

Risk analysis of arabica coffee supply chain in Aceh Tengah regency, Aceh Province, Indonesia

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ABSTRACT

Aceh Tengah is the largest coffee plantation in Aceh. The area of coffee plantation in Aceh Tengah is 49,251 Ha. However, problems and uncertainties often occur in agriculture business. Arabica coffee supply chain actors often faced with several risks. That risks can hamper the supply chain operational process. Supply chain risk that are often faced are production, quality, price and human risk. The purpose of this study are to identify the causes and consequences of risks and the level of risks in each supply chain actor. Risk identification was done using an approach of what-if analysis, and risk evaluation was developed using fuzzy FMEA model. The result shows that the higher to lower level of supply chain risk of 4 variables are (1) Price (632 FRPN), (2) Grade (500 FRPN), and (3) Production and Human (461 FRPN).

Key words: Arabica coffee; Fuzzy FMEA; Supply chain risk.

1 INTRODUCTION

Coffee is one of the leading commodities in the Indonesian plantation sub-sector. The Central Bureau of Statistics (2020) noted that Indonesia's three largest coffee export destinations were the United States at 58,666 tons (US\$ 253,830.1), Italy 35,452.2 tons (US\$ 60,354) and Malaysia at 34,662.2 tons (US\$ 56,136). Data from the Directorate General of Plantations (2019), in 2018 Aceh Province was the area with the third largest coffee area and production in Indonesia with a land area of 124,103 ha and a production of 64,812 tons. In the first and second places, there are the provinces of South Sumatra and Lampung Province with respective land area and total production of 250,913 ha and 184,168 tons, as well as 154,830 ha and 106,764 tons. The Gayo highlands in Aceh Province include Aceh Tengah, Bener Meriah and Gayo Lues Regency are the main suppliers of Arabica coffee in Sumatra. In 2017, Aceh Tengah Regency had the largest Arabica coffee plantation area in Aceh, covering an area of 49,251 ha (Directorate General of Plantations, 2019).

The actors in the Arabica coffee supply chain in Aceh Tengah consist of farmers, collectors and companies. Arabica coffee supply chain is a process that starts from collecting red fruit raw materials by farmers, collected with treatment by collectors, reprocessed by the company and sent to consumers according to grade demand in the export market. Currently, the problem of risk and uncertainty often occurs in the world of agriculture. Arabica coffee farmers are often faced with several obstacles and risks in carrying out their business. The risk factors faced in agriculture come from physical risks that

occur due to natural phenomena, social risks that occur due to human behavior and economic risks caused by inflation, fluctuations and uncertainty (Sriyadi, 2014).

Valkila (2014) states that one of the highest risks faced by coffee farming actors is production and price risk. The quality and quantity of production is very important. This affects the fulfillment of consumer demand. Price plays an important role as a component in the sustainability of farming. This is because the price determines the income and use of inputs in farming. If the price falls, the income of Arabica coffee farmers will also decrease. According to Central Bureau of Statistics (2018) data, in 2017 there was a decline in Arabica coffee prices. This price drop can cause losses for supply chain actors.

There are several factors that cause the decline in coffee quality. Among them are planting materials, natural factors, coffee plantation management factors, harvesting methods and post-harvest treatment. In 2004-2013, the rate of coffee bean defects tends to increase in Aceh Tengah. In 2004 the disability rate was 13.24%, while in 2013 it increased to 18.89%. The level of coffee bean defects will affect the quality of the Arabica coffee beans, where the higher the defect rate, the lower the quality of the coffee beans produced. The quality of coffee beans or the degree of defects in coffee beans can be influenced by natural factors such as altitude. Areas at an altitude of 900-1100 m from sea level have a coffee quality level with a higher defect rate than areas with an altitude of > 1500-1600 m from sea level (Mintesnot; Dechassa, 2018). This study analyzes the cause-and-effect risk in the supply chain and looks at the highest risk that can result in not distributing Gayo Arabica coffee properly so that it can be a reference for mitigating these risks.

2 MATERIAL AND METHOD

This research was carried out in Aceh Tengah Regency, Aceh Province, Indonesia. The object of this research is the risk of supply chain actors, the scope of this research covers the causes of risk and the risk value for each supply chain actor. The sample population is the KSU Sara Ate company, the company's partners as many as six traders from each supply village and 70 coffee farmers (the farmer sample uses the Slovin formula with a standard error of 12%) (Dwirandra; Astika, 2020). Snowball sampling is used for sampling. The method used to see the causes and effects caused by the risk by using a fishbone diagram cause-and-effect analysis (Coccia, 2018). The analytical method used to see the risk value of supply chain actors is Fuzzy FMEA (Failure Modes and Effect Analysis), with production, price, quality and human risk variables (Kumru; Kumru, 2013). Data analysis was performed using MatLab software to obtain FRPN (Fuzzy Risk Priority Number) values. The input variables in the fuzzy FMEA are Severity, Occurrence and Detection.

The output of this research is in the form of FRPN value. Fuzzyfication is a process carried out to include membership functions on each input and output variables. The membership function in fuzzy is a curve that shows the mapping of data input points into their membership values. The following is a table showing the parameters for the membership function of each variable.

Tables 1 and 2 describe the parameters used for the membership function for each variable. The parameters used have five categories, namely from very low to very high category, with each parameter having a numerical value of 0-10 for Severity, Occurance and Detection variables (Table 1). The Fuzzy risk priority number (FRPN) is the final value obtained to determine the priority level of Arabica coffee supply chain risk in Aceh Tengah Regency. The resulting output is a value with a scale of 1-1000 (1 is the scale for the lowest risk and 1000 is the scale for the highest risk) (Table 2). This parameter is selected based on the type of curve used. The membership function for each variable in this study uses two types of curves, namely triangular curves and trapezoidal curves. This curve was chosen because according to Khairuddin et al. (2021) triangular and trapezoidal curves are easy to read. In this study, five categories were used for each variable. These five categories make it easier for researchers to determine the rules used in the interference in the fuzzy calculation process.

The severity parameter is assessed against the seriousness of the effects caused. This means that every failure that arises will be assessed for its seriousness level. Occurance is the frequency of risk that occurs which is calculated in a certain period. Detection is a measurement of the ability to control/detect risks that have the potential to occur.

Table 1: Parameters of membership function variables severity, occurance, detection and FRPN.

No	Category	Curve Type	Parameters
1	Very low	Trapezoid	[0 ; 0 ; 1 ; 2.5]
2	Low	Triangle	[1 ; 2.5 ; 4.5]
3	Moderate	Trapezoid	[2.5 ; 4.5 ; 5.5 ; 7.5]
4	High	Triangle	[5.5 ; 7.5 ; 9]
5	Very high	Trapezoid	[7.5 ; 9 ; 10 ; 10]

Source: Rosyidi, Suliantoro and Susanty (2016).

Table 2: Parameters of membership function variable FRPN.

No	Category	Curve Type	Paremters
1	Very low	Trapezoid	[0 ; 0 ; 100 ; 250]
2	Low	Triangle	[1 ; 250 ; 450]
3	Moderate	Trapezoid	[250 ; 450 ; 550 ; 750]
4	High	Triangle	[550 ; 750 ; 900]
5	Very high	Trapezoid	[750 ; 900 ; 1000 ; 1000]

Source: Rosyidi, Suliantoro, and Susanty (2016).

Defuzzification is a process to produce a value that can be calculated in the form of crisp logic which was previously in the form of fuzzy logic, the value is in accordance with that given by the fuzzy set and the degree of membership. In this process the input values for each variable (severity, occurrence and detection) are entered into the input field. After that, an output value will appear that shows the FRPN value.

Based on Table 3, it is revealed that the Fuzzy FMEA output in the form of FRPN (Fuzzy Risk Priority Number) values has an interval of 1-1000 values. This FRPN value scale parameter is used to see the categories resulting from the defuzzification process. The output in the form of FRPN values is categorized into nine interval classes, namely Very Low (VL) with an interval of 1-49, to Very High (VH) with an interval of 800-1000 FRPN. VL category is the risk that has the least priority to control, while the VH category is the risk that has the greatest priority to be controlled. The risk with VH category means that the adverse impact caused by this risk is very dangerous for the sustainability of farming activities.

3 RESULTS

KSU Sara Ate (Sara Ate Multipurpose Cooperative) is one of the Arabica coffee exporters in Aceh Tengah Regency, Indonesia. KSU Sara Ate is located in Pepalang Village, Pegasing District, which is engaged in fairtrade and organic certification which focuses on farmer development, processing, storage and exporter activities. KSU Sara Ate Has 6 fostered

villages where each village has 1 collector/trader. The number of farmers supplying arabica coffee to KSU Sara Ate is 829 farmers. The coffee supplied by farmers to KSU Sara Ate is the same as CV. Oro Kopi Gayo is a random (unsorted) green bean coffee. The Arabica coffee supply chain at KSU Sara Ate consists of farmers, collectors (traders) to the company. The farmers and traders in question are partners of KSU Sara Ate (Figure 1).

Table 3: Parameters of FRPN (Fuzzy Risk Priority Number) value scale on Arabica coffee supply rate risk.

Category	FRPN Value Interval
Very Low (VL)	1-49
Almost Very Low (AVL)	50-99
Low (L)	100-149
Medium Low (ML)	150-249
Medium (M)	250-349
Medium High (MH)	350-449
High (H)	450-599
Almost Very High (AVH)	600-799
Very High (VH)	800-1000

Source: Garcia et al. (2001).

Figure 1 reveals that the product flow in the Arabica coffee supply chain occurs from upstream to downstream. Farmers sell random green beans (unsorted green coffee) to collectors. Then the collectors carry out the transportation of coffee to the company. the frequency of transportation of coffee by collectors is carried out every 2 to 3 times a month. After that the company processes the coffee and

then exports the coffee in the form of green beans, powder and roasted beans.

Financial flows occur from downstream to upstream, where from the consumer to the farmers. Farmers earn money from selling random Arabica green beans to the collectors in accordance with the quantity and quality of sales. Then, KSU Sara Ate give wages to collectors according to the amount agreed upon by both parties. Furthermore, KSU Sara Ate earn money from the sales process that has been carried out with Arabica coffee buyers.

The flow of information occurs in all members of the supply chain. Farmers and collectors get information from KSU Sara Ate. The information they get is about cultivation techniques to post-harvest, the company's production capacity, demand and market. Information on cultivation techniques to post-harvest is carried out by KSU Sara Ate through direct guidance and counseling. Meanwhile, the information obtained by KSU Sara Ate is the supply in the field.

The risk identification process carried out in this study was through brainstorming which was explained using a fishbone diagram. There are four risk variables used, namely risks in the fields of production, price, quality and human (Figure 2). Each risk variable has a cause that can pose a risk. Each risk in the supply chain can occur due to natural and non-natural factors. Risks caused by natural factors, namely pests and diseases, changes in weather/climate and natural disasters. Non-natural factors that can cause risk are unskilled labor, inadequate road access, changes in market prices and excess/shortage of coffee supply. The consequences of this risk can cause losses and a decrease in the income of each supply chain actor.

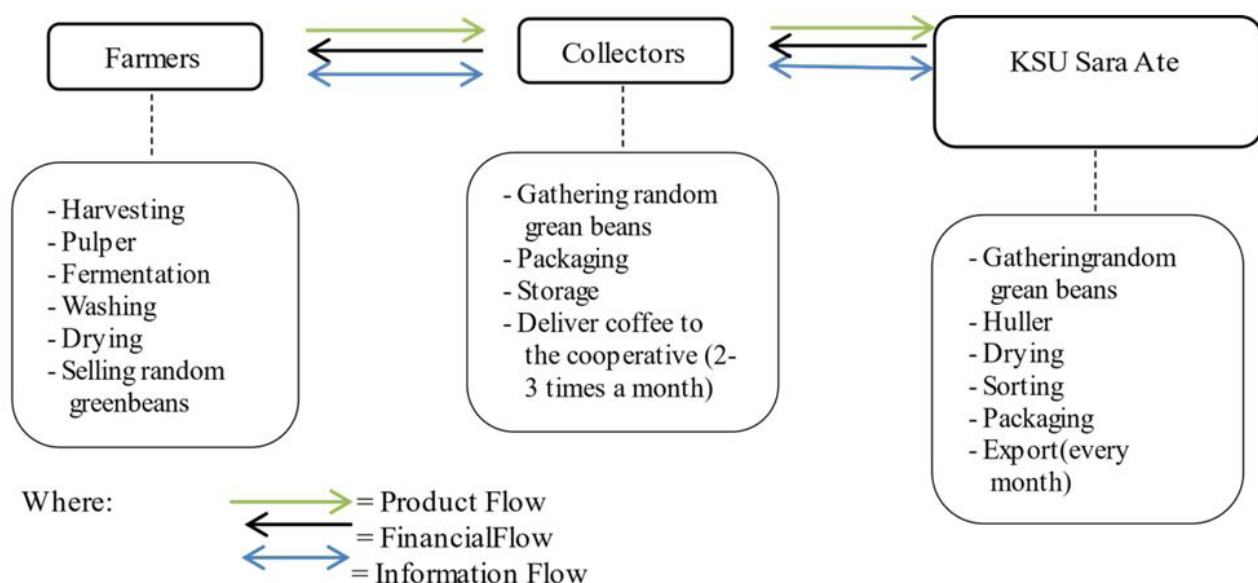


Figure 1: Arabica coffee supply chain structure at KSU Sara Ate.

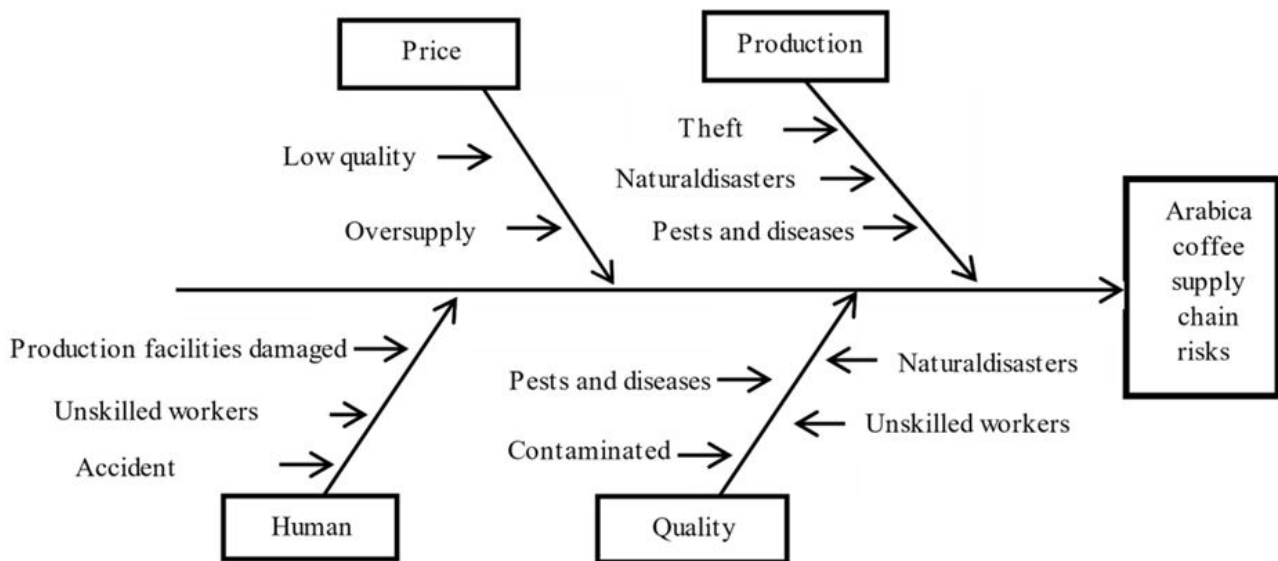


Figure 2: Fishbone diagram (cause and effect) Arabica coffee supply chain risk.

4 DISCUSSION

The results of the farmer risk assessment show that the highest risk is the price included in the Almost Very High (AVH) risk category (500 FRPN) (Table 4). According to Philpott et al. (2007) farmers do not have the ability to determine prices. Therefore, farmers are supply chain actors who get the lowest prices compared to collectors and KSU Sara Ate. A decrease in prices causes a decrease in the income obtained by farmers. Price is one of the important factors in providing profits for Arabica coffee entrepreneurs. The Indonesian Coffee Exporters Association (AEKI) Revealed that price fluctuations can be caused by climate change (Sarirahayu; Aprianingsih, 2018). According to the results of the study, another reason for the decline in coffee prices was the oversupply of Arabica coffee. Coffee prices are strongly influenced by the amount of demand and supply. If the demand for Arabica coffee is high, there will be an increase in the price, and vice versa if the supply of Arabica coffee is high, the price of Arabica coffee will decrease.

Decrease in quality and productivity due to natural disasters/climate change is one of the highest risks in the Medium High (MH) risk category faced by Arabica coffee farmers. Arabica coffee farmers always depend on the weather/climate. Sari and Pardian (2018) in their research state that the highest risk faced by coffee farmers is production risk caused by weather and climate. The risk that occurs is the loss of coffee flowers due to high rainfall. In addition, the impact of climate change causes temperatures to increase so that it significantly affects Arabica coffee production, as happened in Nicaragua, Latin America (Läderach et al., 2017). Arabica coffee can grow and produce optimally at a temperature of 18-22 °C, so climate plays an important role in the production of this type of coffee (Pham et al., 2019).

There are two Arabica coffee harvesting seasons in a year, namely the peak harvest and the intermediate harvest. The peak harvest season in Aceh Tengah Regency usually takes place in June-September and the intermediate harvest season takes place in December-March. Based on this research, there is a change in the pattern of the rainy season and the dry season. During the rainy season, the rainfall is very high and vice versa. Rainfall is needed at the time of coffee fruit formation (Verhage; Anten; Sentelhas, 2017). But at certain times, rain can have a negative impact on coffee. If it rains at the time of coffee flower formation and harvest, it will cause the flowers and cherry coffee to easily fall. Continuous rain can also cause the coffee skin to crack because it expands due to absorbing too much water (Camargo, 2010). In addition, the rain that falls during processing will be very detrimental to farmers, where coffee should be dried in the sun to prevent spoilage and mold.

The decline in the quality of Arabica coffee can be caused by several factors, namely pests/diseases and farmers' mistakes in treating Arabica coffee. The most common pest in the study area was the coffee berry borer. This pest can cause the coffee cherries to become small and turn yellow in color. Decreasing the quality of Arabica coffee can also occur in post-harvest. The results of this study showed as many as 25% of farmers in the study area processed coffee beans after 2 days from harvest time. According to the Minister of Indonesia Agriculture Regulation No. 49/Permentan/OT.140/4/2014, coffee cherries should be processed as soon as possible after harvest. Coffee that is stored for too long or is not processed immediately for more than 1 day after harvest will cause fermentation which can damage the taste of the coffee, causing a bad smell and the coffee beans to turn brown. In Cameroon, Coffee berry disease (CBD) is caused by *Colletotrichum kahawae*, where this pathogen only attacks

green berries that cause cherry fruit rot and premature fruit fall (Bedimo et al., 2007; Bedimo et al., 2008).

In addition, coffee storage must also be considered. Coffee is very easily contaminated so that it can affect the original aroma and taste of coffee. Most Arabica coffee farmers in Aceh Tengah dry their coffee on a special cement floor for drying coffee or use plastic mats. However, there are still farmers who dry their coffee on roads that are traversed by vehicles and animals. This can also result in the quality of the coffee being decreased or even damaged. According to Joët et al. (2010) many coffee farmers do not understand how to handle post-harvest coffee properly, as a result, coffee has decreased taste quality due to chemical transformation in the form of lipids, chlorogenic acid, sugar and coffee caffeine.

Furthermore, a decrease in Arabica coffee productivity can come from pests and diseases, high rainfall, maintenance that is not in accordance with GAP (Good Agriculture Practice), production inputs and incorrect harvesting processes (Sari; Pardian, 2018). Pests that attack arabica coffee are fruit borers and stem borers, while the most common diseases are fungi. Coffee that is attacked by pests and diseases is usually due to dark shade, lack of sanitation and humid garden conditions. If not controlled, these pests and diseases will have an impact on the success of Arabica coffee farming. This is because pests and diseases can infect the entire Arabica coffee plantation.

Arabica coffee farmers who partner with KSU Sara Ate are farmers with certified organic land. Therefore, pest and disease control can only be done organically, such as land clearing (sanitation), the use of traps, the use of pathogens, and the use of natural enemies. The government and partner cooperatives have carried out activities to eradicate pests and diseases through counseling and training. However, there are still farmers who do not control pests and diseases. This

is because farmers think that the intensity of mild pests and diseases does not significantly affect the productivity and quality of Arabica coffee. In addition, another cause of high production risk due to pests and diseases is farming experience. Table 5 reveals farmer risk based on experience.

Table 5 reveals that the risk of crop failure caused by pests and diseases is mostly found in farmers with 1-10 years of farming experience. The coffee plantation partnered with KSU Sara Ate is an organic coffee plantation. So that pest and disease control must be controlled organically. It requires expertise and experience to control pests and diseases. According to Liebig et al. (2016) ways to overcome pests and diseases through better flow of information through extension, training and workshops of existing and new knowledge of science should reach farmers. At the knowledge level, awareness of what technologies are known and accepted by farmers is very important to find out why the developed control strategies are not adopted. Finally, participatory and integrated pest and disease management strategies should be designed according to the spatial variability of agro-ecological conditions as well as rural infrastructure.

Another risk faced by Arabica coffee farmers is the human risk. According to Eakin, Winkels, and Sendzimir (2009), negligence by human resources can result in delays in the production process and cause losses. This can happen because of an unskilled farmer. Garden owners say that coffee pruning often goes wrong. Farmers who work in this field often cut down coffee branches that are still productive. The farmers who are recruited by garden owners to work in their plantations are usually human who have learned to prune coffee on their own. No hands-on training is provided so the farmers often just guesses and chops coffee haphazardly. In addition, unskilled famers can also cause damage to production facilities, including hoes, machetes, coffee pruning shears and pulper machines (coffee peeling machines).

Table 4: Risk assessment results at farmer level (Primary data, 2019).

Risk Variable	Factor	S	O	D	RPN	FRPN	Category
Production	Crop failure due to pests and diseases	4	4	4	64	461	H
	Crop failure due to natural disasters/climate change	3	1	5	15	376	MH
	Garden location	2	2	3	12	223	ML
	Theft	2	3	4	24	223	ML
Price	Price fluctuation	7	7	7	343	500	H
	Input price changes	2	2	5	20	223	ML
Quality	Decrease in quality due to pests and diseases	3	2	2	12	372	MH
	Decrease in quality due to natural disasters/climate change	3	1	5	15	376	MH
	Decrease in quality due to errors in the treatment of coffee beans	3	4	4	48	376	MH
Human	Farmers' mistakes in harvesting	3	5	5	75	376	MH
	Farmers' mistakes in maintenance	3	4	4	48	376	MH
	Damaged production facilities	3	3	2	18	372	MH

Where: S is Severity. O is occurrence. D is Detection. RPN is Risk Priority Number. FRPN is Fuzzy Risk Priority Number.

Table 5: Risk of Arabica coffee farmers based on farming experience (Primary data 2019).

Risk Variable	Factor	1-5 years (FRPN)	6-10 years (FRPN)	11-20 years (FRPN)	21-30 years (FRPN)
Production	Crop failure due to pests and diseases	500	599	461	368
	Crop failure due to natural disasters/climate change	461	223	364	458
	Garden location	368	461	223	461
	Theft	223	97	223	223
Price	Price fluctuation	569	569	574	569
	Input price changes	223	223	99.5	223
Quality	Decrease in quality due to pests and diseases	468	364	223	368
	Decrease in quality due to natural disasters/climate change	500	223	364	364
	Decrease in quality due to errors in the treatment of coffee beans	461	500	233	500
Human	Farmers' mistakes in harvesting	364	461	223	461
	Farmers' mistakes in maintenance	461	461	364	458
	Damaged production facilities	364	364	223	223

Where: S is Severity. O is occurrence. D is Detection. RPN is Risk Priority Number. FRPN is Fuzzy Risk Priority Number.

Based on Table 6, the highest risk owned by collectors is price (500 FRPN) and human (461 FRPN) which are included in the high (H) risk category. Just like farmers, price is the highest risk faced by collectors. In collectors, risk and price are interrelated. The wages given to collectors have previously been agreed with the KSU Sara Ate. The wages given to collectors are adjusted to the quality of Arabica coffee supplied by farmers. If the quality of Arabica coffee supplied by farmers is good, the price offered will also be higher. Therefore, the wages given to collectors are in accordance with the quality of Arabica coffee supplied by farmers.

The loyalty of KSU Sara Ate's partner farmers who supply coffee to collectors is also a risk in running Arabica coffee farming. The low loyalty of farmers occurs because of the difference in prices owned by collectors who partner with KSU Sara Ate between ordinary collectors. This happens because of several factors, namely the price offered by collectors outside partners is higher than partner collectors. Collectors outside partners also do not provide coffee prices according to coffee quality. In addition, farmers sell Arabica coffee beans to mobile collectors, middlemen and other collectors.

The next risk faced by Arabica coffee bean collectors is work accidents. This work accident occurred when the collector was delivering coffee to the company. Distance and weather are the causes of this risk. There are Arabica coffee plantations partnered with KSU Ara Ate which are located at an altitude of 1000 mdpl to 1500 mdpl and have a considerable distance from the company. Access roads are far and have to go up and down hills and heavy rainfall sometimes causes slippery roads and landslides.

Based on Table 7, the highest risk variable faced by KSU Sara Ate is the low price caused by low quality. This risk is included in the Almost Very High (AVH) category with an FRPN value of 632. The quality of coffee supplied by Arabica coffee farmers to the cooperative affects the amount of Arabica coffee production in each company resulting in low volume of quality coffee exports. This can reduce the income of each coffee exporting company. In several countries, such as Nicaragua, Colombia and Ethiopia, trade certification is carried out to standardize products so that coffee prices remain high in the export market and are very profitable for coffee farmers (Valkila, 2009; Valkila; Nygren, 2010; Jena et al., 2012; Bacon et al., 2014; Ibanez; Blackman, 2016). Product certification in this case is also recommended for coffee products in Aceh.

Another risk faced by this cooperative is an unskilled farmer. This happens because the cooperative does not do the selection at the time of recruitment. In addition, there is no training in accordance with the field of work being carried out. Unskilled farmer can cause damage to production facilities. This is because the farmer does not understand the facilities used and how to maintain them. According to Kwanmuang and Lertjunthuk (2021) to overcome unskilled farmers in Thailand, the exchange of farmer information and the provision of information about the practice of picking coffee at the location are needed. In addition, as farmer groups play an important role in building stronger social bonds and reducing farmer barriers, programs that apply technology and tools to support an unskilled harvesting workforce, labor information, and coffee farming practices should be implemented through farmer group communities.

Table 6: Risk assessment results at the level of collectors (Primary data 2019).

Risk Variable	Factor	S	O	D	RPN	FRPN	Category
Production	Orders are not fulfilled due to unavailability of raw materials	1	1	1	1	90.2	AVL
	Price fluctuation	6	6	6	216	500	H
Price	Input price changes	1	1	1	1	90.2	AVL
	Low price due to low quality	3	3	4	36	372	MH
Quality	Supply quality diversity	3	4	4	48	372	MH
	Decrease in quality due to storage/contamination	3	2	2	12	376	MH
	Low supplier loyalty	4	4	5	80	461	H
Human	Accident at work	3	2	3	18	376	MH
	Production facilities damaged	3	3	4	36	372	MH

Where: S is Severity. O is occurrence. D is Detection. RPN is Risk Priority Number. FRPN is Fuzzy Risk Priority Number.

Table 7: Results of the Arabica coffee supply chain risk assessment at the KSU Sara Ate Cooperative (Primary data 2019).

Risk Variable	Factor	S	O	D	RPN	FRPN	Category
Production	Orders are not fulfilled due to unavailability of raw materials	1	1	1	1	90.2	AVL
	Price fluctuation	5	5	7	175	530	H
Price	Input price changes	6	5	6	180	530	H
	Low price due to low quality	7	7	2	98	632	AVH
Quality	Supply quality diversity	4	5	5	100	463	H
	Decrease in quality due to storage/contamination	5	5	4	100	500	H
	Low supplier loyalty	4	5	4	80	463	H
Human	Accident at work	2	1	1	2	223	ML
	Production facilities damaged	4	2	3	24	450	H
	Unskilled farmers	5	4	2	40	461	H

Where: S is Severity. O is occurrence. D is Detection. RPN is Risk Priority Number. FRPN is Fuzzy Risk Priority Number.

The lowest risk faced by KSU Sara Ate is production with the variable risk of orders not being fulfilled due to lack of availability of raw materials (90.2 FRPN). KSU Sara Ate already has supplies that they prepare in case of a decline in production for farmers. This coffee supply is used to meet consumer demand. However, the risk posed by providing this stock is a decrease in quality due to contaminated coffee. Coffee is very easy to absorb the aroma that causes the loss of the distinctive taste of coffee. This can lead to a decrease in the quality of the coffee itself.

5 CONCLUSIONS

Risks in the Arabica coffee supply chain can occur due to natural and non-natural factors. Risks caused by natural factors, namely pests and diseases, changes in weather/climate and natural disasters. Non-natural factors that can cause risk are unskilled farmer, inadequate road access, changes in market prices and excess/shortage of coffee supply. The results of the study using 4 variables indicate

that the high to low values of risk FRPN in the supply chain are (1) Price (632 FRPN), (2) Quality (500 FRPN) and (3) Production and human (461 FRPN).

6 AUTHOR CONTRIBUTIONS

AB: conceptualization, formal analysis, methodology, writing—original draft preparation, writing—review, and editing. US: data curation, formal analysis, writing—original draft preparation and writing—review. MU: formal analysis, methodology, writing—original draft preparation, writing—review, and editing. BB: formal analysis, methodology, writing—original draft preparation, writing—review, and editing.

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