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To cite this article: N Kuswardhani and N F Yulian 2019 *IOP Conf. Ser.: Earth Environ. Sci.* **250** 012061

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Supply chain risk potential of smallholder Robusta coffee farmers in Argopuro mountain area

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Abstract. The supply of coffee can be varied depending on several factors such as low productivity, low quality and behind the control of producers (weather, disease). Due to inelastic demand and supply, any change in supply can cause fluctuation in market price. However, coffee farmers face several problems including the various risk involved in the coffee supply chain. The aim of this research was to identify various risks involved in the coffee supply chain and to analyze and evaluate the supply chain actors' members with the highest risk in the coffee supply chain management. The study was conducted in small enterprise of robust coffee in Argopuro mountain area Jember District, East Java. Analytical Network Process (ANP) and Weighted Failure Mode Effect Analysis (WFMEA) method was used to determine and analyze the highest risk in the coffee supply chain. The results showed that there were six risks identified in the supply chain, such as the quality of Robusta coffee production, prices, supply, environment and transport. The priority of the members of the value chain in the coffee supply chain risk management were the farmer (0.296) with the greatest priority was quality risk (WRNP 222.45).

1. Introduction

The Indonesian area of coffee plantations in 2015 was 1,233,227 Ha with the coffee production reached 655,256 tons [1]. As the third largest coffee producing country in the world after Brazil and Vietnam, Indonesia produce at least 748 thousand tons or 6.6% of the world coffee production in 2012. The productivity of coffee plants in Indonesia only reached 700 kg of coffee beans/ha/year for Robusta and 800 kg of coffee beans/ha/year for Arabica. Meanwhile, the productivity of neighboring country such as Vietnam has reached more than 1,500 kg/ha /year [2].

Jember is one of the areas which cultivates the Robusta coffee. Jember Robusta coffee production in 2010 amounted to 3,120 tons with plantation area of 5,608 Ha [3]. According to the East Java Agricultural Development Research Center, since the Dutch colonial era, Jember Argopuro Mountains region has become a coffee plantation area. Jember Argopuro Mountains region includes Bangsalsari, Tanggul, Sumberbaru, Panti, Sukorambi and Arjasa Sub-Districts.

The Indonesian coffee consumption projection in 2016-2020 is expected to increase by 2.49% per year [4]. Jember coffee consumption also increases in line with the national consumption. Besides, the high level of coffee consumption shows that 80-90% of Robusta coffee consumption produced by farmers is all purchased to middlemen for both exporters and wholesalers. Along with the high level of



the coffee consumption and demand in exporting, the coffee importing must be done to fulfill the coffee consumption.

This research was conducted through a case study in several communities of coffee supply chain members of the Jember Argopuro Mountains using the Analytical Network Process and Failure Mode and Effect Analysis approaches. Based on the problems above, to minimize the risk of the Robusta coffee supply chain in the Argopuro Mountains of Jember, the purpose of this study was to identify various risks and to analyze the highest risk of the Robusta coffee supply chain member in Argopuro Jember Mountains, Bangsalsari Sub-District.

2. Methods

This research was conducted in Argopuro Mountain area of Tugusari Village and Curah Kalong Village in Bangsalsari District, Jember Regency in April to June 2018. This study involved 20 members of farmer groups and 4 experts from academics and non-academics. The primary data and secondary data related to Robusta coffee Argopuro Jember Mountains Bangsalsari District was collected.

The initial step was preliminary research through focus discussion group and direct observation at the location regarding to the business of the Robusta coffee plantation. The information obtained was about the supply of chain flows and risks which often occurred in community's coffee farming activities to exporters. This step leads to the reason exploration whether the criteria (clusters) is important or not and along with the explanation of the sub-criteria. The results of interviews and FGD (Focus Group Discussion) resulted in sub-criteria for each cluster, namely the problem cluster totaling 10 sub-criteria, the risk totaling 15 sub-criteria and actors totaling 5 sub-criteria.

Based on the results of the FGD, the clusters were determined based on the assessment by experts is truly considered important and the validity is examined by using SPSS Version 23. The criteria (clusters) obtained were 4 problems, 6 risks and 5 actors. Based on the results of these criteria determination, it was used as a reference for making ANP framework. This ANP data processing uses super decision software which then gained the priority weight for each criterion.

The risk analysis phase was carried out by using the WFMEA method which aimed to obtain a more accurate assessment of risk factors that have been calculated as priority. The assessment at the WFMEA step was by calculating the weight of each risk using the Weighted Risk Priority Number (WRPN) formula, the formula equation is:

$$WRPN = S_i \times O_i \times D_i \times f(W_i) = RPN_n \times f(W_i)$$

3. Results and discussion

The research results regarding to the supply of chain risk identification after doing the validity testing shows that there are 6 risks its variable each. The following is a risk mapping which can be seen at the fishbone diagram in Figure 1.

The risk factors were generated based on expert discussions, respondents, through observation and previous research related to supply of chain risk, six risks are identified in this study. Quality risks were caused by seasons and weather, pest and disease attacks, low knowledge and cultivation techniques, low quality of raw materials and inadequate storage facilities. Production risks were caused by limited production capacity, low quality of raw material, inefficient production processes and simple production process technology. Price risks were caused by the rupiah exchange rate, price fluctuations and incorrect information about prices. Supply risks were caused by a variety of supply quality and uncertain supply availability. Environmental risks were caused by natural disasters, competing products and social, cultural and political conditions. Also, transportation risks were affected by infrastructure damage, travel insecurity, uncertain transportation times and long transportation distances.

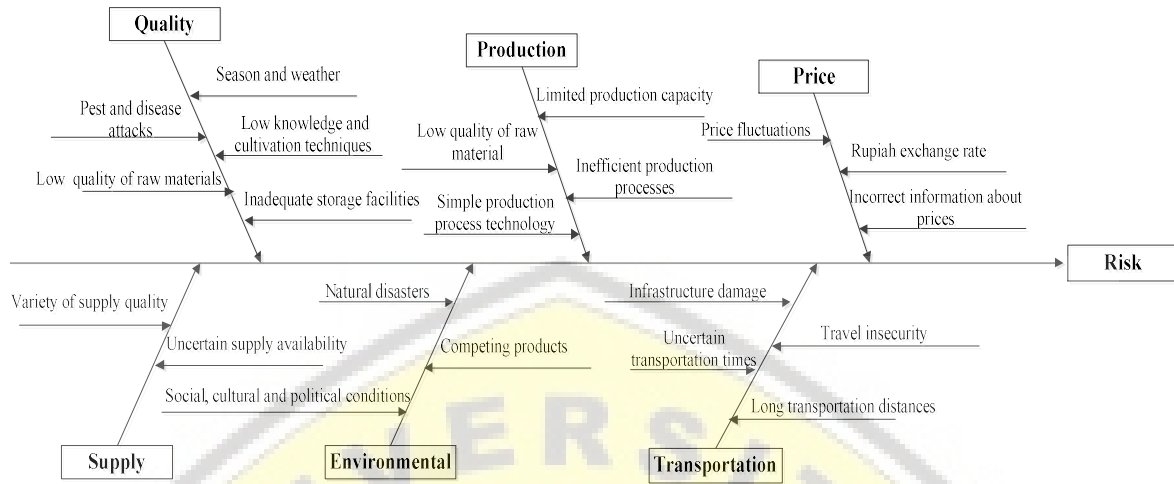


Figure 1. Risk mapping of the coffee chain supply in the fishbone diagram

The result showed the risk analysis of the Robusta coffee supply chain in the Jember Argopuro Mountains from April to June (Figure 2).

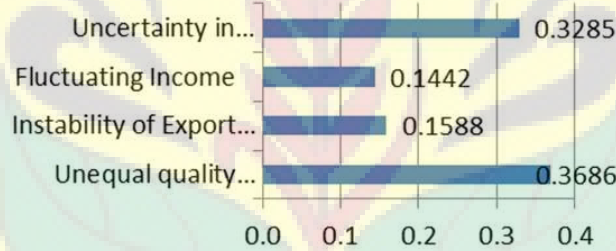


Figure 2. The results of pairwise weigh comparisons on the Robusta coffee supply chain problem

The results of pairwise comparisons can be seen from some highest priority causes, namely the unequal quality problem of Robusta coffee, with the value of 0.3686. The main cause of this problem was the quality of the coffee bean that has been harvested before it fully ripe. This occurs in Bangsalsari district and almost all the farmers are involved in the *ijon* system. Besides that, it was also influenced by erratic seasons and weather. If drying coffee beans does not get sunlight and sufficient facilities, it will affect the quality of coffee. Criteria for determining the good quality of coffee beans are based on water content, physical quality and taste [5].

Moreover, for the results of pairwise comparisons of the risk weight can be seen in Figure 3. Whereas for the results of pairwise comparisons of the member weight of the supply chain can be seen in Figure 4. The results of pairwise comparisons with the highest priority was the quality risk. The risk was caused by highest priority quality which influenced by the season and erratic weather when drying coffee beans. The existence of pests and diseases also affects the coffee beans which cannot grow perfectly and cause fruit defects when it was ready to harvest. The low cultivation knowledge and techniques also affect the quality of coffee beans. The other quality risk influences are caused by the low quality of raw materials which was marked by the unripe coffee beans or not all red. In addition, it was caused by the inadequate storage facilities during both in the cultivation process and dried coffee beans.

The results of pairwise comparisons which have the highest priority weight was farmers, because production of a good quality of Robusta coffee was depending on the farmers' treatment of the coffee. Then, the second priority actor of weight was the collecting trader with 0.1824 of the priority weights,

because the collecting traders were the first recipients of Robusta coffee produced by farmers. Then for the third actor priority was the wholesaler with a value of 0.1790. Large traders are the recipients of coffee after the collecting traders. While for the fourth actor priority was the exporter with a value of 0.1763. Exporters are recipients of coffee from wholesalers. And for the fifth or lowest actor priority was the related institutions with a value of 0.1669. In the case of supply chains, the relevant institutions are responsible for conveying the information about coffee to farmers, collectors, wholesalers and exporters. The intended relevant institutions are the workers or assistants of coffee farmers assigned by the Department of Food Agriculture, Horticulture and Plantations of Jember Regency. Therefore, it can be concluded that in the Robusta coffee supply chain, Argopuro Mountains, Bangsalsari District, Jember, farmers have a tendency to bear a higher risk than other actors, especially related to the quality of robusta coffee. The RPN calculation can be seen on Table 1.



Figure 3. The pairwise comparisons result of the risk weight of the Robusta coffee supply chain

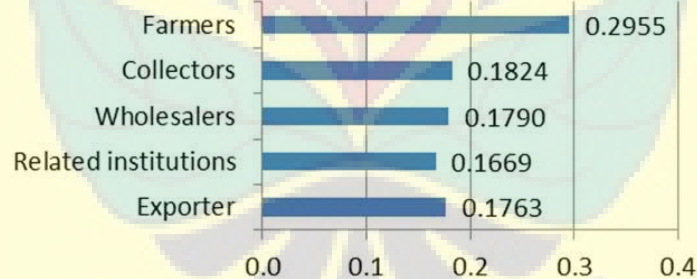


Figure 4. The results of pairwise comparisons of the Robusta coffee supply chain actors

Based on Table 2, a risk evaluation can be done which aims to compare the level of risk that has been calculated at the risk analysis stage with the standard criteria used. Based on the risk category, it can be concluded that the very low risk category was supply risk (WRPN 44.70) and environmental risk (WRPN 31.51). Then the low risk category was price risk (WRPN 71.22) and transportation risk (WRPN 56.18). Medium risk category was production risk with value (WRPN 116.35). Whereas, the very high-risk category was the quality risk with value (WRPN 222.45).

The risks which have the greatest influence on farmers are risks of quality and production because they have a higher WRPN value. Therefore, based on the risk category, it can be interpreted that for the risk of supply, environment, price and transportation for risk control, it can still be accepted with a WRPN value of less than 100 based on the risk category. Production risk controls the risks that need to be avoided because it has a high WRPN value of among 100-150. Quality risk has a very high WRPN value (200-250). The control which must be carried out is in the form of risk mitigation or need to be eliminated.

Table 1. RPN calculation

Risk Factor	Risk Variable	Severity (1-10)	Occurrence (1-10)	Detection (1-10)	RPN
Quality	1. Season and weather	5.75	5.75	4.75	157.05
	2. Pest and disease attacks	6.50	5.75	5	186.88
	3. Low knowledge and cultivation techniques	5.50	6.25	5.25	180.47
	4. Low quality of raw materials	5.25	4.75	4.25	105.98
	5. Inadequate storage facilities	4.75	5.25	4.25	105.98
Production	1. Limited production capacity	5.25	4	4.5	94.50
	2. Low quality of raw material	6.25	5.25	4.75	155.86
	3. Inefficient production processes	6.00	4.5	5.5	148.50
	4. Simple production process technology	4.75	5	5	118.75
Price	1. Rupiah exchange rate	5.25	4.5	5	118.13
	2. Price fluctuations	6.25	6	6	225.00
	3. Incorrect information about prices	4.75	4.25	5.00	100.94
Supply	1. Variety of supply quality	6.00	6	4.25	153.00
	2. Uncertain supply availability	5.25	5.75	5.75	173.58
Environmental	1. Natural disasters	6.25	4.25	6	159.38
	2. Competing products	6.50	5.75	4.25	158.84
	3. Social, cultural and political conditions	4.75	3.5	3.75	62.34
Transportation	1. Infrastructure damage	5.50	5.5	5	151.25
	2. Travel insecurity	5.50	4.75	4	104.50
	3. Uncertain transportation times	5.50	5.75	5	158.13
	4. Long transportation distances	7.25	5	5.25	190.31

Risk control is an action to control risk in the risk management of the Robusta coffee supply chain which refers to the identification and evaluation of risks in the previous stage. Control measures are arranged based on the results of the biggest risk priority, namely the risk of production and quality of farmers. Control can be done in the form of avoiding and mitigating the priority risks.

One of the efforts which can be done in controlling production and quality risks is by familiarizing farmers to apply wet processing to harvest Robusta coffee. Robusta coffee farmers in Sidomulyo Village, Silo District, which have proven it by producing good quality coffee. Good quality of coffee is determined based on water content, physical quality and taste. The most important attributes in the quality of coffee beans are the moisture content contained a maximum value of 11% [5].

Table 2. WRPN calculation

Risk	ANP/W	RPN	WRPN	Rank
Quality	0.3021	736.36	222.45	1
Production	0.2248	517.61	116.35	2
Price	0.1604	444.06	71.22	3
Supply	0.1369	326.58	44.70	5
Environmental	0.0828	380.56	31.51	6
Transportation	0.0930	604.19	56.18	4

The farmers' development in processing wet coffee needs to be improved to produce a good quality coffee. The high quality of ose coffee is one of the requirements in producing good processed coffee. So far, these efforts have been carried out by the establishment of the Sidomulyo Village Koperasi Buah Ketakasi which is very encouraging in developing coffee agro-industry. The cooperative not only provides processing capital but also purchases the processed products of smallholder coffee [6]. The improvement of post-harvest coffee processing and the existence of the cooperatives are to provide coffee plant fertilizer which can be more easily obtained by farmers. So that based on the reference that has been explained, the effort to form a highly recommended cooperative can be realized for the community coffee farming sustainability in Tugusari Village and Curah Kalong Village, Bangsalsari District, Argopuro Jember

4. Conclusion

There are six risks to the Robusta coffee supply chain. These risks includee the risk of quality, production, price, supply, environment and transportation. Efforts that can be made in controlling production and quality risks are by familiarizing farmers to apply wet processing to Robusta coffee post-harvest and the formation of farmer group cooperatives.

Acknowledgments

The researchers gratefully acknowledged the assistance and guidance from the Department of Agriculture, Horticulture and Plantation during the research activities in Bangsalsari Subdistrict, precisely in Tugusari Village and Kalong.

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