112

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Supply Chain Performance of Cayenne Pepper in Gorontalo, Indonesia

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Abstract— **The fluctuating price of cayenne pepper can be caused by the characteristics of agricultural commodities and also inefficient supply chain management arrangements. The supply chain approach is believed to be able to increase the effectiveness of each distribution chain, thus guaranteeing products according to consumer demands. The research objective was to examine the performance of the cayenne supply chain with the approach of SCOR supply chain performance attributes based on reliability, responsiveness, agility, and assets in Gorontalo. The research method used was a survey method using purposive sampling technique. The study was conducted a year (July 2017-July 2018) in Gorontalo Province. Data were obtained from direct interviews with farmers, collectors, wholesalers, retailers. Data analysis utilized DEA (Data Envelopment Analysis). The results showed that the performance of the cayenne supply chain doer in Gorontalo was mostly efficient, only 16.7% farmers, 10% collecting trader, 8.3% large trader and 16.7% retailers whose performance was not efficient. The novelty of this research has measured efficient supply chain performance with indicators of reliability, responsiveness, agility, and assets which are able to optimize supply chain networks and marketing activities.**

Keyywords— *supply chain, performance, cayenne pepper, reliability, responsiveness, agility*

1. Introduction

The Supply Chain concept has three stages in the material flow, namely: the flow of raw materials, financial flows and information flows, which are used to evaluate supply chain flows [1-3]. All supply chain doer have different roles and characteristics in the price mechanism in the supply chain [1,4-5]. In addition, the relationship between exports and supply availability throughout the supply chain has an impact on price fluctuations in domestic end consumers [5]. Besides the price factor plays an important role in the supply chain mechanism, risk factors are also an important element in the sustainability of the supply chain [6-7]. Uncertainty is a very common thing in decision making, especially in supply chain activities [8]. Uncertainty occurs not only on the demand side, but also on the supply side, which is generally observed in business so that optimization and coordination in the supply chain is needed, especially with service needs [9]. There are several models of supply chain management, namely GSCM (Green Supply Chain Management) and MESCO (Meat Supply Chain Ontology) [10-11]. From these findings, it appears that supply chain performance has not been explained so that in this study, it will be directed to supply chain performance.

Gorontalo is one of the centres producing cayenne outside Java. The production and harvest area of cayenne in Gorontalo in 2016 amounted to 11,942 tons and 1,928 Ha [12], with an average productivity of 5.63 tons/ha and an average growth rate of 3.99 percent every year. Gorontalo has a supply of cayenne which is sufficient to meet the needs of Gorontalo people, seen from the consumption of Gorontalo people in 2010 amounted to 2,915 tons, while Gorontalo production was 12,063 tons, so the surplus amounted to 9,148 tons [12]. The development of chili agribusiness in Gorontalo, in general is still at the level of mass production and is spread unevenly in almost all regions [13]. In general, the planting schedule for cayenne in Gorontalo is not simultaneous, where the farmers plant cayenne in October - March called the Tauwa Season (Season of Season) and in the rainy season. Based on the scope of the development of the agribusiness system, in Gorontalo from the upstream to downstream subsystems there is no chili industry, except marketing or distribution of results. Cayenne pepper is generally sold to middlemen and middlemen [14].

The Supply Chain is a concept in implementing an integrated logistics system [15]. The concept is a chain of supply of goods from raw materials to finished goods [16], taking into account costs, quality, availability, after-sales service, and reputation factors [17]. The success of the supply chain can be seen from the level of performance meaning a meeting point between consumers and stakeholders where the requirements of both have been fulfilled with the relevance of the attributes of performance indicators over time [18]. Performance measurement is needed as an approach in order to optimize the supply chain network [19] and to determine the extent of optimization of marketing activities carried out by supply chain members [20-21]. To create an efficient performance, a measurement system is needed that can evaluate supply chain performance and find out where an organization is positioned towards the goals to be achieved and determined the direction of improvement to create competitive advantage [22-24]. In the food supply chain, performance measurement is measured through three food supply chain performance indicators, namely: (1) Responsiveness is the sensitivity and speed of the supply chain providing products and information to customers. Indicators of responsiveness are customer response time, production time, delivery time, customer returns and level of fulfillment of messages, (2) Efficiency is a supply

chain performance indicator that measures the results achieved by the input used. Efficiency indicators in the supply chain include: cost / cost, profit, return on investment and inventory, and (3) Flexibility is an indicator of the level of food supply chain ability in responding to market changes to obtain or maintain competitive advantage [25-26].

At the end of 2016 until the beginning of 2017, there was an increase in the price of red cayenne in Gorontalo. The price of cayenne in the traditional market is Rp. 60,000 / kg, and continues to rise up to Rp. 90,000 / kg [27]. The price increase of cayenne occurs every week. The increase was triggered by the lack of supply of cayenne pepper circulating in the market because it was disturbed by several things ranging from the weather to the distribution process. Erratic weather factors have implications for uncertainty in the amount of production that will affect the supply of cayenne resulting in uncertain prices of chili and generally follow the market mechanism [27]. Efforts are made by the government to stabilize prices by leveling supply in areas that are deficient, where surplus regions such as Gorontalo are sent to deficient areas, such as Kalimantan, causing the price of cayenne in Gorontalo to go up. The condition of fluctuating prices of cayenne is caused by inefficient supply chain management arrangements. The supply chain approach is believed to be able to increase the effectiveness of each distribution chain, so as to guarantee the product according to consumer demands. Based on the description, the performance of the cayenne supply chain in Gorontalo is assessed with the approach of supply chain performance attributes based on SCOR (Supply Chain Operational References), namely reliability, responsiveness, agility, and assets.

2. METHODS

The research method utilized the survey method i.e. purposive sampling technique. The data needed in the study were primary data and secondary data. Primary data was obtained from observations and direct interviews with parties involved in the cayenne pepper supply chain such as farmers, collectors, wholesalers, and retail traders. While secondary data was obtained from the relevant agencies such as the BPS office and the Provincial Agriculture Office of Gorontalo. This research was carried out for 1 year (July 2017-July 2018) in Gorontalo based on Pohuwato and North Gorontalo Regencies. The primary data obtained were analyzed using DEA (Data Envelopment Analysis) and also calculation of supply chain performance. The DEA model used CCR (Constant Return to Scale) which calculated maximum efficiency according to Gofindarajan (2007) is:

$$\eta_{s1} = \frac{\sum_r U r Y r j_{s1}}{\sum_i V i \overline{X i} j_{s1}}$$

note:
s1 = the decision unit to be evaluated
Ur = weight of output
Vi = weight of output
Yrj = output value
Xij = output value

DEA measurement based on input and output variables conducted on farmers and traders of cayenne pepper. The inputs and outputs used were based on the SCOR (Supply Chain Operation Reference) performance attributes including reliability, responsiveness, agility, and assets. Input variables were such as order fulfillment cycle time, order fulfillment lead time, volume flexibility, delivery flexibility, cash to cash cycle, and daily inventory. Meanwhile, the output variables were delivery performance and order fulfillment. DEA processing was completed with the help of software from MaxDEA Pro 6.1.

3. RESULTS AND DISCUSSION
3.1 Cayenne pepper farmers
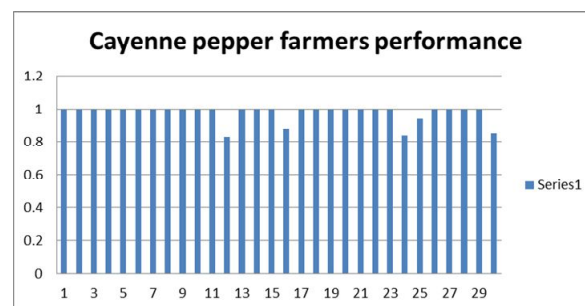The results of the performance of cayenne farmers in Gorontalo are seen in Figure 1.

Figure 1. Performance Value of Chilli Farmers in Gorontalo 2018

The graph shows that most of the cayenne farmers in Gorontalo have a performance value of up to 1 meaning efficient. However, there were 5 farmers who did not achieve efficiency 1, namely farmers 12 (0.83), 16 (0.88), 24 (0.84), 25 (0.94) and 30 (0, 85). This may be due to their low yields of cayenne production ranging from 5-15 kg per harvest with the number of harvests 18-24 times a year which is equivalent to an average production of around 225 kg/ha of value that is very far from the average production level of the province as much as 5.63 tons/ha. Planting is done once a year, and there is no use of inputs for production facilities in the form of fertilizers and medicines. In addition there was no use of fertilizers and medicines. Based on input and output, the performance of ineffective five farmers are caused by the cycle of fulfillment of an average order of 4.4 months, lead time for fulfilling orders on average 12 days, flexibility on average volume 41 kg, flexibility of delivery on average 0.34 hours or 34 minutes, the average cash to cash cycle for 1 day, and the average daily inventory for 1 day. Meanwhile, the average shipping performance was only 78.4% because it did not reach the target where the average total shipment of cayenne was 20.6 kg on time while the total delivery of cayenne pepper was 29.8 kg. Likewise, the fulfillment of perfect orders was only an average of 78.4% because the total demand fulfilled an average of 20.6 kg, while the total demand from cayenne traders was 29.8 kg, meaning there is a difference of 9.2 kg.

The graph also shows that from 5 cayenn;e farmers whose performance values did not reach 1 (inefficient), farmer

12 had the lowest performance value. The results of the analysis of farmers' potential improvement 12 can be seen in Table 1.

**Table 1**. Potential Improvements in Supply Chain Performance Farmers 12 in Gorontalo, 2018

Factor	Performance matrix	Actual	Target	Potential improvement
Input	Order Fulfillment c.time	6	5.27	-0.73
	Lead time of order	10	3.81	-6.19
	Volume flexibility (kg)	15	15	0
	Delivery flexibility (hour)	0.5	0.5	0
	Cash to cash cycle time (day)	1	1	0
	Inventory days of supply	1	1	0
Output	Delivery performance (%)	70	100	30
	Perfect order fulfillment (%)	70	100	30

Table 1 shows the results of the calculation of farmers' potential improvements 12 occurred slack on the supply chain performance output. The amount of deficiency that occurs in the delivery performance was 30% and the lack of order fulfillment was 30%. Efficiency of cayenne supply chain performance at the farmer level can be overcome by improving the performance of the supply chain. The trick is to reduce the input value or maximize the output value by increasing it. The occurrence of this slack or deficiency must be done to improve supply chain performance to increase the output value of both delivery performance and perfect order fulfillment.

This can be done by farmers for increasing the productivity of cayenne with appropriate cultivation, the right time for planting and harvesting, choosing the right cayenne variety, using fertilizers to increase soil fertility and drugs to overcome the pest of white birds that cause leaves cayenne becomes curly. This is in line with Syukur, et.al. (2016) stated the cultivation of chili in the right way by using superior varieties, tillage till fertilization can produce high yields, but there are several ways to be able to increase crop yields namely: pruning, function spraying, with the provision of fertilizing microbes, proper fertilization and use of green house because chili plants are susceptible to water, so that chili cultivation can be carried out even though the rainy season and chili keep producing high [28].

In addition, the occurrence of slack, there is also a surplus in the performance of this supply chain for farmers such as the order fulfillment cycle and order fulfillment lead times i.e. 0.73 months and 6.19 days, respectively. It means that farmer 12 must reduce the cyclical order fulfillment value to 5.27 months and the order fulfillment lead time will be 3.81 days. This can be done by farmers increasing the productivity of cayenne with appropriate cultivation, the right time for planting and harvesting, choosing the right cayenne variety, using fertilizers to increase soil fertility and drugs to overcome the pest of white birds that cause leaves cayenne becomes curly. According to Syukur, Yunianti and Dermawan (2016) stated that chili cultivation in the right way by using superior varieties, tillage till fertilization is able to produce high yields, but there are several ways to be able

to increase crop yields namely: pruning, functionide spraying, microbial giving fertilizers, proper fertilization and use of greenhouses because chili plants are susceptible to water, so that chili cultivation can be done even though the rainy season and chili keep producing high. This means that the order fulfillment cycle is 5.27 months by choosing cayenne varieties with shorter production cycles and harvesting can be done at least once a week. Reference comparison is an analysis used to compare the performance of a unit that is inefficient compared to other efficient units. Reference on the performance of the supply chain of cayenne in Figure 2 shows a performance comparison of farmers 12 with farmers who have efficient performance.
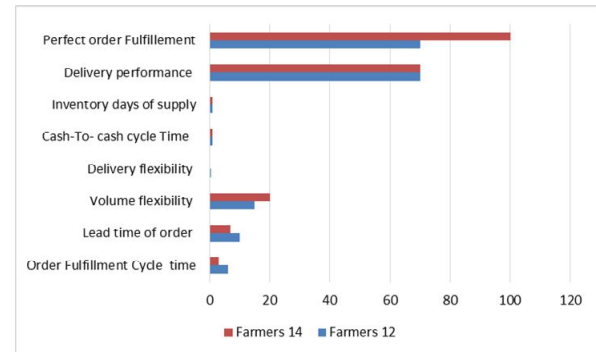

Figure 2. Reference comparison of farmers 12 and 14 in Gorontalo 2018

The graph showed that the input value of farmer 12 was much lower than farmer 10. Likewise the output value of farmer 12 was much lower than farmer 10 who has an efficient performance. So that farmer 12 has an inefficient performance compared to farmer 14.

3.2 Collecting traders

The performance of collectors in Gorontalo can be seen in Figure 3
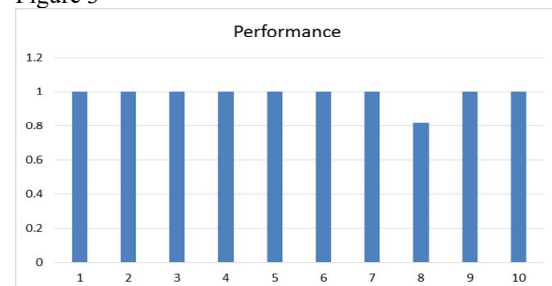
Figure 3. Performance Value of Chili Raw Traders in Gorontalo 2018

The graph shows that the average trader of cayenne in Gorontalo has a performance value of 1 meaning efficient. There was only one cayenne collecting trader whose performance was inefficient, namely collecting traders 8 (0.82). This was probably due to the fact that the collectors 8 were unable to meet the demand of large traders for the commodity of cayenne. The demand for cayenne pepper is higher than that which can be met by the collectors 8, because the collectors 8 are village collectors and only receive the supply of cayenne from farmers in Siduwange Village, Randangan Subdistrict, Pohuwato Regency, which is sometimes not sufficient

because of the small amount of harvest. Besides that, the delivery of cayenne to wholesalers is done every day. The results of the analysis of farmers' potential improvement 8 can be seen in Table 2.

Table 2. Potential Improvements in the Supply Chain Performance of the Collecting Traders 8 in Gorontalo 2018

Factor	Performance matrix	Actual	Target	Potential improvement
Input	Lead time of order (day)	1	1	0
	Volume flexibility (kg)	500	500	0
	Delivery flexibility (hour)	0.25	0.2	-0.08
	Cash to cash cycle (day)	1	1	0
	Inventory days of supply	1	1	0
Output	Delivery performance (%)	82	100	28
	Perfect order fulfillment (%)	82	100	28

Table 2 shows the results of the potential improvements for collecting 8 occurring slack on the supply chain performance output. The amount of deficiency that occurs in the delivery and order fulfillment performance was 28% respectively. The occurrence of slack must be carried out to improve supply chain performance to increase the output value of both delivery performance and perfect order fulfillment.

This may be due to the collector 8 being unable to fulfill the demand of large traders for cayenne commodities, the demand for cayenne is higher than that which can be fulfilled by collectors 8, because collectors 8 are village collectors and only receive supplies of cayenne from farmers in Siduwange village, Randangan subdistrict ,
Reference performance of cayenne supply chain to collectors 8 and collectors 10 can be seen in Figure 4.
which is sometimes insufficient because of the small amount of yield due to the Gaduh season. While shipping chili to wholesalers is done every day. In addition, the roads in Siduwange village which were damaged and perforated due to the construction of factories in the area caused the timely performance of chili delivery by collector traders. 8. For this reason, improvements must be made to increase the performance of cayenne pepper supply, especially the road improvement from Siduwange village. The capital of Randangan Subdistrict and collecting traders 8 must increase the supply of cayenne from farmers, for example by finding new farmer partners. Meanwhile, there was an excess in input supply chain performance at this collector 8, namely on the delivery flexibility 0.08 days, respectively, which means that collectors 8 must reduce delivery flexibility. This value indicates that collector 8 must reduce the delivery flexibility from 0.25 hours to 0.2 hours which means that collector 8 must shorten the distance traveled in sending chili to wholesalers in Randangan about 10 minutes.

Reference performance of cayenne supply chain to collectors 8 and collectors 4 can be seen in Figure 4.
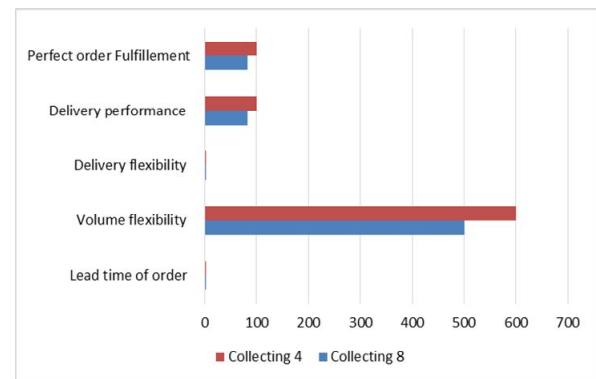

Figure 4. Reference comparison of traders 8 and traders 4 in Gorontalo 2018

Figure 4 shows that the value of the output owned by the collectors 8 is lower than the collector 4 who has an efficient performance, while the input value owned by the collector 8 is the same as the collector 10, so it does not need to be reduced. The lead time for fulfilling orders for cayenne that is done every day is as expected. The condition of the cash to cash cycle time that occurs, the current condition of the collector's money collection starting from the payment or repayment of cayenne pepper by wholesalers and retailers is appropriate, so that this condition is expected to be maintained. The consistency of the maintained cash to cash cycle time will have an impact on the condition of the traders as well as the financial condition of the farmers and will have an impact on increasing the effectiveness of capital turnover for the cultivation of cayenne pepper.

3.3 Wholesalers
The performance of large traders in Gorontalo can be seen in Figure 5.
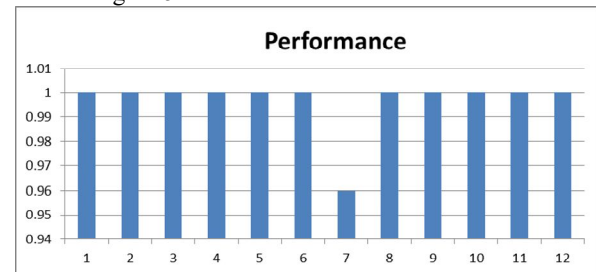
Figure 5. Performance Value of Chili Raw Traders in Gorontalo 2018

The graph shows that the average wholesaler of cayenne in Gorontalo has a performance value of up to 1 which means efficient. There was only one large cayenne trader who did not achieve an efficiency score of 1, namely wholesaler 7 (0.96). This may be due to the large traders 7 not being able to meet the demand for cayenne, because wholesalers 7 were big traders in Randangan subdistrict and only receive the supply of cayenne from farmers and collectors in the surrounding villages, which was sometimes not enough because the yields were few in number. Besides that, the delivery of cayenne to out-of-town traders was carried out every day with a wide range of areas to Palu, Manado and the City of Gorontalo and Surabaya at any time. The performance of the supply chain of cayenne at large traders 7 which was inefficient

116

Int. J Sup. Chain. Mgt   Vol. 8, No. 5, October 2019

can be overcome by reducing the input value or increasing the output value. The results of the analysis of potential improvement of wholesalers 7 can be seen in Table 3.

Table 3. Potential Improvements in Supply Chain Performance 7 wholesaler traders in, Gorontalo 2018

Factor	Performance matrix	Actual	Target	Potential improvement
Input	Lead time of order (day)	2	1.6	-0.4
	Volume flexibility (kg)	1000	1000	0
	Delivery flexibility (hour)	24	14.1	-9.87
	Cash to cash cycle (day)	1	1	0
	Inventory days of supply	1	1	0
Output	Delivery performance (%)	96	100	4
	Perfect order fulfillment (%)	96	100	4

Table 3 shows the results of the calculation of the potential improvements for large traders 7 that occurred slack on the supply chain performance output that was 4% and the lack of order fulfillment was 4%. This is probably due to the large number of traders 7 unable to meet the demand of outside traders for the commodity of chili, the demand for cayenne was higher than that for large traders 7, because large traders 7 were large traders in Randangan sub-district and only received cayenne from farmers and collectors in the surrounding villages, which were sometimes inadequate because of the small amount of harvest. Meanwhile, the delivery of cayenne pepper to outside traders is carried out every day with a wide range of areas, namely to Palu, Manado and Gorontalo City and Surabaya at any time. The occurrence of this slack must be carried out to improve supply chain performance by improving delivery performance and perfect order fulfillment. Solutions to improve delivery and order fulfillment performance by large traders are to increase the number of cayenne supply by increasing the number of partners both farmers and collectors who supply cayenne not only in Randangan subdistrict, but in other districts around Randangan such as Marisa, Paguat and Papayato.

In addition, there was a surplus in input supply chain performance at large traders 7, so it must reduce leadtime of order (1.6 days) and delivery flexibility (14.1 hours).

The reference performance of the cayenne supply chain in Figure 6 is a comparison of the performance of large traders 7 with large traders 11 having efficient performance.
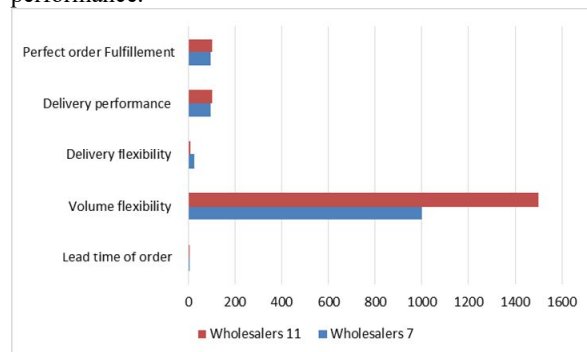

Figure 6. Reference comparison of wholesalers 7 and wholesalers 11 in Gorontalo 2018

The graph shows that the output value of wholesaler 7 was the same as that of large traders 11 who have efficient performance, while the input value of wholesalers 7 was higher than large traders 11, so it does not need to be reduced.

3.4 Retailers

The purpose of measuring retailers is to find out the performance of other supply chain members to the cayenne retailers on the market. The performance of retailers in Gorontalo can be seen in Figure 7.
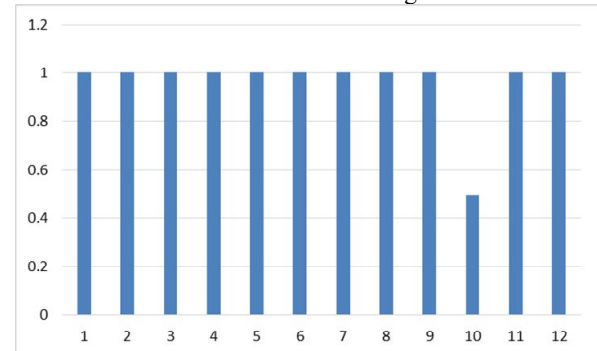
Figure 7. Performance Value of Chili Raw Retailers in Gorontalo 2018

The graph shows that the average of cayenne retailer in Gorontalo has a performance value of 1 meaning efficient. There were only 2 retailers or DMU retailers whose performance did not reach the efficiency score of 1 such as traders of retailers 3 (0.65) and retailers of 10 (0.5). This may be due to retailers not being able to meet consumer demand for cayenne pepper especially when the price of cayenne was expensive, they found it which was difficult to obtain supplies of cayenne directly from farmers, so they have to buy from large traders, even though the capital owned by them is not too large, only IDR 500,000-2,000,000. The results of the potential improvement analysis of retailers 10 can be seen in Table 4.

**Table 4**. Potential Improvements in Supply Chain Performance 10 Retailers in Gorontalo 2018

Factor	Performance matrix	Actual	Target	Potential improvement
Input	Lead time of order (day)	3	2.9	0.13
	Volume flexibility (kg)	15	15	0
	Delivery flexibility (hour)	0.5	0.5	0
	Cash to cash cycle (day)	1	1	0
	Inventory days of supply	3	2.99	0.12
Output	Delivery performance (%)	50	100	50
	Perfect order fulfillment (%)	50	100	50

Table 4 shows the results of the calculation of potential improvements of retailers 10 occurring slack on the supply chain performance output. The amount of deficiency that occurs in the delivery performance was

50% and the lack of order fulfillment 50%. The occurrence of this slack or deficiency must be done to improve supply chain performance to increase the output value of both delivery performance and perfect order fulfillment. This can be done by increasing the purchase of cayenne, not only from market traders in Bugis Village, but also from buying cayenne pepper to market traders in Andalas and Telaga markets.

In addition, the occurrence of slack was also a surplus in the efficiency of supply chain performance at this retailer 10, namely in lead time of order of 0.13 days and inventory days of supply of 0.12, which means retailer 10 must reduce the lead time of order to 2.9 days and inventory days of supply to 2.99 days.

Reference performance of the supply chain of cayenne in Figure 8 is a performance comparison of retailers 10 with retailers 8 having efficient performance.
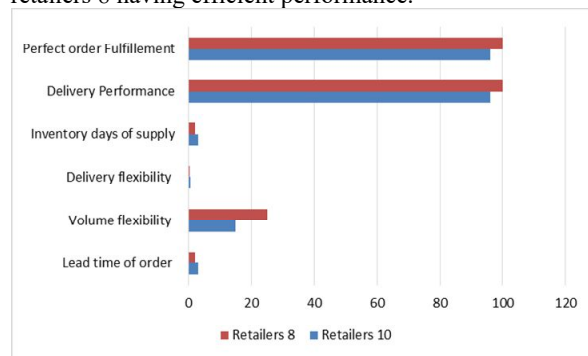
Figure 8. Reference comparison of retailers 10 and retailer traders 8 in Gorontalo 2018

The Graph shows that the output value of retailer 10 was lower than retailer 4 which had efficient performance, while the input value of retailer 10 was higher than retailer 8, so it needs to be reduced. Retailers 10 have inefficient performance compared to retailers 8.

CONCLUSION
The performance of the cayenne supply chain in Gorontalo was the most of the cayenne farmers in Gorontalo have a performance of 1 meaning efficient. There were only 16.7% farmers, 10% collecting trader, 8.3% large trader and 16.7% retailers whose performance was not efficient. The performance of the cayenne supply chain in the perpetrators of cayenne supply chain in Gorontalo which was inefficient and could overcome by improving the performance of the supply chain, by reducing the input value or maximizing the output value by increasing it.

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