Shallot supply chain with food supply chain networks approach in Pontianak

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Abstract. In order to stabilize the supply and price of shallots in Indonesia, a production development program was held outside Java. Pontianak City is one of the areas for the development of shallot production in West Kalimantan. The level of demand for Pontianak City increases every year. This indicates an increase in consumption per capita. The problem of shallots in Pontianak is the high price fluctuations. This does not only occur at the consumer level, but also at the producer level. The method used was descriptive qualitative to analyze the shallot supply chain with framework FSCN, while descriptive quantitative for measuring supply chain performance with an operational efficiency and price efficiency. The sampling technique used was purposive sampling and snowball sampling. The results showed that shallots already have a clear target market and the chain structure consists of 2 marketing channels. Supply chain actors consist of farmers, collectors, distributors, agents and retailers. The contractual agreements that occur are informal and the relationship between the actors is well structured. Supply chain performance shows marketing channels 1 and 2 have not been efficient and prices have not been transmitted properly.

1 Introduction

In order to stabilize the supply and price of shallots in Indonesia, a production development program was held outside Java. Pontianak City is one of the areas for the development of shallot production in West Kalimantan[1]. However, the production of shallots in Pontianak City tends to decrease. The highest production occurred in 2016 reaching 39 tons, while production in 2020 only reached 8 tons. Likewise, the harvested area decreased from 6 ha to 5 ha in the same year [2].

The level of demand for Pontianak City increases every year. This indicates an increase in consumption per capita [3]. In 2020 the demand for shallots reached 1,455 tons, limited production necessitated the supply of shallots from outside the province. The total supply of shallots reached 1,775 tons in the same year. In 2019 and 2020 the supply of shallots tends to fluctuate [2].

The problem of shallots in Pontianak is the high price fluctuations. This does not only occur at the consumer level, but also at the producer level. Price changes at the consumer

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level can even occur within one day. In 2020 there was the highest price spike at the consumer level reaching Rp 63,000 per kg. Then, the highest price at the farm level was only IDR 31,000 per kg in the same year, even this price could fall even further when the increase supplies from outside the province [4]. This condition results in the farmers’ bargaining value will be lower. In addition, high price fluctuations create opportunities for traders to play games price [5].

Shallot production activities are supported by the supply chain that is formed along with the production process. However, supply chain contractual agreements tend to be verbal and there is still a need for optimization of the target market of each supply chain actor [6]. The supply chain is an activity related to the flow of goods, information flow, and financial flows from producers to final consumers [7]. Van Der Vorst Developed a Food Supply Chain Networks (FSCN) framework to describe a complex supply chain because of the many actors involved [8]. Therefore, the purpose of this study was to analyze the condition and performance of the shallot supply chain using the Food Supply Chain Networks framework.

2 Methods

This research was conducted in Pontianak City which was chosen by considering it is as one of the development areas for shallot production and shallot consumption centers in West Kalimantan. Primary data was obtained from interviews with all respondents and secondary data was obtained from the results of research reports, journals, and related institutions. The sampling technique was purposive sampling to obtain farmers’ data and snowball sampling to obtain traders’ data.

There are 37 respondents and divided into 2 categories, farmers and traders. The farmers in this study were horticultural farmers who cultivated shallots as many as 13 people. Traders who became respondents totalled 24 people consisting of from 5 collectors, 4 distributors, 9 agents, and 6 retailers. This study uses a descriptive method that examines an object or condition with the aim of interpreting and describing data that occurs systematically, factually, and accurately about an event [9]. Qualitative descriptive method was used to analyze the shallot supply chain according to the Food Supply Chain Networks framework, while quantitative descriptive method was used to measure supply chain performance.

![Fig. 1. Framework for food supply chain networks.](image)

This study was analyzed using the FSCN framework to describe and analyze the supply chain consisting of objectives, structure, management, resources, business processes, and supply chain performance. Finally, supply chain performance analysis is carried out using an
operational efficiency approach (marketing margin and farmer's share) and price efficiency analysis (price transmission elasticity). Marketing margin analysis is used to measure the difference between the prices at one level against the price at another level with the following formula [10]:

\[ M_i = P_{ji} - P_{bi} \]  
\[ \rightarrow M_i = C_i + \pi_i \]  
\[ \rightarrow P_{ji} - P_{bi} = C_i + \pi_i \]  

Then the marketing advantage at level i is:

\[ \pi_i = P_{ji} - P_{bi} + C_i \]  

Therefore, the total marketing margin is:

\[ M_T = \sum M_i \]  

Annotation:
Mi = Marketing margin at the agency level ke-I (Rp/Kg)  
Pji = Selling price for marketing agency ke-i (Rp/Kg)  
Pbi = Purchasing price for marketing agencies ke-I (Rp/Kg)  
Ci = Level marketing agency fee ke-I (Rp/Kg)  
\( \pi_i \) = Advantages of level marketing agency ke-I (Rp/Kg)  
MT = Total marketing margin i = 1, 2, 3, ..., n

Furthermore, Farmer's share analysis is used to find out how big the share received by farmers from the price paid by the final consumer with the following formula [10]:

\[ F_s = \frac{P_f}{P_r} \times 100\% \]  

Annotation:
Fs = Farmer’s share  
Pf = Prices at farm level  
Pr = Prices at the consumer level

Criteria:  
If \( F_s \geq 50\% \), it means efficient supply chain performance.  
If \( F_s \leq 50\% \), it means inefficient supply chain performance.

The last is the analysis of the elasticity of price transmission which describes the extent of the impact of price changes at one level on another level [11]. The first stage is a pre-estimation test, namely checking the stationarity of the time series data using the Phillips-Perron (PP) test. The PP test equation models are:

\[ \Delta Y_t = \gamma Y_{t-1} + \varepsilon_t \]  
\[ \Delta Y_t = \beta_0 + \alpha Y_{t-1} + \varepsilon_t \]  
\[ \Delta Y_t = \beta_0 + \beta_1 + \alpha Y_{t-1} + \varepsilon_t \]  

Annotation:
t = Time period  
\( \gamma \) and \( \beta \) = coefficient model  
Y = tested data  
\( \varepsilon_t \) = error

Then a cointegration test is performed to see if there is a long-term relationship between the variables used in the model. Cointegration testing is carried out using the Engle-Granger test which has the following equation model:

\[ Y_{it} = \alpha + \beta X_{it} + \varepsilon_t \]  

Annotation:
Y = dependent variable  
X = Independent variables  
t = time period  
\( \beta \) = coefficient model  
\( \alpha \) = Constanta  
\( \varepsilon_t \) = error

Next, estimate the Error Correction Model to determine the elasticity of the transmission of shallot prices in Pontianak City. In this model, the price transmission process can be seen
in the short-term and long-term parameters. The ECM equation model for the variables $Y_t$ and $X_t$ is:

$$\Delta Y_t = \alpha + \sum_{i=1}^{n} \gamma_i \Delta Y_{t-i} + \sum_{i=1}^{n} \beta_i \Delta X_{t-i} + \delta ECT + \varepsilon_t \quad (10)$$

**Annotation:**

$\Delta Y_t = Y_t + Y_{t-1}$  $\alpha = \text{Constanta}$

$\Delta X_t = X_t + X_{t-1}$  $\beta, \gamma, \delta = \text{coefficient model}$

$Y = \text{dependent variables}$  $T = \text{time period}$

$X = \text{independent variables}$  $\varepsilon_t = \text{error}$

$ECT = \text{long-term adjustment mechanism}$

**Criteria:**

If $Et = 1$, it means that a 1% price change at the retail level will result in a 1% price change at the farm level (unitary).

If $Et < 1$, it means that a 1% price change at the consumer level will result in a less than 1% price change at the producer level (inelastic).

If $Et > 1$, it means that a 1% price change at the consumer level results in a price change greater than 1% at the producer level (elastic).

### 3 Result and discussion

#### 3.1 The goals of supply chain

The target market for shallots in Pontianak City is shallot consumption for the local domestic market. The supply of shallots in Pontianak City is divided into two based on the source, namely farmers in West Kalimantan and outside the province. Supply outside the province comes from Brebes, Probolinggo, and Sumbawa. The marketing of Shallots are divided into 2 grades, namely grade A and grade B. The difference between the two grades is in the size and cleanliness. In line with Fahroji et al [12] determining the class of shallots based on uniformity of shape, level of cleanliness, density, and diameter and free from disease and damage.

The target of development in Pontianak City has occurred in several chain actors’ supply, such as cooperation between farmer groups and the Department of Agriculture, the establishment of coordination such as the exchange of information, as well as being a permanent supplier between agent and owner of a restaurant business in Pontianak. However, there are still development targets that supply chain actors want to improve. First, there is continuous cooperation between the Department of Agriculture and farmers, such as assistance in providing input and training for farmer groups. The training is supposed to increase knowledge of cultivation on peatlands because the results depend on the method of planting, fertilization, varieties and quality of seeds used [13]. Second, there is an increase in coordination involving all supply chain actors so as to create price stability and provide benefits to each party, especially farmers. The increase in prices at the consumer level is not felt by farmers so that farmers are very disadvantaged ([14, 15].

#### 3.2 The structure of supply chain

##### 3.2.1 Farmers

Farmers are actors who play an important role in determining the quality and quantity of shallots. Shallot cultivation in Pontianak City is carried out on peatlands 2 times a year.
Shallot cultivation activities are carried out by farmers starting from land preparation to harvesting. Collectors will come as the harvest season approaches to bargain. In line with Megasari [16] the ability of collectors to approach farmers greatly affects social relations primarily to seek benefits for both parties.

3.2.2 Collectors

Collectors are supply chain actors who act as intermediaries between farmers and agents. Collectors also provide price information for farmers' consideration. The packed shallots will be brought by the collector to the storage area and the collector will deliver the shallots to the agent. With a relationship that has existed for a long time, it makes coordination easier and financial flow activities run smoothly. Therefore, collectors play an important role as liaisons and lenders of capital to farmers [16].

3.2.3 Distributors

The distributor acts as a supplier of shallots from outside the province and markets it to areas in West Kalimantan. The cooperative relationship that occurs is very important for the availability of shallots in West Kalimantan. Ongoing coordination makes it easier for distributors to supply shallots because the demand for shallots still depends on supplies from outside the province. In line with Kharisma [17] that distributors are key players in supply availability. Good cooperation with agents is also the key to smooth product flow, financial flow, and information flow.

3.2.4 Agents

Agents are wholesalers whose business locations are located in Pasar Flamboyan and Pasar Mawar. The supply of shallots owned by agents comes from collectors and distributors. The agent sells shallots directly to retailers and supplies several restaurants in Pontianak. The large supply of shallots entering the central market is the basis for determining the high and low prices of shallots in Pontianak City. When the supply is abundant, market forces will weaken and affect the price level because the amount of supply is not proportional to demand [18].

3.2.5 Retailers

The retailer obtains the shallots directly from the agent. Long-standing cooperation allows retailers to get from the same agent. Consumers from retailers come from the community around the place of business. In line with Kharisma [17] that the purchasing capacity of retailers will be smaller than that of other traders. This is done by retailers to reduce the risk of depreciation.
3.3 Supply chain management

3.3.1 Partner selection

Shallot farmers in Pontianak choose partners based on favorable pricing, financial smoothness, and have become customers. One of the basic considerations for the price of collectors is the transportation costs incurred. Distributors partner from friendly relations with suppliers outside the province. In addition, suppliers from outside the province also survey distributors to establish cooperation. Then, the cooperation between agents and distributors starts from distributors down directly to agents to supply shallots. It is contrast to retailers who only consider the best purchase price from the agent. The selection of partners according to the criteria of supply chain actors is very important in facilitating the circulation of capital and the process of the flow of goods and information [6, 19].

3.3.2 Contractual agreement

Agreements that occur between all supply chain actors are still informal orally. Informal agreements can occur because cooperation is carried out using the principle of trust by holding commitments and mutual need for each other [20, 21]. The agreement was in the form of determining the selling price, ensuring the quality and availability of the supply of shallots.

3.3.3 Transaction system

The system of transactions between farmers and collectors, collectors and agents, as well as agents and retailers occurs in cash after getting a price agreement. It is different with transactions between distributors and agents which are suspended every month. Proof of purchase will be kept by each party and at the beginning of each month the agent will transfer it to the distributor.

Fig. 2. Structure of shallot supply chain relationship in Pontianak.
3.3.4 Government support

Some of the actions taken by the government in the shallot supply chain in Pontianak City include counseling related to shallot cultivation on peatlands and providing input assistance, but since the Covid-19 pandemic, the provision of assistance has begun to decrease. Other assistance includes the provision of tractors and water machines as well as road construction in several farming areas. From the marketing side, it is in the form of monitoring market prices, but it has not been able to suppress it when prices soared. The government's role as a facilitator and motivator is very important in realizing a conducive business, especially in the horticulture sector [21].

3.3.5 Supply chain collaboration

Information comes from distributors who are the reference for determining the price of shallots in Pontianak. Furthermore, the information is distributed to agents, collectors, retailers, and farmers in Pontianak. The existence of good information disclosure can support smooth activities and affect supply chain performance [22, 23].

3.4 Supply chain performance

3.4.1 Marketing margin

The selling price set by each marketing agency on shallots is different. This is influenced by the marketing function and ultimately affects the profits earned [24]. Marketing costs for agricultural commodities generally include transportation costs, storage costs, sorting costs, and business risk costs [25]. Marketing institutions in the shallot supply chain in Pontianak are farmers, collectors, distributors, agents, and retailers.

Table 1. Marketing functions in shallot marketing institutions.

<table>
<thead>
<tr>
<th>Institution Marketing</th>
<th>Marketing Function</th>
<th>Physical</th>
<th>Facilities</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Exchange</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Selling</td>
<td>Buying</td>
<td>Storage</td>
</tr>
<tr>
<td>Farmers</td>
<td>-</td>
<td>✓</td>
<td>-</td>
</tr>
<tr>
<td>Collectors</td>
<td>✓</td>
<td>✓</td>
<td>*</td>
</tr>
<tr>
<td>Distributor</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Agent</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Retailer</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
</tbody>
</table>

Source: Processed primary data (2021)

Annotation:
✓ : Perform marketing function
* : Sometimes performing marketing function
- : Does not perform a marketing function

Furthermore, the calculation of marketing margins in each marketing channel and agency is presented in Table 2. Analysis of marketing margins shows that the highest marketing margins for channels 1 and 2 are at the marketing margin level retailer. Then the smallest marketing margin on channel 1 is at the collector level and channel 2 at the agent level.
The largest total marketing margin overall is in channel 1, which is Rp 26,400 per kg. The highest total cost of marketing shallots in Pontianak City is in channel 2 is Rp. 6,368 per kg. Then in terms of the highest total profit found in channel 1 is Rp. 20,391 per kg. In line with the research of Lekatompessy et al. [26] that the longer the marketing channel, the greater the marketing margin because of the marketing agencies involved more and more.

### 3.4.2 Farmer’s share

The value of Farmer's share received by shallot farmers in Pontianak can be seen in Table 3. In this study, the value of farmer's share in Pontianak City is only on channel 1. Channel 2 is the supply of shallots from outside the province. The value of the farmer's share is not economically efficient because it has a value below 50 percent.

### Table 3. Farmer's share on the shallots channel.

<table>
<thead>
<tr>
<th>Channel Marketing</th>
<th>Prices at Farmer Level (Rp/Kg)</th>
<th>Prices at the Consumer Level (Rp/Kg)</th>
<th>Farmer's Share</th>
</tr>
</thead>
<tbody>
<tr>
<td>Channel 1</td>
<td>19.300</td>
<td>45.700</td>
<td>42.23</td>
</tr>
</tbody>
</table>

Source: Processed Primary Data (2021)

The shorter the marketing channel, the greater the price contribution felt by farmers. As research conducted by Hidayat et al [27]. The larger Farmer's share reflects an increasingly efficient supply chain.
3.4.3 Price transmission elasticity

The elasticity of transmission of shallot prices in Pontianak City uses the Eviews 9 software. First, the data series stationarity test is carried out under several conditions to obtain stationary data. Table 4 shows all the stationary variables in the first difference. Furthermore, cointegration test between variables was carried out in the second stage. According to Sahara et al [28] cointegration testing needs to be done if the data used is not stationary at the level.

Table 4. Data stationarity test.

<table>
<thead>
<tr>
<th>Price</th>
<th>Level</th>
<th>First Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>PP Test</td>
<td>Prob.</td>
</tr>
<tr>
<td>Farmers</td>
<td>-2,292</td>
<td>0,1785</td>
</tr>
<tr>
<td>Collectors</td>
<td>-2,410</td>
<td>0,1443</td>
</tr>
<tr>
<td>Distributor</td>
<td>-2,321</td>
<td>0,1697</td>
</tr>
<tr>
<td>Agent</td>
<td>-2,176</td>
<td>0,2171</td>
</tr>
<tr>
<td>Retailer</td>
<td>-2,237</td>
<td>0,1962</td>
</tr>
</tbody>
</table>

Source: Processed Primary Data (2021)
Annotation: *Stationer at 5% level

The Engle–Granger cointegration test is carried out by examining the residuals of the long-term relationship. If the result is stationary at the level, then the variable is said to be cointegrated. Table 6 shows that all stationary variable at level. This indicates that the variable is cointegrated or has a long-term relationship.

Table 5. Estimation of long-term relationships.

Channel 1

<table>
<thead>
<tr>
<th>Variable (Y - X)</th>
<th>Farmers - Collectors</th>
<th>Collectors - Agents</th>
<th>Agent - Retailers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constanta</td>
<td>1,398178</td>
<td>-0,087582</td>
<td>-1,11851</td>
</tr>
<tr>
<td>d(X)</td>
<td>0,827047</td>
<td>0,984162</td>
<td>1,082675</td>
</tr>
<tr>
<td>Prob. X</td>
<td>0,0000</td>
<td>0,0000</td>
<td>0,0000</td>
</tr>
<tr>
<td>F-Statistic</td>
<td>0,000000</td>
<td>0,000000</td>
<td>0,000000</td>
</tr>
</tbody>
</table>

Channel 2

<table>
<thead>
<tr>
<th>Variable (Y - X)</th>
<th>Distributors - Agents</th>
<th>Agents - Retailers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constanta</td>
<td>-0,163411</td>
<td>-1,11851</td>
</tr>
<tr>
<td>d(X)</td>
<td>1,001557</td>
<td>1,082675</td>
</tr>
<tr>
<td>Prob. X</td>
<td>0,0000</td>
<td>0,0000</td>
</tr>
<tr>
<td>F-Statistic</td>
<td>0,000000</td>
<td>0,000000</td>
</tr>
</tbody>
</table>

Source: Processed primary data (2021)

Table 6. Cointegration test.

Channel 1

<table>
<thead>
<tr>
<th>Variable</th>
<th>Level</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Farmers - Collectors</td>
</tr>
<tr>
<td>PP Test</td>
<td>-4,326</td>
</tr>
<tr>
<td>Prob.</td>
<td>0,0012*</td>
</tr>
</tbody>
</table>

Channel 2

<table>
<thead>
<tr>
<th>Variable</th>
<th>Level</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Distributors - Agents</td>
</tr>
<tr>
<td>PP Test</td>
<td>-3,272</td>
</tr>
<tr>
<td>Prob.</td>
<td>0,0220*</td>
</tr>
</tbody>
</table>

Source: Processed primary data (2021). Annotation: *Stationer at 5% level
Error Correction Model displays the short-term relationship that occurs in the analyzed variables. In addition, the ECM also displays error correction or Error Correction Term. The ECT coefficient is defined as the difference in response or delay in adjusting the price increase or decrease for each variable [28]. From Table 7, it can be seen that the entire probability value of the F-Statistic is smaller than the alpha value (0.05). Then, the coefficient of ECT (-1) is between zero and negative one and the probability is below 0.05. This identifies that the Error Correction Model used is valid.

The results of the ECM estimation illustrate how much price adjustments occur between marketing agencies [29]. The value of the elasticity of short-term price transmission is obtained from the coefficient of $X$ in Table 7. Then, for the elasticity of long-term price transmission of the coefficient of $X$ in Table 5. It can be seen that the coefficient of elasticity of the long-term price transmission will be greater than the short-term. In accordance with the research of Malik et al [30] that the elasticity coefficient of long-term price transmission is greater than the short term because price changes that occur can be anticipated by carrying out various adjustment actions by market participants at that level.

Table 7. Estimation of error correction model.

<table>
<thead>
<tr>
<th>Variable (Y - X)</th>
<th>Channel 1</th>
<th>Channel 2</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Farmers - Collectors</td>
<td>Collectors - Agents</td>
</tr>
<tr>
<td>Constanta</td>
<td>-0,002469</td>
<td>0,000909</td>
</tr>
<tr>
<td>$d(lnX)$</td>
<td>0,767597</td>
<td>0,952686</td>
</tr>
<tr>
<td>ECT(-1)</td>
<td>-0,600725</td>
<td>-0,466045</td>
</tr>
<tr>
<td>Prob. ECT(-1)</td>
<td>0,0001</td>
<td>0,0009</td>
</tr>
<tr>
<td>F-Statistic</td>
<td>0,000000</td>
<td>0,000000</td>
</tr>
</tbody>
</table>

Source: Processed Primary Data (2021)
Annotation: *Stationer at 5% level

The smallest value of price transmission elasticity in the short and long term is found between farmers and collectors who are inelastic. This shows the slow response to price adjustments due to differences in the information received by farmers. According to Asmara and Ardhiani [31] and Drabik et al [32] that the slow response to price changes can occur due to differences in information received by market participants, especially farmers so that they cannot make decisions correctly. Prices that are transmitted asymmetrically can result in farmers who are generally the disadvantaged parties, who will always live in the poverty line.

The greatest value of price transmission elasticity in both the short and long term is seen in the elastic agent-retailer relationship. This indicates that retailers respond more quickly to price changes than other supply chain actors. In line with research by Rajendran [33] where retailers will respond more quickly to price changes that occur. The high level of demand will cause the price game at the retail level to be bigger. Therefore, when there is a decrease or increase in prices at the retailer level, it does not affect its profits.

4 Conclusions and suggestions
The condition of the shallot supply chain in Pontianak has a clear target market and the chain structure consists of 2 marketing channels. Supply chain actors consist of farmers, collectors,
distributors, agents and retailers. The contractual agreement occurs is informal so that it is only based on mutual trust. The relationship between actors is well structured. The marketing margin results show that channel 1 has the largest total margin of Rp. 26,000 per kilogram. Then the results of the farmer's share of 42.23% which shows this channel is not efficient. The results of the analysis of the elasticity of price transmission in channels 1 and 2 have not been well transmitted from one market level to another.

Some efforts that can be made to improve supply chains are the establishment and strengthening of roles between supply chain actors in establishing cooperation and information disclosure. The role of the government is needed to provide continuous counseling to members of farmer groups regarding cultivation techniques and attitudes that farmers must take in trying to cultivate shallots in uncertain weather conditions. In addition, business capital assistance is needed so that farmers do not have to borrow from collectors. With this effort, it is also hoped that the productivity of shallots can increase so that the fulfillment of the domestic supply of shallots is immediately achieved with more stable prices both at the producer and consumer levels.

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