36.4.516

Júnior JCR, Tamanini R, Oliveira ALM, Alfieri AA, Beloti V (2018). Genetic Diversity of Thermoduric Spoilage Microorganisms of Milk from Brazilian Dairy Farms. J. Dairy Sci., 101(8):6927–6936. https://doi.org/10.3168/jds.2017-13948

Khan S, Khan MI, Haleem A, Jami AR (2019). Prioritising the Risks in Halal Food Supply Chain: An McDm Approach. J. Islam Mark, 13(1): 45–65. https://doi.org/10.1108/JIMA-10-2018-0206

Khaqiqi AS, Damara A, Azuningrum MP, Nisa WNH (2022). Evaluation Analysis of Commercial Port Hierarchy in Indonesia: A Case Study of Ports in East Java Province. Jurnal Penelitian Transportasi Laut, 23(2): 67–76. https://doi.org/10.25104/transla.v23i2.1783

Khasanah H, Purnamasari L, Suciati LP (2023). Pakan Amoniasi Untuk Mendorong Pengembangan Sentra Ternak Unggul Di Jember. JPPM Jurnal Pengabdian Dan Pemberdayaan Masyarakat, 7(1): 65. https://doi.org/10.30595/jppm.v7i1.9764

Król J, Wawryniuk A, Brodziak A, Barłowska J, Kuczyńska B (2020). The effect of selected factors on the content of fat-soluble vitamins and macro-elements in raw milk from holstein-friesian and simmental cows and acid curd cheese (tvarog). Animals, 10(10): 1800. https://doi.org/10.3390/ani10101800

Kurniawan H, Anggraeni IAA (2020). Analisis Risiko Rantai Pasok Material Terhadap Keterlambatan Pelaksanaan Proyek Konstruksi. Rekayasa Sipil, 14(1): 43–50. https://doi.org/10.21776/ub.rekayasasipil.2020.014.01.6

Lestari F, Mas'ari A, Meilani S, Riandika IN, Hamid ABA (2021). Risk Mitigation via Integrating House of Risk and Probability Impact Matrix in Halal Food Supply Chain. J. Tek Ind., 22(2): 138–154. https://doi.org/10.22219/JTIUMM.Vol22.No2.138-154

Maesya A, Rusdiana S (2018). Prospek Pengembangan Usaha Ternak Kambing dan Memacu Peningkatan Ekonomi Peternak. Agriekonomika, 7(2): 135. https://doi.org/10.21107/agriekonomika.v7i2.4459

Mahanani AA, Andi Sukma Indah AS, Irmayanti, Haloho RD, Ermanda AP, Pratiwi NA, Palayukan J, Ningtiyas WD, Khatifah (2023). Evaluasi Manajemen Pemberian Pakan Kambing Peranakan Etawa (PE) Di Unit Pelaksana Teknis Daerah (UPTD) Pembibitan Ternak Dan Pakan di Wilayah Kabupaten Majene. J. Triton, 14(2): 313–322. https://doi.org/10.47687/jt.v14i2.463

Mal G, Singh B, Mane BG, Sharma V, Sharma R, Bhar R, Dhar J (2018). Milk Composition, Antioxidant Activities and Protein Profile of Gaddi Goat Milk. J. Food Biochem., 42(6): 12660. https://doi.org/10.1111/jfbc.12660

Miller BA, Lu CD (2019). Current Status of Global Dairy Goat Production: An overview. Asian-Australas. J. Anim. Sci., 32(8):1219. https://doi.org/10.5713/ajas.19.0253

Mulatmi SNW, Guntoro B, Widyobroto BP, Nurtini S, Pertiwiningrum A (2016). Strategi Peningkatan Adopsi Inovasi Pada Peternakan Sapi Perah Rakyat Di Daerah

Istimewa Yogyakarta, Jawa Tengah, Dan Jawa Timur. Buletin Peternakan, 40(3): 219. https://doi.org/10.21059/buletinpeternak.v40i3.12470

Nguyen VT, Nguyen C, Ma TC, Nguyen D, Han TA, Le TTH (2023). Goat Production, Supply Chains, Challenges, and Opportunities for Development in Vietnam: A Review. Animals, 13(15): 2546. https://doi.org/10.3390/ani13152546

Nisa CF, Primandita KA (2024). Karakteristik Fisikokimia Dan Mikrostruktur Yoghurt Susu Kambing Dengan Penambahan Pektin Dan Bubur Buah (Pulp) Nangka (Artocarpus Heterophyllus). J. Teknologi Pertanian., 25(1): 25–38. https://doi.org/10.21776/ub.jtp.2024.025.01.3

Pham HT, Testorelli R, Verbano C (2023). The Impact of Operational Risk on Performance in Supply Chains and the Moderating Role of Integration. Balt. J. Manage., 18(2): 207–225. https://doi.org/10.1108/BJM-10-2021-0385

Pisestyani H, Dalimunthe M, Nisa C, Pamungkas FA (2021). The Total Microorganisms of Milk Sapera Goat Raised at the Bogor Animal Husbandry Research Institute. Ind. J. Anim. Sci., 23(2): 122. https://doi.org/10.25077/jpi.23.2.122-129.2021

Popescu A, Marcuta A, Marcuta L, Tindeche C (2021). Trends in Goats'livestock and Goat Milk, Meat and Cheese Production in The World In The Period 1990-2019-A Statisincal Approach. Scientific Papers: Management, Econ. Eng. Agric. Rural Dev., 21(1): 647-654. https://managementjournal.usamv.ro/pdf/vol.21_1/Art73.pdf

Putri RAA, Tyasningsih W, Fikri F (2021). Uji Cemaran Salmonella Sp. Pada Susu Segar Kambing Sapera Di Kecamatan Siliragung Kabupaten Banyuwangi. Prosiding Seminar Nasional Pembangunan Dan Pendidikan Vokasi Pertanian. 2(1): 186–197. https://doi.org/10.47687/snppvp.v2i1.186

Santoso DB, Suman A (2023). Determinant of Capital Efficiency and Its Impact on Economic Growth: Empirical Evidence in East Java. Signifikan Jurnal Ilmu Ekonomi, 12(1): 1–10. https://doi.org/10.15408/sjie.v12i1.29965

Schuller BW, Burns A, Ceilley EA, King AG, LeTourneau J, Markovic A, Sterkel L, Taplin B, Wanner J, Albert JM (2017). Failure Mode and Effects Analysis: A Community Practice Perspective. J. Appl. Clin. Med. Phys., 18(6): 258–267. https://doi.org/10.1002/acm2.12190

Schulte HD, Mußhoff O, Meuwissen MPM (2018). Considering Milk Price Volatility for Investment Decisions on the Farm Level After European Milk Quota Abolition. J. Dairy Sci., 101(8): 7531–7539. https://doi.org/10.3168/jds.2017-14305

Seprianto S, Alham F, Hartutik H, Mahyuddin T, Ahmad F (2023). Diversification and Development of Yogurt Products at UD Susu Kambing Ettawa in Karang Anyar Village, Langsa City. Jurnal Abdi Insani, 10(2): 809–817. https://doi.org/10.29303/abdiinsani.v10i2.952

Septiani W, Djatna T (2015). A Supply Chain Risk Performance Model for Local Raw Milk Agro-Industry Based on Fuzzy Logic Approach. Jurnal Agritech., 35(01): 88. https://doi.org/10.22146/agritech.9423

Shenoi VV, Dath TNS, Rajendran C, Shahabudeen P (2018). Strategic Action Grids: A Study on Supply Chain Risk Management in Manufacturing Industries in India. Benchmarking an Int. J., 25(8): 3045–3061. https://doi.org/10.1108/BIJ-11-2017-0321

Suharto ELS, Kurnia YF, Purwati E (2021). Total Bacteria of Lactic Acid, Total Plate Count, and Total Titrated Acid of Fermented Goat Milk with Addition of Carrot Juice during Cold Storage. Ind. J. Anim. Sci., 23(2):102. https://doi.org/10.25077/jpi.23.2.102-107.2021

Sumanto (2017). Milk Products Diversification to Increase Profit of Dairy Goat Farming. Indones. Bull. Anim. Vet. Sci., 26(4): 173. https://dx.doi.org/10.14334/wartazoa.v26i4.1401

Sumarmono J (2022). Current goat milk production, characteristics, and utilization in Indonesia. In: IOP Conference Series: Earth Environ. Sci., IOP Publishing, 1041:012082. https://doi.org/10.1088/1755-1315/1041/1/012082

Suwito W, Andriani A, Nugroho WS (2019). Isolation and identification of bacteria from goat milks subclinical mastitis Ettawa crossbreed goat (PE) in Kemiri Kebo, Sleman, Yogyakarta. Indones. J Anim. Sci., 29(1): 56–64. https://doi.org/10.21776/ub.jiip.2019.029.01.07

Tran TH (2018). Critical Factors and Enablers of Food Quality and Safety Compliance Risk Management in the Vietnamese Seafood Supply Chain. Int. J. Supply Chain Manage., 9(1): 01–20. https://doi.org/10.5121/ijmvsc.2018.9101

Trimadya NM, Hardjomidjojo H, Anggraeni E (2018). Risk Management System for Contamination On Food Supply Chain (Case Study: Pasteurizon Milk). J. Teknol. Ind. Pertan., 28(2): 162–170. https://doi.org/10.24961/j.tek.ind.pert.2018.28.2.162

Triyanti R, Yusuf R (2016). Analisis Manajemen Rantai Pasok Lobster (Studi Kasus Di Kabupaten Simeulue, Aceh). Jurnal Sosial Ekonomi Kelautan Dan Perikanan, 10(2): 203. https://dx.doi.org/10.15578/jsekp.v10i2.1260

Tsakali E, Agkastra C, Koliaki C, Livanios D, Boutris G, Christopoulou MI, Koulouris S, Koussissis S, Impe J Van, Houhoula D (2019). Milk Adulteration: Detection of Bovine Milk in Caprine Dairy Products by Real Time PCR. J. Food Res., 8(4): 52-57. https://doi.org/10.5539/jfr.v8n4p52

Wadjdi MF, Ali U (2023). Ipteks Bagi Usaha Peternakan Kambing Peranakan Etawah Desa Binaan Unisma, Pomcokusuma, Malang. Jurnal Pengabdian Masyarakat Progresif Humanis Brainstorming, 6(3): 638–644. https://doi.org/10.30591/japhb.v6i3.5380

Warsi SAA, Asim M, Manzoor S (2020). The Effects of Supply Chain Management Practices on Technological Innovation: A Case of Manufacturing Sector of Pakistan. CenRaPS, 2(1): 58–75. https://doi.org/10.46291/cenraps.v2i1.10

Wu JY, Hsiao HI (2021). Food quality and safety risk diagnosis in the food cold chain through failure mode and effect analysis. Food Control, 120: 107501. https://doi.org/10.1016/j.foodcont.2020.107501

Yusrianafi N, Dahdah S (2021). Pengukuran Kinerja Pada UKM Kerudung Menggunakan Metode Supply Chain Operator Reference (SCOR) Dan AHP. Jurnal Manajemen Teknologi dan Teknik Industri, 3(2): 131. https://doi.org/10.30737/jurmatis.v3i2.1774

Zandi P, Rahmani M, Khanian M, Mosavi A (2020). Agricultural risk management using fuzzy TOPSIS analytical hierarchy process (AHP) and failure mode and effects analysis (FMEA). Agriculture, 10(11): 504-531. https://doi.org/10.3390/agriculture10110504

Zhang R, Zhu Z, Jia W (2022). Molecular mechanism associated with the use of magnetic fermentation in modulating the dietary lipid composition and nutritional quality of goat milk. Food Chem., 366:130554. https://doi.org/10.1016/j.foodchem.2021.130554