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# Implementation of Sustainable Risk Management in Reverse Supply Chain Management Coffee Product Waste Processing in the Teaching Factory

Andarula Galushasti *; Annisa Lutfi Alwi; Fandyka Yufriza Ali
Department of Agricultural Production, Jember State Polytechnic, Jember, Indonesia

Amalia Dwi Marseva
Department of Agribusiness Management
Jember State Polytechnic, Jember, Indonesia

* Corresponding Author: Andarula Galushasti,
Department of Agricultural Production, Jember State Polytechnic, Jember, Indonesia

**Abstract:- The business challenge in the future is business unpredictability. A requirement for assistance from industrial strategy to be both competitive and sustainable. The idea of reverse supply chain management may be used to apply coffee waste processing management, as well as to establish integration between waste management, to prevent waste from going to waste and polluting the environment. However, waste will be controlled and turned back into a processed well, adding economic value. Descriptive analysis is the employed technique. Using analytical network process methodologies and the outcomes of effect weighing and weighted failure mode analysis.to assess risk control utilizing a sustainable risk management strategy in the coffee supply chain. Farmers have the highest amount of influence among supply chain participants for coffee commodities in terms of supply chain risk management. The risk of production still coming in the first place is the one that has the most impact on it. The construction of a model for an institutional structure that may be used to apply intense reverse supply chain management, particularly in the context of balancing risk with sustainable risk management in reverse supply chain management networks, is the study's main contribution.**

***Keywords***:- *Coffee waste, teaching factory, risk management, reverse supply chain management.*

## I. INTRODUCTION

The agricultural industry is very important in the Indonesian economy. Indonesia's economy has recorded solid growth in recent decades, with a strong pace of economic expansion [1]. The contribution of the agricultural sector to the national economy is increasingly evident. During the period 2010-2014, the average contribution of the agricultural sector to Gross Domestic Product (GDP) reached 10.26 percent, with a growth of around 3.90 percent. The plantation subsector is the most significant contributor to the GDP of the agricultural sector [2]. Coffee, one of the commodities produced in plantations became one of the leading plantation subsectors.

Jember Regency is the second largest producer of artisanal coffee in East Java [3] which is in line with the high market and opportunities in implementing the national coffee industry. One of Polije's efforts in contributing to the development of processed coffee products in the Jember region is through the development of a Coffee Product Processing Teaching Factory (TEFA). TEFA is a place of learning and a coffee product processing business unit. Therefore, TEFA is expected to become a learning concept in real situations that can close the gap between the knowledge gained on campus and the needs of the industrial world. So that students can learn and acquire skills or abilities that are applied based on standards and work in real industries.

The development of TEFA processing coffee products began in 2020 through the pioneering TEFA processing of coffee products and has been running until now to become TEFA processing coffee products in 2023. The production of processed coffee products at TEFA coffee processing currently reaches 50 kg/month in the form of ground coffee. The transition of status to TEFA Polije, of course, production is projected to increase three times from the current production and is expected to continue to increase over time and the product is widely known. Along with the massive increase in the amount of production, it will cause a new problem in TEFA Polije coffee processing, namely the accumulation of waste from coffee processing that is not utilized optimally.

Based on the description of the phenomenon above, to be able to support the industrial strategy in TEFA processing coffee products to be competitive and sustainable, the concept of coffee waste processing management is needed. The application of coffee waste processing management can be done with the concept of Reverse Supply Chain Management (RSCM), as well as to implement the integration of waste management with RSCM, so that waste is not wasted into waste and pollutes the environment. However, waste will be managed back into a processed product and will have added value economically and will add benefits in TEFA processing coffee products.

Pay attention to TEFA problems with the research topic code (7-03) on the Coffee Waste Treatment Process attached to the Jember State Polytechnic Lecturer Research Guide [4]. As well as the background of the research mentioned above, several problems can be formulated, namely First, how to identify ongoing problems and practices in TEFA Coffee Product Processing; Second, how to overcome the increasing amount of coffee waste along with the increase in production capacity; Third, how to prepare coffee waste management using the RSCM concept; Fourth, how is the risk analysis of the RSCM concept in coffee waste processing that will be applied at TEFA Coffee Product Processing. Based on the description of existing problems, to be able to implement integrated waste treatment, research is needed related to the Application of the RSCM Concept of Waste Treatment at TEFA Coffee Product Processing Jember State Polytechnic.

## II. LITERATURE REVIEW

### A. *State of the art*

The empirical study in this study is taken from several previous research results which were used as the basis for conducting related research from Ali, et al. (2022) [5]; Rosdiana, et al. (2022) [6]; Kurniawan, et al. (2023) [7]; Kurniawan and Galushasti (2021) [8]. Furthermore, in previous studies, there has been no empirical research discussing coffee waste supply chain management. There have been many studies that examine the coffee waste supply chain, but in each region, it certainly has its characteristics related to conditions to determine the right strategy [9]. In addition, the focus of the problem studied has not been done much by previous researchers related to the application of reverse supply chain management and is closely related to the largest leading coffee producers, and competition in the coffee industry that exists today.

The contribution of each research journal mentioned earlier is to compile a state of the art, which is related to a collection of theories, and references that either support or do not support research. As for that, everything is done so that research becomes more solid because it can be referred to. From the state of the art, it can be seen that no one specifically discusses the process of processing coffee waste using the concept of reverse supply chain management. This concept can be used as an alternative for the sustainability of Jember coffee waste supply chain risk management. Thus, it can be concluded that this study has a very significant novelty because there is no previous reference related to the Application of Reverse Supply Chain Management in the Coffee Waste Processing Process. The following is the concept of reverse supply chain management that can be applied in the coffee waste processing process can be seen in Fig. 1.

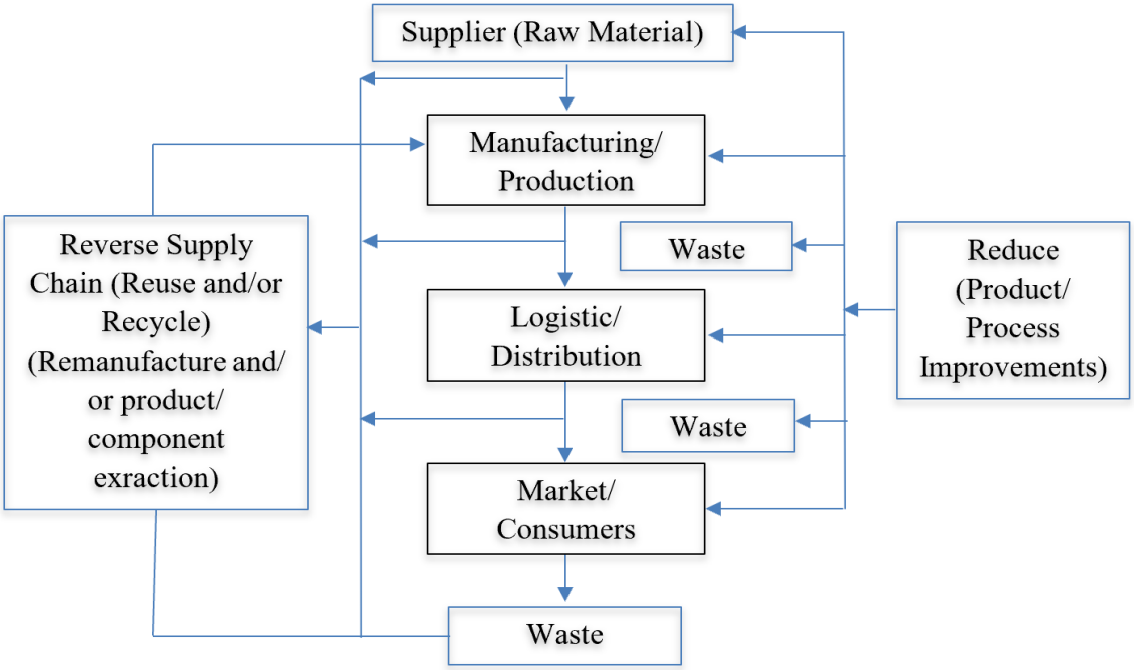


Fig. 1: The concept of reverse supply chain management in waste treatment

### B. *Risk management*

Risk is the chance of loss. Chance of loss is usually used to indicate a situation where there is an excess of loss or a possibility of loss. Conversely, if adjusted to the term used in statistics, then "chance" is often used to indicate the level of probability of a certain situation arising. Risk is the possibility of loss. The term "possibility" means the probability of an event being between zero and one. This definition is probably very close to the definition of risk that is used daily. However, this definition is rather loose, and not suitable for quantitative analysis. Risk is uncertainty. There seems to be agreement that risk is related to uncertainty, that is, the presence of risk, because of uncertainty. That's why there are authors who interpret that risk as the same as uncertainty.

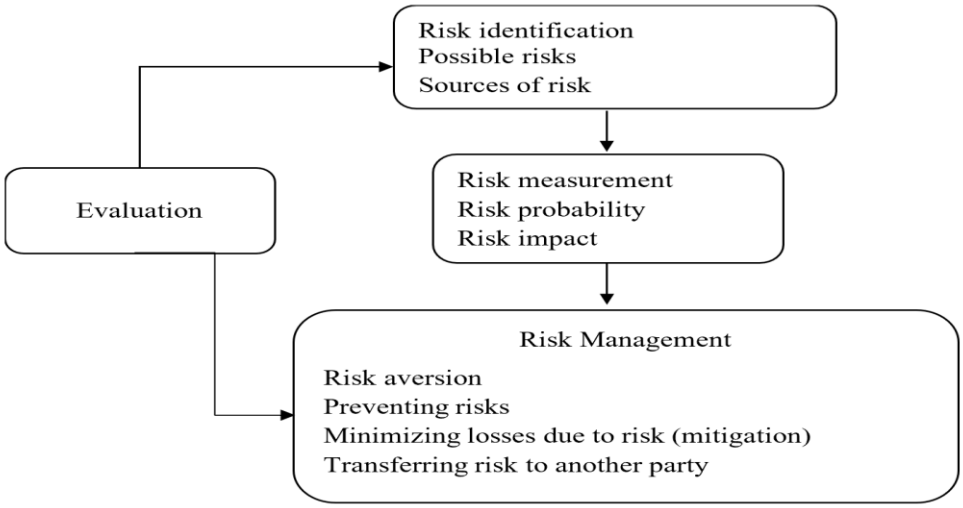


Fig. 2: Risk management process

According to Morden [24] Management is a process that involves the guidance or direction of a group of people to achieve goals. The purpose of risk management is to minimize losses received by the company due to risk, which is an effort made by the company to recognize, assess, and handle the risks faced. Good risk handling is needed so that the chances of losses that befall the company can be minimized so that costs become smaller and the company will get greater profits. If applied in risk management, the risk management function will be easier to understand through the steps of the risk management process consisting of risk identification, risk measurement, risk handling, and evaluation. Risk management is a process that aims to identify, evaluate, and manage the risks faced by the organization. The risk management process can be seen in **Error! Reference source not found.**.

*C. Reverse supply chain management*

The supply chain is a process that connects raw material suppliers with producers and consumers. The coffee waste supply chain is a process that connects coffee bean suppliers with coffee producers and end consumers. A supply chain is a whole series of activities (transportation, inventory control, etc.) that take time along the network to convert raw materials into finished goods as well as information that is passed on to the end customer and has added value for the customer. According to Pryke [10] supply chain can be defined as a group consisting of three or more entities (organizations or individuals) directly involved in the upstream and downstream flow of products, services, finance, or information from suppliers to customers. The supply chain concept is new in logistics. The concept is a link in the chain of providing raw materials to finished goods.

Supply chain management is a set of approaches applied to efficiently integrate suppliers, entrepreneurs, warehouses, and other storage sites [11]. All companies or organizations involved in the supply chain are divided into two, namely the main members and supporting members. The main members of the supply chain are all business units that carry out operational or managerial activities in the business process [12]. Supply chain management of agricultural products represents the management of the entire production process to the distribution of products to consumers. Besides being more complex, the supply chain of agricultural products is also probabilistic and dynamic. This happens because agricultural products are perishable, the process of planting, growing and harvesting depends on the season, crops have varying shapes and sizes, and agricultural products are waste so that agricultural products are difficult to handle [11]. Sustainability of coffee waste supply chain risk management focuses on improving product efficiency and quality. This allows organizations to increase added value and helps reduce production costs. It also allows organizations to reduce risks and improve product safety.

*D. Analytical Network Process*

Analytical Network Process (ANP) is an analytical tool that can show the level of influence of various parties by considering the dependency relationship between both clusters and nodes [13]. The first stage carried out in ANP is to define the problem determine the desired solution criteria and determine the weighting from a managerial point of view.

*E. Weighted Failure Mode Effect and Analysis*

Weighted Failure Mode Effect and Analysis (WFMEA) is an analytical technique that combines technology and experience from people in identifying the causes of failure of a product or process and planning for the elimination of those causes of failure [14].

## III. METHODS

This research uses a reverse supply chain management approach and sustainable risk management of the coffee waste processing process. Analysis of model behavior to sustainable coffee waste supply chain action plan based on risk management is carried out until 2026, where 2026 is following the long-term goals contained in the research roadmap. The sample used in this study was an expert and manager at TeFa Polije Coffee Product Processing. Expert determination uses the purposive sampling method to determine the experts involved in the research. The

considerations used to determine experts are the suitability of education, experience, and track record of expertise. Then determine the peak sample for coffee plant sampling using the tracing method. Then sampling for the supply chain below is also based on the tracing method where the collection of information is carried out starting from a small amount and then enlarging until information is obtained that is considered sufficient to describe the overall information in the study.

The data used in this study are primary and secondary. Secondary data are obtained from journals, literature, and previous research. Primary data is obtained by field observation, expert interviews, and questionnaires. This study uses descriptive analysis, which is a method of examining the status of human groups, objects, sets of conditions, thought systems, or classes of events in the present [15]. This study used Super Decision 2.2.6 software as a tool for completing ANP calculations. The numbers obtained from the results of the questionnaire in the form of respondents' opinions about the interdependent interactions between elements in each cluster were reduced to a supermatrix. The final result will show which element has a greater contribution [[16], [17] The detailed process of performing an FMEA can be divided into several steps. The variable output value is the Weighted Risk Priority Number (WRPN) which is calculated and used to represent the priority of corrective actions categorized into five interval classes.

## IV. RESULTS

Jember State Polytechnic is one of the universities in Indonesia that organizes vocational education, which is an educational program that leads the teaching and learning process at a specific level of expertise, skills, and competency standards following the needs of the job market and stakeholders, and has independence in working and entrepreneurship based on science and technology. Until now, Polytechnic has 9 Departments and 33 Study Programs, 8 Academic Support Units (UPA), and 29 TeFa Units, one of which is TeFa Coffee Product Management.

### *A. Identify problems and sources of ongoing risk events*

After discussion, interviews, and unification of ideas with experts and based on previous research, an ANP cluster structure was obtained to identify risks that exist in the coffee waste supply chain. The risk weight for each member of the coffee waste supply chain is carried out using the ANP method by providing points of influence between each actor, problem, and risk factor. After conducting discussions and direct interviews with experts and looking at previous studies, four main types of problems were obtained. The problems that exist in the coffee waste supply chain in the research area are quality improvement, increased productivity, guaranteed product continuity, and increased income.

Determination of coffee quality first in the bean sorting process. Seeds that have been harvested and then peeled from the skin are then sorted based on the condition of the seeds. Beans that produce coffee with the best aroma and taste are coffee with intact beans, not damaged, and free from pest attacks during the planting period to harvest. However, often collectors mix these good beans with damaged ones as long as they can be consumed even though it will reduce the taste of the coffee itself. The reason is that seeds with this condition are also still accepted by the factory under the pretext of increasing profits. There are still many consumers who are not aware of this.

Defective seeds referred to in this case are damaged seed conditions such as broken, split, discolored, and others. Both are caused by pests and poor harvest handling. In general, arabica coffee is exported in quality 1, while robusta coffee is about 60% exported in quality 4, about 30% in quality 5 and 6, and 10% in quality 1. Although there are standards for coffee beans, often factories mix other ingredients into the coffee grinding process to increase profits. There needs to be special regulations that can maintain the quality of coffee both at home and abroad. After weighting according to questionnaires that have been processed using ANP with the help of Super Decision 2.2.6. From the calculation, the crucial problem is the increase in income, which is 0.323. It can be concluded that increasing revenue is a priority that needs to be considered in every link of the supply chain.

In the coffee waste supply chain, some risks have been identified previously. Then after conducting a study of previous research as well as conducting interviews, observations, and discussions with experts, six types of risks were identified in this study. The risks covered in this study are quality, production, price, supply, environmental, and transportation risks. After weighting according to the questionnaire that has been processed using ANP, the risk result that has a value of 0.252 is production risk which means that this risk has the greatest influence. The results of this study follow research on risks which are factors causing production in high, normal, and low conditions such as weather factors, pests and diseases, and production technology used, namely planting on open land and greenhouses.

Before making a decision, an assessment of the severity of the impact of each risk is first carried out. This is done to determine the priority risk. So that appropriate action can be taken in controlling a type of risk. Based on the results of risk analysis, data can be obtained that are useful for sorting out mild to severe risks and will help the risk evaluation and control stage. The risk assessment stage will use the WFMEA method. Components such as severity, occurrence, and detection are multiplied by the risk weight, then the value of WRPN is generated.

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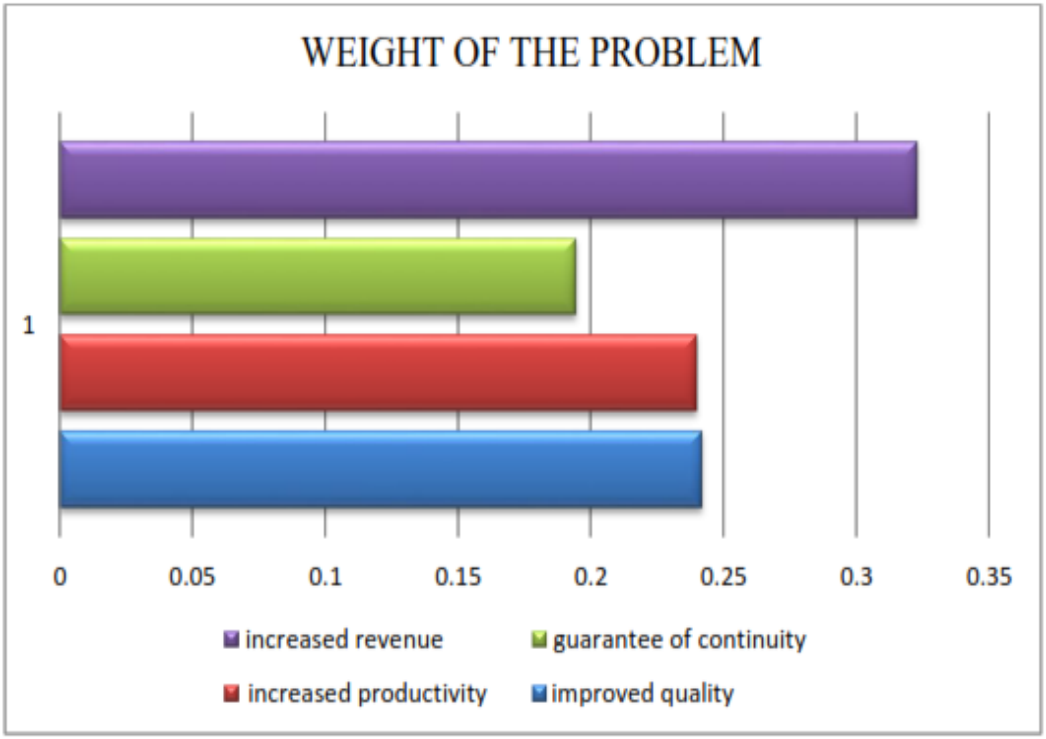


Fig. 3: Comparison of coffee supply chain weight of the problem

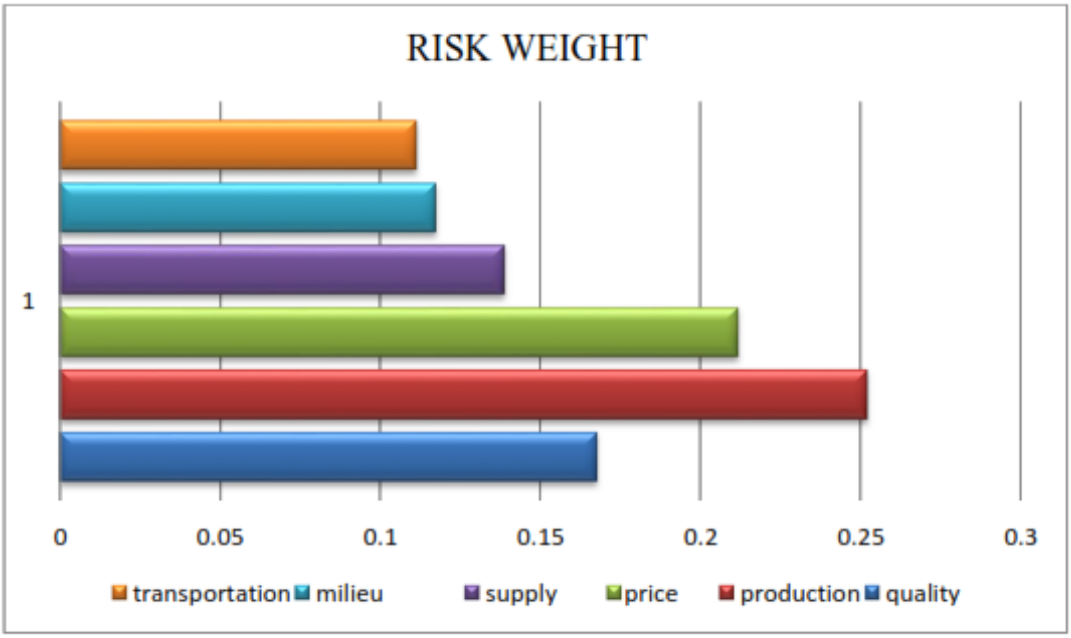


Fig. 4. Comparison of coffee supply chain weight of risk

The results of the risk assessment can be seen in the Risk Factor and Risk Variable Table then adjusted to field conditions based on in-depth interviews with resource persons who are considered experts in handling upstream downstream coffee. After knowing the assessment of the severity of the impact of each risk, conducting a mild to severe risk analysis will help the risk evaluation and control stage. The risk assessment stage will use the WFMEA method [18]. Components such as severity, occurrence, and detection are multiplied by the risk weight, then the WRPN value is generated [19].

After getting the multiplication results between the severity, occurrence, and detection components, these results can be integrated with the previous ANP calculation results to get a WRPN for a more accurate assessment [20]. Here is a plan of priority results table of risk identification. So that the decisions taken can be maximally implicated and actions are obtained that can reduce the impact of these risks.

Table 1: Risk results research

| Factor Risk | Risk Variables | Severity | Occurrence | Detection | RPN |
|---|---|---|---|---|---|
| Quality | Autumns and uncertain weather | 7 | 5 | 6 | 210 |
| | Low quality of supply raw materials | 6 | 4 | 5 | 120 |
| | Engineering knowledge low cultivation | 7 | 5 | 5 | 175 |
| | Inadequate storage facilities | 7 | 4 | 5 | 140 |
| | Pests and diseases | 8 | 7 | 7 | 392 |
| Production | Limited production capacity | 6 | 5 | 10 | 300 |
| | Low raw material quality | 8 | 6 | 8 | 384 |
| | The production process is inefficient. | 8 | 6 | 7 | 336 |
| | Use of simple production technology | 7 | 5 | 7 | 245 |
| | Inflation | 6 | 5 | 5 | 150 |
| Price | Rupiah exchange rate and bank interest | 4 | 5 | 5 | 100 |
| | Price fluctuations | 8 | 6 | 7 | 336 |
| | Distortion of price and supply information | 7 | 6 | 5 | 210 |
| Supply | Diversity of supply quality | 8 | 6 | 7 | 336 |
| | Supplier loyalty | 7 | 5 | 5 | 175 |
| | Uncertainty oversupply availability | 6 | 4 | 7 | 168 |
| | Quality certification risks | 4 | 3 | 8 | 96 |
| | Natural disasters | 7 | 2 | 1 | 14 |
| Milieu | Government policy | 9 | 5 | 2 | 90 |
| | Competitor products | 6 | 5 | 6 | 180 |
| | Social, cultural, and political conditions | 2 | 4 | 8 | 64 |
| | Damage to infrastructure | 8 | 6 | 5 | 240 |
| Transportation | Travel insecurity | 3 | 7 | 5 | 105 |
| | Uncertainty of transport time | 7 | 6 | 4 | 168 |
| | Long haul distances | 3 | 5 | 7 | 105 |

Table 2: Risk priority outcomes

| Risk | ANP (W) | Rank | RPN | Rank | WRPN | Rank |
|---|---|---|---|---|---|---|
| Quality | 0.168 | 3 | 1037 | 2 | 174.216 | 2 |
| Production | 0.252 | 1 | 1265 | 1 | 318.780 | 1 |
| Price | 0.212 | 2 | 796 | 3 | 168.752 | 3 |
| Supply | 0.139 | 4 | 775 | 4 | 107.725 | 4 |
| Milieu | 0.118 | 5 | 348 | 6 | 41.064 | 6 |
| Transportation | 0.111 | 6 | 618 | 5 | 68.598 | 5 |

Table 3: Strategies to increase the competitiveness of coffee commodities

| Problems | Risk | Implications | Actor |
|---|---|---|---|
| Quality Improvement | Quality, Production, Environment | Direct interaction between factories and farmers so that quality can be controlled better | Farmer, Factory |
| Increased Productivity | Production, Environment | The balance between demand and supply needs to be maintained to stimulate the actors to maintain productivity and provide coffee farm business insurance. In addition, it is necessary to use social farmer's land to boost productivity. | Farmer, Factory |
| Product Continuity Guarantee | Production, Supply, Transportation, Environment | The correct information between domestic and abroad markets can be integrated to maintain market capacity and domestic consumption. It is also necessary to apply a Warehouse receipt guarantee system to maintain supply chain flow. | Farmer, Collector Merchant, Factory |
| Increased Revenue | Price, Quality, Supply | Monotonous coffee processed products that only boil down to the diversification of flavors and aromas should be further developed to target other products to add value to farmers and provide coffee farming business insurance. | Farmer, Factory |

## V. CONCLUSION

Based on the results of ANP calculations, the largest level of influence of coffee commodity supply chain members in supply chain risk management is farmers, with the risk that has the greatest level of influence being production risk. Based on the results of WFMEA, production risk still ranks first. Risk control that is prioritized in the coffee waste supply chain is increasing coffee production and quality by providing appropriate and periodic counseling to coffee farmers to be able to maintain production and quality, guarantees in terms of capital to farmers to be able to develop production scale in the form of low-interest loans by the government, distribution of

market information appropriately and quickly, also the establishment of guaranteed coffee quality supervisors.

The most important control system or evaluation system is the sustainability of the control or decisions that have been taken. The decision is whether it can only be used for a certain time or can be used for a long enough period. So, in making decisions on actions to be carried out in risk control in this study, a Sustainable Risk Management (SRM) approach is used. All stakeholders involved, both internal parties such as farmers, collecting traders, agroindustry, and exporters must be able to synergize risk mitigation scenarios in the form of revenue-sharing-based farmer contracts that include quality specifications that must be met, quantity and time delivery so that the objectives of coffee waste supply chain management can be achieved.

## ACKNOWLEDGMENT

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