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Supply chain risk classification shallot agribusiness in the Highland through analytical hierarchy process approach

Sri Ayu Andayani[1], Yayan Sumekar[2*], Suhaeni[3], Jaka Sulaksana[1]
[1] Faculty of Agriculture, Universitas Majalengka, West Java, Indonesia
[2] Faculty of Agriculture, Universitas Padjadjaran, West Java, Indonesia
[3] Faculty of Agriculture, Universitas Singaperbangsa Karawang, Sukamakmur, Indonesia

Abstract
One of the horticultural commodities that has the potential to be developed is shallots, however, supply chain performance problems in this commodity still have many potential risks. In risk mitigation, it is necessary to identify various types of risk with a priority scale. This study is to analyze the various risks that occur in the supply chain flow as well as the various actors involved. The research was conducted in the highlands of Majalengka Regency. The research was conducted using a descriptive survey method and data collection of 100 respondents through interviews and questionnaires. The collected data were analyzed using the Analytical Hierarchy Process (AHP) model. The results showed that the risks acquired in the highlands were price risk (16.3%), production risk (14.2%), market risk (13.4%), distribution risk (9.7%), quality risk (8.3), storage risk (8.3%), capital risk (8.0%), information risk (5.8%), technology risk (5.7%), policy risk (5.4%), and environmental risk (4.9%). The actors involved consist of farmers, farmer groups, traders, middlemen, retailers and consumers. The results of this study can recommend to steak holders to facilitate decision making in risk mitigation by paying attention to the priority scale.

Keywords: supply chain, shallot, risk, AHP model, highland

Introduction

Shallots, one of the plants that are considered important in our country (Fitriana N & Susandarini, 2019) [15] are also strategic horticultural crops (Sutardi & Heni P, 2018) [25], so this plant becomes a potential commodity. Shallots as a food flavoring agent need an adequate supply (Ansar, M *et al*, 2019) [3]. In addition to consumption of cooking spices, shallots are also used as an ingredient in the production of liver cancer drugs (Hosseini, *et al*, 2017) [17], and can also be used for menopause treatment from Dayak shallot bulbs (Bahtiar A & Riza Annisa, 2018) [5] However, susceptibility to pests and diseases is one of the problems (Berhanu, 2014), as well as low productivity (Eugene F, *et al*, 2019), and there are still many production risks that occur (Darwanto, *et al*, 2019) [6]. One risk faced in the small industry is the production that does not meet targets and specifications as in cocoa, this condition also occurs in shallots (Ernita, Y, *et al*, 2018) [12]. Therefore, risk priority mitigation strategies must be considered (Andayani SA, *et al*, 2020) [1] because even in a perishable food supply chain there must be an effective risk mitigation strategy (Prakash S, *et al*, 2015). In this crop, it also experiences problems with instability. prices so there must be a clear situation analysis (Trisnasari W, *et al*, 2020) [30]. Price and production risks are high for horticultural commodities (Hasan F, *et al*, 2016) [16].

One of the alternatives for the development of shallot agribusiness is through increasing healthy and quality seeds (Sembiring A, *et al*, 2018) [29], because mitigation through seed quality is one of the mitigation priorities for a source of risk (Fahadha, *et al*, 2019) [13]. One of the true shallot seed (TSS) technologies is an ideal choice to increase the competitiveness of shallots (Heni SP, *et al*, 2019) [18]. Technological innovation and improvisation can create a more resilient and sustainable supply chain (Mor Rahul, S, *et al*, 2020) [20]. In addition, there must also be identification of the number of horticultural supply chains at the initiative of the government and consumer demand as is done in the UK (Pearson, DHA & Bailey A, 2009) [24]. In increasing the acceleration of the development of the agricultural sector, it is also necessary to form a special independent team to study conditions in the field (Festianto, D, 2019) [14]. The smart supply chain model can answer the difficulties faced by upstream and downstream actors including smart technology, social engineering, farmer clusters, their respective potentials such as in the rice industry, it does not rule out this being applied to the shallot industry (Perdana T, *et al*, 2020) [30]. In shallot agribusiness, a more efficient supply chain channel is needed (Susanawati, *et al*, 2017) [26], as well as primary and supporting actors in the management of the shallot supply chain, their role continues to be improved (Andayani S, A, *et al*, 2017) [2].

Seeing the above, especially the Majalengka area in shallot agribusiness, still leaves problems that must be studied even though it has the potential to be developed. The problems that exist include various indications of supply chain risk and low productivity, although if you look at Malang, the risk of production and risk of income is low (Nazwan, *et al*, 2020) [21]. Based on this description, the purpose of this study is to identify supply chain risks and see the involvement of actors in the shallot supply chain in the highlands so that it can create a priority scale for mitigation. This study uses the Analytic Hierarchy Process (AHP) methodology, this approach can see the identification of

supply chain risks (Susanawati, Fauzan M, 2019) [27]. This methodology is also tried in the consideration of site selection in minimizing wind energy project risks (Akhalidi A, *et al*, 2019). This is also linked to the basic process of risk management which consists of identification, evaluation, mitigation and risk control (Costa G, D, *et al*, 2020) [8].

The focus of this research is identifying supply chain risks in shallots, making a priority scale in mitigas, and determining the actors involved. Methodological approach through AHP in highland areas. As far as the references are traced, there has been no research that analyzes this aspect in the highland areas and this can be used as a comparison for determining the priority scale of the main risk mitigation of the shallot supply chain as well as consideration for local government policies in the development of shallots.

Methodology

Methods the descriptive method is the method used in this research. The data collection technique was carried out by means of surveys, in-depth *interview s*and distributing questionnaires to respondents. Surveys and interviews were conducted to determine the actors involved in the shallot supply chain. The questionnaire was used to identify the types of supply chain risks on shallots.

This research was conducted in the highlands of Majalengka Regency from December 2019 to June 2020. Determination of the location was carried out by *purposive sampling*, namely Argapura District (highland area) with the consideration that this sub-district is a shallot production center.

Respondents in this study consisted of government experts, academics and actors involved in the shallot supply chain (farmers, farmer groups, dealers, retailers, and consumers) as many as 100 people. Respondents as experts were selected *purposively* with the following criteria:

a. Have expertise and experience in the field of supply chain for agricultural commodities, especially onion commodities.
b. know the general conditions of shallot farming starting from cultivation, post-harvest and marketing of shallots.
c. Have knowledge of the sources and types of risks faced by shallot supply chain actors.

Themodel *Analytical Hierarchy Process (AHP)* is the analytical method used in this study and is used to make decisions and determine the best alternative by considering various criteria (Ennaceur A, *et al*, 2016) [11].

The AHP model through *expert choice 11 software* can be used to identify the risk of the shallot supply chain. The data processed for AHP analysis is in the form of data on the risks faced by each actor involved in the supply chain of shallots. Risk data is obtained from literature studies and in-depth interviews with several experts who are familiar with supply chain r isks, both from government, academia and practitioners.

The stages of AHP's working principle are as follows (Susanawati and Fauzan, M (2019) [27],

Identification of the problem

The first step is to identify the problem in depth (C. Kumar *et al*, 2015) [7]. The next process is the identification and selection of elements that will be included in the system components, such as goals, objectives, actors / actors and alternatives in the AHP structure. The hierarchical structure of the shallot supply chain can be seen in Figure 1.

Fig 1: Hierarchical structure of shallot supply chain identification

Creating a hierarchical structure

Based on literature studies and expert opinions, the hierarchical structure in this study consists of 4 levels including goals, actors / criteria, sub-criteria and alternatives.

The AHP process method involves considering a hierarchical structure in the form of targets, criteria and alternatives (Lukinskiy *et al*, 2015) [19]. The goal is to identify the risk of shallot supply chain actors. Actors / criteria are actors involved in the shallot supply chain consisting of farmers, farmer groups, dealers, retailers and consumers. Sub criteria consist of fairness in profit sharing among supply chain actors, supply chain efficiency and smooth flow of goods, money and information. Whereas the alternatives are the types of risks that are often faced by shallot supply chain actors consisting of price risk, production risk, market risk, capital risk, technology risk, policy risk, quality risk, transportation risk, environmental risk, information risk, and storage risk.

Assessment of each level of the hierarchy

This assessment is carried out to find the elements that most influence the overall goal. The step taken is to make an assessment of the relative importance of two elements at a certain level in relation to the level above it. The results of the assessment are made in the form of a matrix, namely the pairwise comparison matrix with the size of nxn (Lukinskiy *et al*, 2015) [19]. Base scale 1 to 9 to assess the comparison of the importance of an element to other elements (Schmindt *et al*, 2016) [28].

Table 1: Rating scale

Comparative value	Definition	Explanation
1	Both elements are equally important	Two elements have the same influence on the goal
3 One	element is slightly more important than the other element sare slightly more important for	Experience and judg men tone element than the other Elements
5	which one is more important than the other elements	Experience and judgment Very strongly supports one element over another
7	One element is clearly more important than another	One element is very strongly supported and its domain has been seen in practice
9	One element is absolutely important over the other elements	Evidence supporting one element against another has the highest degree of affirmation possible confirms
2, 4, 6, 8	Value between two adjacent considerations	This value is given when there are 2 components between 2 options

Element prioritization

Each level of the hierarchy needs to be compared in pairs to determine priority. A pair of elements is compared based on certain criteria and weighs the intensity of preference between elements. The relationship between elements from each level of the hierarchy is established by comparing the elements in pairs. This relationship describes the relative influence of an element at a hierarchical level to each element at a higher level. The elements at this higher level function as a criterion and are called properties. The result of this differentiation process is the priority vector or the relative importance of an element to each trait. Pairwise comparisons are repeated for each element in each level. Then the next step is to give weight to each vector with its priority properties. The pairwise comparison process starts at the top of the hierarchy (goal) which will be used to make the first comparison. Then from the level just below it (criteria), take the elements to be compared.

Table 2: Random index value (R1)

Matriks size	RI	Matriks size	RI
1	0	9	1,45
2	0	10	1,49
3	0,58	11	1,51
4	0,90	12	1,48
5	1,12	13	1,56
6	1,24	14	1,57
7	1,32	15	1,59
8	1,41		

Logical consistency

In making decisions, an assessment that has high consistency is needed so that the results are accurate. Consistency is done to get authentic results in the real world. AHP measures the overall consistency of various considerations through a consistency ratio. The consistency ratio value must be 10% or less. If more than 10%, the assessment is still random and needs to be improved. Consistency ratio is calculated using the formula:

$$CI = (\lambda \text{ makx-n}) / (n-1) \text{ and } CR =$$

Where
CI = Consistency Index
CR = Consistency Ratio
RI = Random Index
N = Size Matrix

Results and Discussion

Shallots supply chain actors

The actors of the shallot supply chain referred to in this study are institutions or marketing actors involved in the supply chain, ranging from shallot farmers in the highlands of Majalengka Regency to consumers outside of Majalengka Regency. The actors involved in the shallot supply chain consist of farmers, farmer groups, dealers, retailers and consumers. There are 5 flow patterns of the shallot supply chain in the highlands of Majalengka Regency (Figure 2).

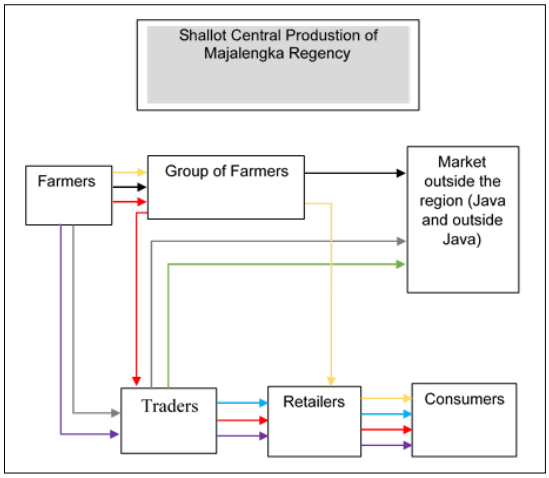

Fig 2: Flow of shallot supply chain

The actors who play a big role in the supply chain of shallots in the highlands are farmer groups. The Independent Farmer Group is the only shallot farmer group in Sukasari Kidul Village, Argapura Subdistrict, that operates shallots. Its members are 100 people. The cultivated shallot varieties are Maja Cipanas and bali karet. This variety is very suitable for planting in the highlands. Maja Cipanas is the only variety in Indonesia. Farmers who become members usually sell shallots to farmer groups. Apart from buying shallots from members, the Mandiri farmer group also receives shallots from outside members. Especially when the need for supply of shallots increases. However, farmers who are members of farmer groups have other advantages compared to farmers who are not members. Farmers who are members can borrow capital in the form of seeds or fertilizers from the farmer groups. Meanwhile, non-member farmers cannot do that. Farmer groups send shallots to wholesale markets in Bandung, Jakarta and Brebes. In addition, farmer groups also send them outside Java, such as Sumatra and Kalimantan. Shallots sent out of the region are usually of super quality. While the quality is poor, it is usually sent to a local dealer.

Shallots supply chain risks

Risk identification begins with creating a hierarchical structure in the supply chain of shallots. The hierarchical structure consists of objectives, criteria, sub criteria and

alternatives. The aim is to identify the risk of shallots in the highlands as contained in the hierarchical structure of the shallot supply chain (Figure 1).

Pairwise comparisons between criteria in the identification of risk of shallot supply chain actors in the highlands can be seen in Table 3.According to experts from farmer groups, supply chain efficiency is a top priority. This condition can be seen from the supply chain pattern 1, namely by breaking the marketing chain from farmer groups to dealers. Thus, the supply chain pattern is more efficient. Supply chain efficiency as a priority is also indicated by consumer assessments. The high evaluation from consumers is due to the efficient supply chain, which lowers the price received by consumers. Farmers consider that the criteria for fairness of profit sharing among chain actors are the top priority, followed by the smooth flow of goods, money and information and finally supply chain efficiency. This rating is the same as that of the retailer. Such an assessment occurs because farmers and retailers feel that their share received is unequal compared to other supply chain actors. Moreover, farmers lack access to price and market information.

The smooth flow of goods, money and information is a priority based on the dealer assessment, followed by fairness in profit sharing between actors, and finally supply chain efficiency. The assessments from the bookie are the same as those of experts from academia and the government. The consistency index value below 10% indicates that the data is consistent.

Table 3: Comparison between criteria in the identification supply chain of highland

Criteria	Farmers	Farmer Group	Bandar	Retailer	Consumer	Academics	Government
Supply chain efficiency	0,157	0,493	0,196	0,157	0,493	0,196	0,163
Smooth Flow of Goods, Money and Information	0,249	0,196	0,493	0,249	0,311	0,493	0,540
Equity of Profit Sharing Between Chain Actors	0,594	0,311	0,311	0,594	0,196	0,311	0,297
Consistency Index	0,05	0,05	0,05	0,05	0,05	0,05	0,01

Table 4 shows the results of the synthesis of risk identification of shallot supply chain actors in the highlands. According to farmers in the highlands, there are five types of biggest risks in the shallot supply chain, namely production risk, price risk, market risk, storage risk and capital risk. The five biggest risks according to farmer groups in the highlands are price risk, production risk, market risk, capital risk and distribution risk. Price risk is a priority because onion prices are volatile. When the price goes down during the peak harvest and when it is not during the peak harvest the price goes up. According to bookies in the highlands the biggest risk is price. Then followed by production risk, market risk, distribution risk and capital risk. The five biggest risks of shallot supply chain according to highland retailers are price risk, market risk, capital risk, distribution risk and production risk. According to consumers in the highlands the five biggest risks are price risk, production risk, market risk, distribution risk and quality risk. Meanwhile, the assessment from academicians and government experts, price risk is a priority compared to other risks.

Tabel 4: The risk assesment of the shallot supply chain in the highland according all participants

Kinds of risk	Farmers	Group of faremers	Traders	Retailers	Consumers	Academian	Goverment
Price	0,146	0,167	0,180	0,172	0,187	0,157	0,146
Production	0,164	0,152	0,136	0,091	0,122	0,135	0,144
Market	0,125	0,142	0,135	0,149	0,119	0,151	0,135
Capital	0,088	0,93	0,086	0,126	0,060	0,072	0,046
Technology	0,053	0,070	0,044	0,041	0,047	0,073	0,064
Policy	0,035	0,043	0,047	0,057	0,054	0,079	0,096
Quality	0,087	0,074	0,085	0,081	0,104	0,077	0,067
Distribution	0,067	0,088	0,106	0,112	0,116	0,101	0,127
Environmental	0,081	0,043	0,036	0,039	0,038	0,038	0,037
Information	0,037	0,048	0,074	0,060	0,077	0,063	0,074
Storage	0,118	0,080	0,071	0,072	0,075	0,055	0,063

Figure 3 shows the combined assessment of shallot supply chain actors in the highlands. The five biggest risks in the highlands are price risk (16.3%), production risk (14.2%), market risk (13.4%), distribution risk (9.7%) and quality risk (8.3%). Meanwhile in the lowlands, namely production risk (15.6%), price risk (14.2%), market risk (10.9%), environmental risk (8.7%) and distribution risk (8.6%). These five types of risk should get greater attention than the other risks. Price risk is caused by fluctuations in the price of shallots, inflation rates, bank interest rates, and distortion of information and supply. Production risks come from weather and climate, pests and diseases, quality of seeds, irrigation and human resources or farmers who carry out the process of shallot cultivation. Sources of market risk are market structure, fluctuations in shallot prices, shallot quality standards in the market and consumer demand. Capital risk comes from the limited capital of farmers in carrying out shallot farming, and if you make a loan to banks, not all farmers have a guarantee, while the risk of technology comes from the not optimal application of shallot farming technology from the cultivation process to post harvest and marketing, this is in addition to constrained by cost, the skills and knowledge of farmers are still limited.

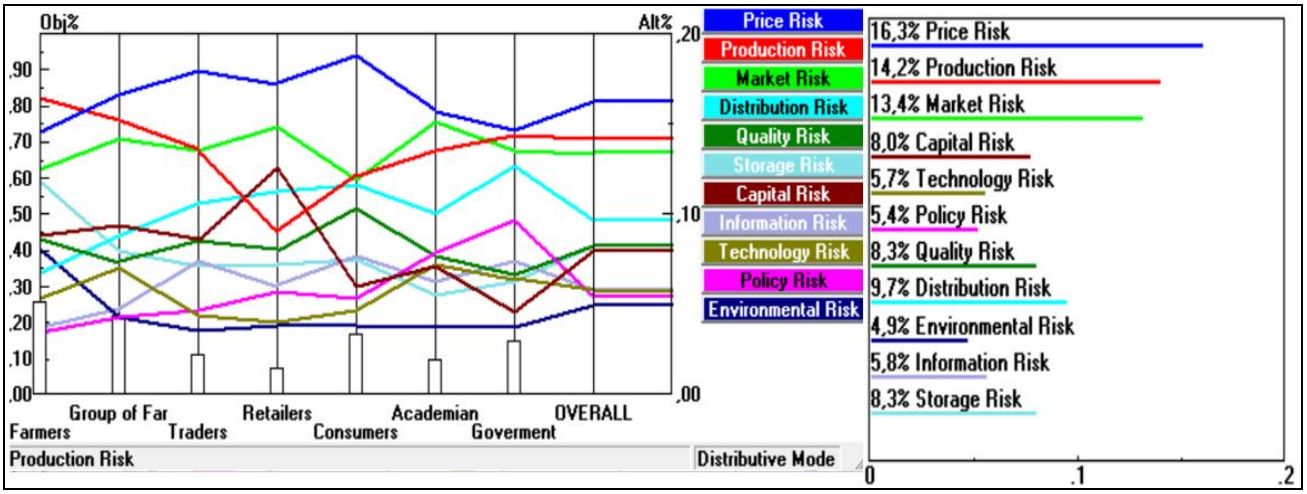

Fig 3: Kinds of risk the shallot supply chain in the Highland according based on priority

Conclusion

There are five actors in the shallot supply chain in the highlands, namely farmers, farmer groups, dealers, retailers and consumers. The pairwise comparison results based on the AHP model analysis show that fairness of profit sharing among supply chain actors is a priority at the farmer and retailer level. Supply chain efficiency is a priority at the farmer and consumer group level. The smooth flow of goods, money and information is a priority according to dealers, academic experts and government experts. The results of the identification of the supply chain of shallots based on consideration of the criteria and sub-criteria indicate that there are five types of the biggest risks that need attention from various parties, both practitioners and academics and the government. The five risks are price risk, production risk, market risk, capital risk and technology risk.

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