

Supply Chain Performance Analysis of Corn Processed Animal Feed

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ABSTRACT

The purpose of this study was to analyze the general description of the corn supply chain as a raw material for animal feed in the research area using the Food Supply Chain Networks (FSCN) model, to analyze the performance of the supply chain for corn as a raw material for animal feed in the study area using the Analytical Hierarchy Process (AHP) method. The samples in the research were farmers (raw material suppliers), animal feed entrepreneurs, animal feed traders and breeders consisting of 7 farmers (raw material suppliers), 5 animal feed entrepreneurs, 10 animal feed traders and 8 breeders with the research location is in the Simalungun Regency. Based on the results of the study it can be concluded that in general, the supply chain for corn as a raw material for animal feed in this study area is farmers (raw material suppliers) - animal feed entrepreneurs - animal feed traders - breeders (consumers). From a business point of view, the supply chain for corn as a raw material for animal feed has carried out two business processes, namely procurement and customer orders. Supply chain performance in the study area is quite consistent with a consistency ratio value of 0.015. The value points that there is good cooperation from partnerships such as raw material suppliers who are currently still able to meet demands from entrepreneurs, then the consistency obtained from this method is also related to a workforce that is skilled enough to help develop businesses and can support the development of product marketing.

Keywords: corn feed; supply chain; performance; AHP

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1. Introduction

Corn is a type of plant that can be used as a need for food and animal feed, especially in the tropics. In Indonesia, about 51 percent of manufactured feed components are corn. The content of energy, protein and other nutrients in corn is very suitable for the needs of livestock, especially poultry. According to Aseffe, et.al (2021), Smith, et.al (2021) and Ton, et.al (2023) The influence of energy recovery from corn cob residues on the environmental performance of the seed-corn supply chain was the main research purpose of this work and corn production, and its associated inputs, is a relatively large source of greenhouse gas emissions and uses significant

amounts of water and land, thus contributing to climate change, fossil fuel depletion, local air pollutants, and local water scarcity. In Addition, Here we explore scenarios for implementing structural and technological changes across the pork supply chain to improve environmental sustainability and meet future demand.

The need for corn for the feed industry continues to increase significantly each year, which is in line with the growing livestock industry. Under these conditions, the quality of local corn cannot optimally absorb feed requirements in the future. cause local corn cannot be absorbed optimally. According to Kurniawan et.al (2020) about analysis of supply chain in corn commodities at Dompu District West Nusa Tenggara Province show that All of farmers have not been selled the corn because the quality of local corn can not have value added.

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As a production center area, currently corn is one of the mainstay commodities for farmers in Simalungun Regency because the production cost

is relatively low compared to other commodities. In general, production data and harvested area will be displayed as follows table 1.

Table 1. Data on Corn Production and Harvested Area 2017-2021 in Simalungun Regency (BPS,2022)

Year	Harvest Area (Ha)	Production (Tons)
2017	58,374	339,911
2018	29,992	168,158
2019	41,676.8	234,977
2020	45,720	256,944
2021	30,490	175,419

From the table 1, there has been a decrease in harvested area and production data in the last 5 years. This happens because many corn farmers have switched land functions to other commodities because the exchange rate of corn farmers has decreased. This decline occurred because corn farmers were unable to form partners with wholesalers in the Simalungun area. In the Simalungun area, many traders receive corn from other areas to be processed into animal feed.

According to Ditjenpkh (2022) The largest volume of corn purchases in 2021 was carried out by feed mills in Java, amounting to 4,374,354 tons (67.93% of the total corn purchases from feed mills nationally). Meanwhile, the purchase of feed mill corn on Sumatra Island was 1,395,833 tons (21.68%), Sulawesi Island was 519,626 tons (8.07%) and Kalimantan Island was 149,483 tons (2.32%). The large volume of purchases of corn for feed mills in Java is in line with the large installed capacity of feed mills on this island (75.05% of the total installed capacity of national feed mills). The difference in harvest volume and purchase volume of corn has implications for the potential for excess production at the peak of the t harvest which is not absorbed by feed mills as one of the biggest users of local corn. In this situation there will be a potential decline in local corn prices. Conversely, when there is a decrease in corn production while purchases tend to be constant, there will be a potential increase in corn prices. To overcome this condition, ideally there is a national corn reserve mechanism that can absorb excess supply during the main harvest and distribute it when production decreases.

Data from the Directorate General of Food Crops records maize production in Indonesia in 2021 amounted to 23.04 million tonnes, an increase of 30.60% compared to 2011 of 17.64 million tons. Even though Java Island is still the main center for national corn production, the

relative contribution of Java Island to national corn production has decreased from 53.66% in 2011 to 44.94% in 2021. This happened because the increase in production in Java was only 9%, while production outside Java increased significantly. Maize production on the island without a feed mill increased 134.93% so that its relative contribution increased from 6.21% to 11.17% over the last 10 years.

From the 87 feed mills that reported purchasing corn, 63 were feed mills (72.41%) are in Java Island. If we compare the distribution pattern of corn production with the distribution pattern of feed mills, in 2021 there will be around 6.13 million tons of corn production produced from areas where there are no feed factories. This amount is equivalent to 26.62% of the total national corn production.

The largest domestic user of corn (72.48%) is the feed industry, shifting corn production centers will require the support of a logistical system to transport corn from corn production centers where there are no feed factories to feed factory centers which are dominantly located in Java and Sumatra.

A reliable national corn logistics system is also needed to anticipate potential fluctuations in corn prices. One of the fundamental problems in the national corn production system is the uneven harvest pattern throughout the year. The peak of corn production always occurs in the first quarter, and gets smaller in the following quarters. This uneven harvest pattern has the potential to cause volatility in corn prices at the end of the year. To anticipate this, it is necessary to support a logistical system to store corn during peak harvest times and distribute it when harvests decline.

Apart from functioning as a food ingredient, corn can also be processed as a poultry feed ingredient which has an important contribution to the production of eggs and chicken meat. The

availability of corn provides multiple effects on other agribusiness businesses, especially livestock. According Deppermann, et. al (2018) about the market impacts of shortening feed supply chains in Europe show that the increase in the price of animal feed is currently influenced by the price of corn considering that corn used for animal feed must be imported and corn costs almost 70 percent of the cost of producing animal feed. This condition will burden small farmers and the final impact will be felt by consumers, namely the price of chicken meat and eggs will increase.

The increasing need for corn feed requires a supply chain to be able to distribute corn yields from farmers to consumers where all activities from managing supply and demand, procurement of raw materials, production inputs, production and assembly activities or processes, production storage and management activities, shipping processes as well as distribution to consumers can be well integrated so that all elements of marketing actors can minimize costs to be incurred. However, according to Nurliza et. al (2020), Guritno et.al (2021) and Cadilhon (2021) smallholders in farmer cooperatives are unsustainable because of the lack of decision-making power at the grassroots level; limited access to land, capital, technologies, information and financial services; low market competitiveness; weak management; and limited policy and socio-cultural norms.

Supply chain performance is the level of ability of the supply chain to meet consumer needs by considering the appropriate key performance indicators at a certain time and at a certain cost. Supply chain performance is the result of various efforts made by each member of the supply chain to meet the ultimate goal of the supply chain, namely customer satisfaction (Rasyid, 2021).

Supply chain management has the goal of reducing costs, reducing capital, and improving service for consumers. Supply chain management must be concerned with reducing or eliminating uncertainty to improve supply chain performance. The main objective of supply chain management is to maximize its performance in creating product value by allocating limited or as small costs as possible. (Oliveira, et.al, 2022).

According to Van Der Vorst (2006) states that the model to describe the supply chain descriptively is the Food Supply Chain Network (FSCN). FSCN is a supply chain model that describes the process of product flow, the management involved and the resources used has

discussed a framework to describe the supply chain, the actors involved, processes, products and the characteristics of the supply chain flow. The use of this discussion framework is expected to clarify the condition of the supply chain, the results of which are used as input in measuring supply chain performance.

The form of supply chain regulation really needs special attention. There needs to be an approach in the corn supply chain in Simalungun Regency, Simalungun Regency which is expected to provide an overview of the availability of corn supply as a consideration for managing the corn supply chain in conveying products from producers to consumers as well as consumers will find it easier to get products from producers. By knowing the corn supply chain in Simalungun Regency, Simalungun Regency, it will be able to provide optimal solutions for product accuracy, timeliness and market needs.

Supply chains can work well if there is strong and effective interaction between suppliers, farmers, collectors and other actors. For corn as a raw material for animal feed in Simalungun Regency, the applied supply chain has not been fully managed properly because each farmer or business is still carried out individually, has not implemented a good supply chain management system and there is no overshadowing institution such as farmer group institutions to make it easier farmers in producing and marketing their corn products. This is supported by research by Sibuea, et.al (2020) concerning the performance of the Medan city broiler supply chain which states that integration between marketing actors determines the performance of the chicken supply chain so that there is an efficient market share in every marketing actor involved.

2. Theoretical Underpinning

The need for corn for the feed industry continues to increase significantly every year in line with the rapid development of the livestock industry. The quality of local corn which then causes local corn cannot be absorbed optimally. Regarding this information, further evidence is needed to ascertain what happened in relation to the capability of domestic corn as a raw material for animal feed (Apriyani et.al, 2018).

As a production center area, currently corn is one of the mainstay commodities for farmers in Simalungun Regency because the production cost is relatively low compared to other commodities. In addition to production data, domestic corn sales

channel data indicate dominance at certain nodes that need to be proven. The Indonesian Poultry Entrepreneurs Association (GAPPI) said that 83.3 percent of farmers' corn was absorbed/purchased by traders. And 35.8% of the corn owned by traders is distributed to breeders and 25.37% to the feed industry. This condition indicates that the role of traders is very large in distributing local corn to corn processors into feed (Septiana et.al 2017)

Supply chain management is a network of facilities with the functions of purchasing raw materials, converting raw materials into final products and distributing final products to customers. At each level of facilities along the supply chain, vertical coordination is required from each business entity. With good supply chain management, delays in the arrival of raw materials, delays in marketing due to order negotiations, the absence of long-term strategic cooperation and the unavailability of information on the number of products ready for sale can be avoided. At its core, supply chain management integrates supply and demand (Tama et.al, 2019).

Supply chain integration is defined as the degree to which all activities within an organization, activities of suppliers, customers and other members are integrated together. Supply chain integration is a useful approach for improving various measures of company performance. Integration can be characterized by cooperation, collaboration, sharing of information, trust, partnerships and technology due to the competitive environment becoming increasingly challenging and companies making efforts to compete in various fields. However, many companies find it difficult to compete in the market relying on their internal resources and competencies. They have turned to collaborating with their customers and suppliers for complementary information and resources they can use to build a competitive advantage. So, when integration and collaboration have been established both among operational actors involved in internal and external business involving various marketing actors, the supply chain can increase maximum profits for each actor concerned (Adha, 2017).

The marketing quality of a company depends on how the company is able to carry out marketing in the form of a supply chain that is mutually collaborating and integrated with each other from one business process unit to another. In the research that has been done, there are several examples in business process research from corn. In general, corn is obtained through farmers who

will be sent to various parties such as wholesalers, collectors or retail traders and then will be distributed to the final consumer. The product supply chain process flows products that are in accordance with market demand, whether upstream or downstream products. All product orders are in accordance with the needs and desires of customers, both intermediate and final customers. This is in accordance with research conducted by Hetharia et al (2021) concerning supply chain management, interactions between suppliers, manufacturers, distributors, retailers and end consumers will have an influence on activities in the supply chain. Good relations between links in the supply chain will also result in good service for end consumers and at the same time additional profits for the company will occur. This can be realized by fulfilling the needs of each link in the previous chain, from suppliers of raw materials to end consumers (Hetharia et.al, 2017).

3. Research Methods

Determining the research location was carried out purposively (intentionally), namely a technique for determining areas based on certain considerations. The areas used as research sites were Simalungun Regency. The selection of this area is one of the areas where most of the population has a livelihood as corn farmers.

The sampling technique using the snowball sampling model. According to Sugiyono (2010) Snowball Sampling is a sampling technique based on previous information. It is a sampling technique, in which existing subjects provide referrals to recruit the required sample for research studies. The samples in this study totaled 30 samples which consisted of 7 farmers, 5 animal feed entrepreneurs, 10 animal feed traders and 8 breeders (consumers).

The analysis used is descriptive qualitative analysis using the Food Supply Chain Networking (FSCN) framework method and AHP method. FSCN analysis is usually used to analyze a supply chain in agricultural products. A supply chain system that is implemented must be well integrated and coordinated. The condition of an integrated supply chain is known by analyzing the target chain, chain structure, chain resources and chain business processes.

In this study the research method used was quantitative analysis method. In this study, the Analytical Hierarchy Process (AHP) method was used. The Analytical Hierarchy Process (AHP) method according to Munthafa (2017) is a method

that can support a decision by describing problems related to factors and criteria to become a hierarchy. Define a problem and determine the solution to be used. The Analytical Hierarchy Process (AHP) has the advantage of being able to

support a decision by outlining the problem of several alternatives so as to form a consistent hierarchy. Create a hierarchical structure that has the main objectives presented.

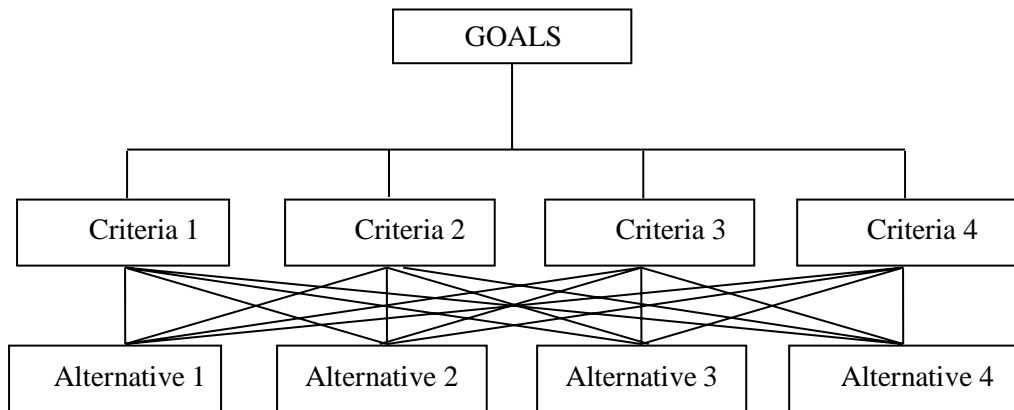


Figure 1. AHP Model

- a. Create a pairwise comparison matrix that affects each element against the criteria presented
- b. Defines the total number of assessors as $n \times [(n-1)/2]$, where n is the number of elements compared to get the size of the table used.
- c. Calculate the eigenvalues and test their consistency, if they are not consistent then the data collection is repeated.
- d. Repeat steps 3, 4 and 5 for all hierarchical levels.
- e. Calculating the eigenvector values of each pairwise comparison matrix sum for prioritizing the lowest hierarchical level elements until the goal is achieved.
- f. The calculation is done by adding up the values of each column in question to obtain a normalized matrix and adding up the values from each row and dividing by the number of elements to get the average value.
- g. If A is a pairwise comparison matrix, then the vector of the weights formed is as follows:

$$(A)(wT) = (n)(wT)$$

can be approached by:

- 1) Normalize each column j in matrix A , such that:

$$\sum_i a(i, j) = 1$$

Call it as A' :

- 2) Compute the average value for each row i in A' :

$$w_i = \frac{1}{n} \sum_i a(i, j)$$

where w_i is the i th destination of the weight vector.

can be approached by:

- 3) Normalize each column j in matrix A , such that:

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Call it as A' :

- 4) Compute the average value for each row i in A' :

$$w_i = \frac{1}{n} \sum_i a(i, j)$$

Where w_i is the i th destination of the weight vector.

Calculate the consistency ratio with criteria:

- a. If the CR value = 0, then the hierarchical value is quite consistent.
- b. If the CR value < 0.1 then the hierarchical value is said to be quite consistent.
- c. If the CR value > 0.1 then the hierarchical value is said to be inconsistent.

4. Results and Discussion

Corn is one of the cereal crops that grows almost all over the world and is classified as a species with great genetic variability. In Indonesia, about 51 percent of manufactured feed components (especially complete feeds) are corn. Therefore, cooperation is important, especially between supply chain members from upstream to downstream to maintain the quality of corn products in the hands of consumers. The following is explained in the image below:

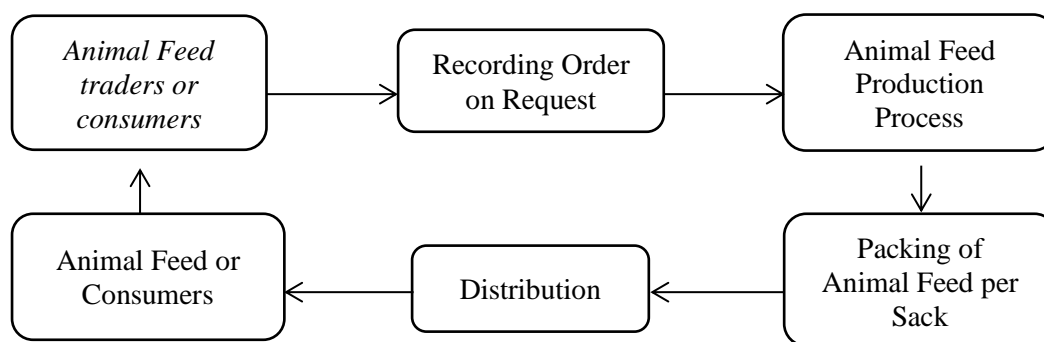


Figure 2. The Process of Ordering and Production of Corn for Animal Feed in the Animal Feed Business

From the picture above, it can be seen that corn farmers as actors who play a role in supplying to be processed into animal feed, animal feed entrepreneurs play a role in the process of animal feed production and marketing of animal feed, animal feed traders also play a role in marketing animal feed products and breeders as consumers. According Dwijatenaya. et.al (2020) about production management and value chain of corn commodity Each member of the supply chain must have a well-coordinated relationship to carry out supply chain business processes.

Corn products as raw material for animal feed are household businesses that produce animal feed. In this animal feed business, the capital used to run this business is private capital belonging to entrepreneurs who are in Simalungun Regency. The animal feed business in Simalungun Regency is run by 5 entrepreneurs who run their business by producing quality animal feed that is marketable.

The ordering process begins with a purchase or purchase from the trader or consumer to the owner of the animal feed business. After the purchase order is recorded by the entrepreneur, then the entrepreneur will convey orders from traders and consumers to workers who will produce animal feed to prepare animal feed orders requested by traders or consumers. The animal feed production process is adjusted to orders received by entrepreneurs. Animal feed that has been produced is then packaged using sacks or plastic bags to be delivered or taken directly to the location of the animal feed manufacture.

According to Dube, et.al (2021) if the market of corn feed has the good supply chain, the market will increase that unexercised market power increases profit by 55%. Personalization improves expected profits by an additional 19% and by 86% relative to the nonoptimized price. While total consumer surplus declines under personalized pricing, over 60% of consumers benefit from personalization.

For reseller prices, entrepreneurs usually sell in a variety of ways, where for round corn the entrepreneur sells at a price of Rp. 173,000 per sack weighing 30 kg, for milled corn the entrepreneur sells for Rp. 180.000,- per sack. Meanwhile, the final consumer price for round corn is IDR 6,500 per kg, milled corn at IDR 7,500 per kg and corn groats at IDR 7,500 per kg. It can refer the whole of marketing in corn feed has been integration revenue if it is seen price revenue. According to Johnson (2017) Revenue-sharing is extremely attractive to firms that are able to set the revenue shares but often makes the firms that set retail prices worse off. This is so whether revenue-sharing lowers or raises industry profits.

Corn for animal feed originating from animal feed manufacturers is valued at the agreed price, namely: round corn at a price of IDR 5,800 per kg for traders and IDR 6,500 per kg for consumers, milled corn at a price of IDR 6,300. - per kg for traders and IDR 7,500 per kg for consumers and corn groats at a price of IDR 6,300 per kg for traders and IDR 7,500 for consumers. All activities carried out by marketers in this business can be seen in table 3.

Table 3. Activities of Marketers

Supply Chain Functions	Businessman	Trader
Exchange Function		
Sale	✓	✓
Purchase	✓	✓
Physical Function		

Production	✓	
Packing	✓	
Freight		✓
Facility Function		
Promotion		✓
Financing	✓	
Risk bearing	✓	✓
Price information	✓	✓

From table 3 it can be interpreted that those who play an important role in the business process are animal feed entrepreneurs, where the performance of animal feed entrepreneurs does not only carry out marketing activities but also carries out the animal feed production process. Meanwhile, suppliers only play an important role as providers of raw materials and traders only play a role in reselling by carrying out a little promotion and carrying out transportation as a facility to end consumers.

In addition, Defining the problem and determining the solution that can be used by researchers to examine performance appraisal in

the corn business as a raw material for animal feed in Simalungun Regency, Simalungun Regency. Performance appraisal is carried out by experienced animal feed entrepreneurs (animal feed business experts) with the assessment criteria.

The alternative performance assessment that will be taken is 30 people consisting of farmers, animal feed entrepreneurs, animal feed traders and breeders who are in Simalungun Regency, Simalungun Regency Create a hierarchical structure whose primary purpose performance appraisal. The hierarchical structure of can be seen from the figure 3:

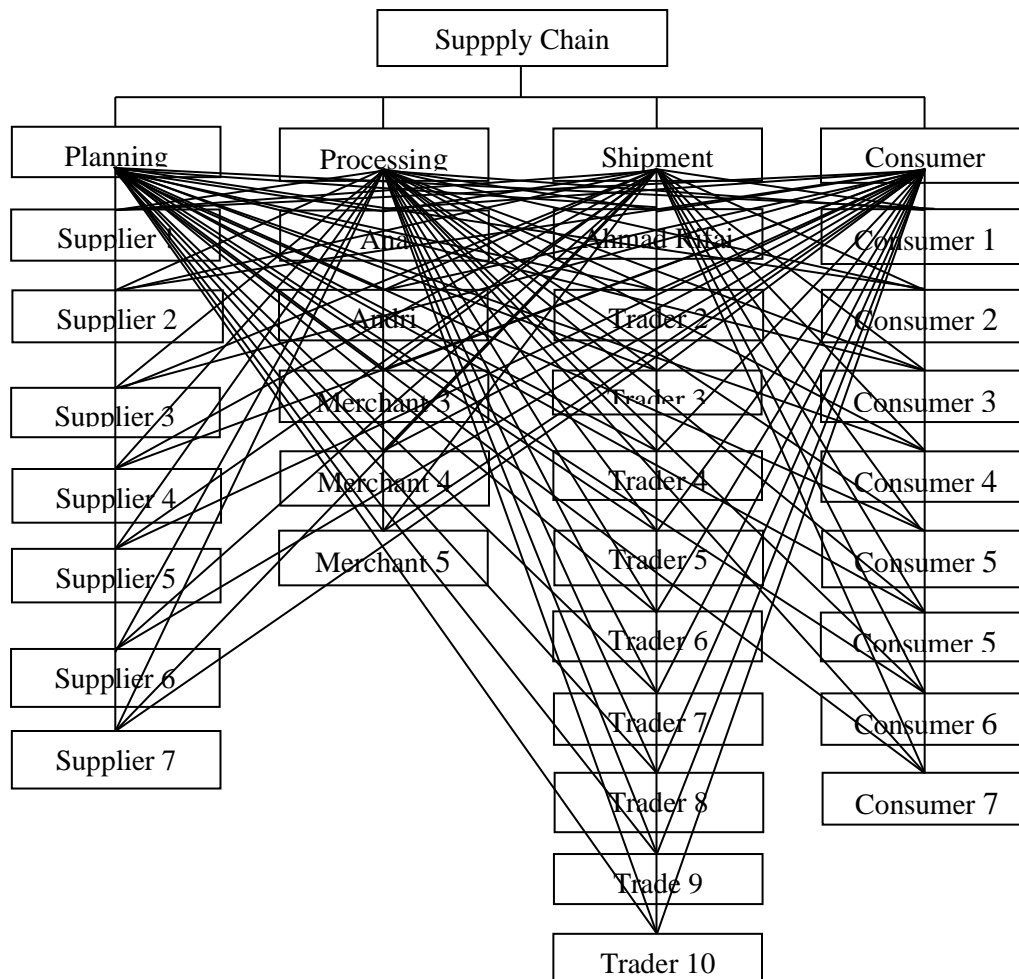


Figure 3. Hierarchical Structure of Corn Feed Business as Animal Feed Raw Materia

From the picture above, it can be seen that the hierarchical structure of the corn feed supply chain is well integrated. The supply chain actors involved are suppliers/farmers, agents, feed entrepreneurs and breeders where marketing activities such as planning, product processing and delivery have been coordinated with a good system. It is the same of reserch by Rasyid, et.al (2020) about the effect of upstream production on corn supply chain sustainability as broiler feed. Therefore, in order to sustain the corn supply chain from the farmers or upstream supply chain, the

primary factors that should be fulfilled included the agricultural capital, land area, and corn Sheller and dryer.

The result of determinant show that pairwise comparison matrix with the results obtained from business experts namely processing of planning is worth 5, delivery of planning is worth 4, consumers of planning is worth 2, delivery of processing is worth 1/2, consumers of processing is worth 1/3 and consumers of shipping are worth 1/3. After getting the value, the next step is to enter each value according to the place presented in the table 4.

Table 4. Pairwise Comparison Matrix

Criteria	Planning	Processing	Delivery	Consumer
Planning	1	1/5	1/4	1/2
Processing	5	1	2	3
Delivery	4	1/2	1	3
Consumer	2	1/3	1/3	1
Total	12	2,033	3,583	7,5

In Addition, defines pairwise comparisons that will obtain a total number of assessors Calculating eigenvalues by testing their consistency. If the value is inconsistent, the data collection is repeated. To calculate the normalized eigenvector, you must add up the matrix of each criterion.

Calculating the eigenvectors in each pairwise comparison matrix which is the weight of each element for determining the priority of elements starting from the lowest hierarchy to achieving the goals presented in Table 5.

Table 5. Calculating Eigenvectors for Each Matrix

Criteria	Planning	Processing	Delivery	Consumer	Total	EVN
Planning	4	0,692	1,067	2,35	8,108	0,078
Processing	24	4	6,25	14,5	48,75	0,469
Delivery	16,5	2,8	4	9,5	32,8	0,316
Consumer	7	1,233	1,833	4	14,067	0,135
Total		103,725				

After the calculating eigen factor, it will calculate of consistency ratio. With the shape from the explanation above, a criterion consistency ratio of 0.015 is obtained, which means that the performance of the corn business as a raw material for animal feed is quite consistent. It is accordance the research by Puarada, et. al (2020) about technique efficiency supply chain corn Deli Serdang Regency that show the relationship between the criteria and alternatives that are mutually dependent, then the values of the criteria and alternatives are tested for consistency using a comparison matrix and the search for normalization eigengences. So that a CR value of <0.1 is obtained, the hierarchical explanation is quite consistent. According to Loew, et.al (2023), Abideen (2021) and Amentae (2018) and

Producers face various challenges on a daily basis within a dynamic, everchanging environment, which increases risk to such a degree that, in order to be able to farm sustainably, a competitive advantage in the form of lower-cost and higher-quality produce must be established

This fairly consistent value is also obtained because of good cooperation from partnerships such as raw material suppliers who are currently still able to meet demands from entrepreneurs, then the consistency obtained from this method is also related to a workforce that is skilled enough to help develop businesses and can support business development. product marketing.

Pairwise comparisons given by expert respondents have an inconsistency ratio that is less than 0.1 as the maximum value for the

inconsistency ratio. Thus, the results of the combined geometric calculation of the respondent's data are quite consistent where the processing criteria are given first priority by expert respondents in determining the selection of the right supply chain performance by obtaining the highest weight value of the existing criteria of 0.469 or equivalent to 46.9% of the total criteria.

Furthermore, the results of the combined geometric calculation of the respondent's data are quite consistent, in which the delivery criteria are given second priority by the expert respondents in determining the selection of the right supply chain performance by obtaining a weight value of the existing criteria of 0.316 or equivalent to 3.16% of the total criteria.

Furthermore, the results of geometric calculations combined with respondent data are quite consistent where consumer criteria are given third priority by expert respondents in determining the selection of the right supply chain performance by obtaining a weight value of the existing criteria of 0.135 or equivalent to 1.35% of the total criteria.

Furthermore, the results of geometric calculations combined with respondent data are quite consistent, where the planning criteria are given third priority by expert respondents in determining the selection of the right supply chain performance by obtaining a weight value of the existing criteria of 0.078 or equivalent to 0.78% of the total criteria.

It can be concluded that the weight value of the highest criteria in this study is in the criteria for processing, shipping, consumers and planning which in this study there are problems because the actual structure should start with planning, processing, shipping and consumers. However, in this study, respondents prioritized processing, shipping and consumers before planning because when the researchers came down to the field, the respondents gave a statement that they prioritized planning when a business was just starting to be built, but when the researchers came down, the business was already running

5. Conclusion

- a. In general, the supply chain for corn as a raw material for animal feed that has been running in this research area is farmers (suppliers) – animal feed entrepreneurs – animal feed traders – breeders (consumers). In terms of the supply chain business, the corn business as a raw material for animal

feed has carried out two business processes, namely the procurement business process and the customer order business process.

- b. The performance of the corn supply chain as a raw material for animal feed in the study area is quite consistent and efficient.

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