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An Analysis of Logistic Cost Structure in Corn Commodity Supply Chain (Zea Mays L) in East Java Using Activity Based Costing (ABC) Method

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Abstract

East Java is Indonesia's biggest corn producer in 2022, with a percentage of 26,24. The El Niño phenomenon of 2023 caused a decrease in corn production in Indonesia. El Nino phenomenon in non-farming land can add logistic costs, especially in procurement. The goal of the logistic cost structure analysis is to determine the proportion of logistic costs. This research was conducted in three regencies in East Java, a representative of the corn producer centre. A total of 98 respondents were included in the study. The research sample was selected based on convenience sampling and snowball sampling. The Activity Based Costing (ABC) method calculates the logistic-cost structure. The structural analysis of logistic costs used descriptive statistics. The analysis of the logistic cost structure showed that the most significant proportion of logistic cost was procurement activity, with a percentage of 63,09%. The activity at the farmers' tier with the most significant cost proportion was procurement activity, with a percentage of 69,73%. Transportation was the activity with the most considerable logistic cost proportion in the collector trader and large trader tiers, with proportions amounting to 52,31% and 83,01%. The right supply chain strategy for corn commodities in East Java was push-based.

1. Introduction

The demand for corn in Indonesia is increasing, along with the demand for raw materials for animal feed. Corn with a high protein content is used in animal feed and food [1]. The national corn production used as animal feed is 72.48% (9,786,583 tons) [2]. East Java Province is the largest corn producer in Indonesia, with a percentage of 26.24% [2]. East Java Province is the largest corn producer in Indonesia, with a percentage of 26.24% [3]. In the first three months, the corn production pattern in East Java in 2021 reached 42.50%. This condition caused corn demand to be greater than supply in the following month, causing instability in the corn supply.

Price disparities were found between farmers and producers, because farmers have weak bargaining power in setting corn prices. The large number of supply chain actors involved causes disparities in corn prices. Corn supplies are decreasing owing to the impact of climate change and the El Niño phenomenon. The impact of the El Niño phenomenon on non-farming land is a decrease in corn production due to the limited water supply. This condition can increase logistics costs, especially in procurement activities.

The supply chain involves all processes from production to product delivery [4]. Logistics manages, procures, and stores materials through organizations and marketing channels. Logistics management focuses on material coordination and information flow [5]. High logistics costs threaten the supply chain of agricultural products. The

logistics costs incurred by each tier affect the profits of each supply chain actor. The goal of the logistic cost structure analysis in the corn supply chain in East Java is to determine the proportion of logistic costs and the most influential cost component. Calculate logistics cost structure using the Activity Based Costing (ABC) method. ABC considers activities that absorb resources and thus incur costs [6]. The ABC method focuses on the actual activities of each supply chain actor. ABC helps business activities by providing accurate cost information [7]. This research aims to analyze the supply chain and logistics costs in East Java's corn supply chain. The results of supply chain analysis and logistics cost analysis as a basis for formulating corn supply chain strategies.

Several studies have been conducted on Indonesia's corn commodity supply chain for 2013-2023. Researchers conducted a content analysis of the journal content with 45 journal references. The analysis focused on the topic, objectives, methods, and research location. The results of the analysis show that logistics costs are yet to be analyzed in the corn production center area in East Java. The novelty of the author's research is that it can answer problems in the latest conditions, namely the El Nino phenomenon, which affects logistics costs for each supply chain actor.

2. Materials and Method

This research was carried out in East Java because it is the highest corn producer in Indonesia. The districts chosen were Kediri Regency, Tuban Regency, and Jember Regency, which are representative corn-producing centers in East Java. Convenience and snowball sampling were used. Convenience sampling was used to determine a tier sample for corn farmers. Convenience sampling takes samples based on the availability of sources, the ability to provide information, and the ease of obtaining the sample [8]. Snowball sampling traces the chain that distributes corn from the farmer's tier to the next. The total number of samples used was 98, divided into three districts. Research using statistical data analysis requires a minimum of 30 samples [9]. Details of the research respondents are presented in Table 1. The primary data collection used interviews and observations. The interview method used in-depth interviews. In-depth interviews involved intensive implementation to explore perspectives on specific ideas, programs, or situations. The calculation of the logistics cost structure using the ABC method consists of two stages. The first stage includes activity classification, cost grouping, determining cost drivers, and determining homogeneous cost groups. The second stage involves tracking and assigning costs for each cost group to the product [7]. The next stage calculates the logistics costs' mean, minimum, maximum, and proportion. The data analysis used was descriptive statistical analysis, which describes or illustrates the data collected. Data will be presented using tables and diagrams, and the mean will be calculated.

Table 1 *Number of research respondents*

Respondent	District Name		
	Kediri	Jember	Tuban
Farmer	22	22	28
Collector trader	7	6	6
Large trader	2	2	3
Total	31	30	37

3. Results and Discussion

3.1 Corn Supply Chain

The supply chain connects suppliers, industries, and consumers. The supply chain includes all the processes involved in producing and delivering a product [4]. The supply chain includes all the processes involved in producing and delivering a product [10]. The supply chain moves materials from the initial supplier to the final consumer. Supply chain management (SCM) involves planning and controlling all business processes, from raw materials and purchasing to final consumers and the recycling stage [11]. SCM helps achieve customer satisfaction and the efficient use of resources to minimize costs. SCM is described as clockwork that continues to spin to achieve a company's business goals [12]. The application of SCM emphasizes the importance of an extensive supply chain network and building a company network that can contribute to sustainable behavior [13].

Fig. 1 shows four patterns of the corn supply chain in East Java, consisting of three flows: products, information, and financial. The first supply chain pattern shows the delivery of corn from farmers to collecting traders using small or large trucks. The corn packaging used was sack packaging. Collector traders send corn to large traders using small or large trucks. Delivery of corn from large traders to final consumers uses trucks with a capacity of 8-10 tons. Corn sold to consumers is packaged using sacks or without packaging. Final consumers

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include chicken farmers, the food industry, and the animal feed industry in several regions of East Java. The first supply chain pattern was found in all research areas.

The flow of products in the second pattern starts with sending corn from farmers to collecting traders. Collector traders take corn from farmers using small or large trucks. Collector traders then take corn to final consumers, chicken farmers, and the food industry. Corn packaging uses sacks. The second pattern is found in several areas of the Kediri Regency. The flow of products in the third pattern begins with the delivery of corn from farmers to large traders. Some farmers send corn to large traders, incurring transportation costs. Next, corn is sent to the final consumer, namely, the animal feed industry in East Java. Corn packaging uses either a sack or no packaging. The third supply chain pattern is found in all research areas. The fourth pattern of product flow starts with sending corn from farmers to consumers. This supply chain pattern was also observed in the Kediri Regency area. Finally, consumers perform corn collection. The final consumers are local chicken farmers in Kediri Regency.

The flow of information from collector traders to farmers and from collector traders to large traders includes information on corn prices, estimated picking time, quantity of corn, and standardization of corn. Corn standardization includes checking for moisture content and impurities. The flow of information between large traders and final consumers includes prices, corn standardization, corn packaging, delivery schedules, and estimates of the amount of corn sent.

Financial flows relate to the amount of money that must be paid according to the agreement between each supply chain actor. The results show two payment types: cash and tempo. The cash payment type is money given directly after corn has been weighed. The tempo payment system pays corn by providing an estimated payment deadline. Collector traders make most corn payments to farmers using cash payments. Corn payments from large traders to collector traders or farmers use cash and tempos. Payments from chicken farmers to farmers use the tempo type, with an estimated payment of 7 to 10 days. Industrial consumers make payments using the tempo type with a maximum payment estimate of 30 days.

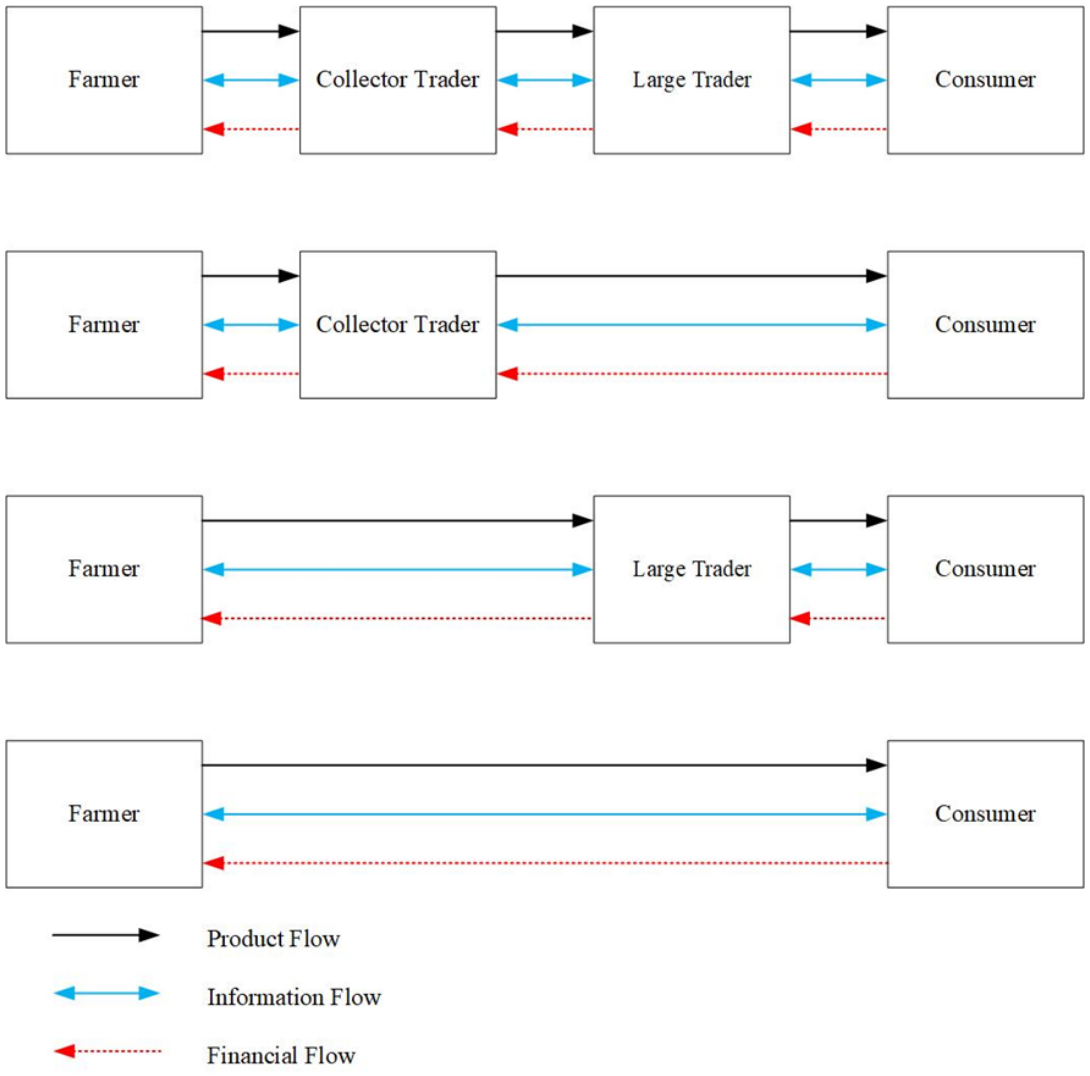

Fig. 1 *Corn supply chain pattern in East Java*

3.2 Logistics cost structure analysis

Logistics is a part of the planned supply chain process. Logistics can satisfy consumers by controlling the flow of goods [14]. Logistics focuses on the efficient movement of goods from sources of supply to points of consumption, with cost savings and provision of acceptable services to customers [15]. Logistics costs are a component of the product price. Logistics costs are direct, indirect, fixed, variable, engineered, and discretionary [11]. Logistics costs have a significant influence on business because they contribute 10% of the total costs [16]. Calculation of logistics costs to monitor and evaluate logistics activities. Logistics costs are controlled by identifying the relationship between costs and logistics activities. The aim of measuring logistics costs is to monitor and evaluate national logistics. Logistics cost components are found in logistics activities such as procurement, material handling, transportation, inventory, and customer communication [17]. Logistics costs arise from the initial transportation to product delivery [18].

The logistics cost structure analysis determines the most dominant proportion of logistics costs. Six logistics activities are based on observations: procurement, material handling, maintenance, transportation, and customer communication (communication with customers). The logistics cost calculation method uses the activity based costing (ABC) method. The calculation steps for the ABC method are as follows.

A. Classification of logistics activities
   The first stage is activity classification. The classification is based on a hierarchy. The cost levels found in logistics activities consist of four types: unit, batch, facility, and customer.
B. Determination of cost groups
   The next stage is to group the costs. The grouping of activities and costs in this research is adjusted to the main logistics activities, which include procurement, material handling, transportation, inventory, maintenance, and customer communication.
C. Determining cost drivers for each activity
   Cost drivers assign costs to activities and from activities to other activities for a product or service.
D. Determination of homogeneous cost pools
   The cost driver controls the homogeneous cost pool. Homogeneous cost pools are found in procurement activities, such as planting, fertilizing, controlling pests and diseases, and irrigation and maintenance of crops. In addition, there is a homogeneous cost pool for material handling activities, such as harvesting, drying, packaging, and loading and unloading. Maintenance activities, namely the maintenance of equipment and vehicles, are also controlled by the same cost driver, namely, the number of equipment and vehicles. Homogeneous logistics activity cost pools are presented in Table 2.
E. Determination of pool rate
   The next stage is to determine the pool rate. The pool rate calculation is performed by dividing the total cost of a cost pool by the cost driver used. The next stage is tracking and assigning products. This stage is conducted by dividing the logistics costs for each activity by the units produced. The units resulting in this research were the harvest or the number of corn purchased. A recapitulation of the logistics cost structure for corn in East Java according to logistics activities is presented in Table 3. Fig. 2 shows the proportion of corn logistics costs in East Java for all supply chain actors. The highest proportion of logistics costs is for procurement activities, with a percentage of 63.09%. The lowest proportion of logistics costs is for inventory activities, at 0.23%. The cost components in procurement activities with a high percentage are purchasing and on-farm costs, with percentages of 39.463% and 22.663 %, respectively. The farmer tier dominates high logistics costs for purchasing several raw materials such as fertilizer, seeds, and pesticides.

The proportion of logistics costs for each logistics activity at each level is presented in Table 4. Farmers incur the most significant proportion of the costs in procurement activities, material handling, maintenance, and customer communication. Collector traders have the most significant proportion of costs in inventory activities, with a percentage of 48.16%. The most significant proportion of transportation costs is found in large traders, with a percentage of 65.48%.

The appropriate supply chain strategy for corn commodities in East Java is push based and efficient. The push-based strategy is based on long-term demand estimates [19]. This strategy is used because corn products have low demand uncertainty. These conditions allow supply chain actors to focus on the production processes and inventory. The push-based strategy is based on the business processes that occur in the corn supply chain. According to Chopra and Meindl, an efficient supply chain strategy focuses on cost considerations considering several aspects, namely, the primary goal aspect, pricing strategy, product design strategy, inventory strategy, and supplier strategy [20]. Increasing efficiency costs creates an efficient supply chain strategy. This is done by reducing logistics activities in each tier that does not have needs. This strategy is applied in activities logistics, with each tier's most significant logistics costs.

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Table 2 *Classification of activities and grouping of homogeneous costs*

Logistic Activity		Resource	Cost driver	Cost Level	Cost pool
Procurement	Purchase of fertilizer.	Urea Fertilizer and Phonska	The number (kg) of fertilizer.	Unit	1
	Purchase of pesticides.	Insecticides, herbicides and fungicides	The number of bottles or packs of pesticides	Unit	2
	Purchase of corn seeds	Hybrid seeds	The number (kg) of seeds.	Unit	3
	Procurement communications	Communication tools and credits	The number of credit purchased and the frequency of communication.	Batch	4
	Transportation for procurement of goods	Type of vehicle and vehicle fuel	The number (liters) of fuel purchased and the intensity of the purchase	Batch	5
	Planting, Fertilization, Pest and disease control, Irrigation and maintenance of crops	Labor	The number of labor and hours worked.	Batch	6
	Land cultivation	Land	Land area	Batch	7
Material Handling	Corn harvesting, Drying, packaging, and loading and unloading,	Labor	The number of labor and hours worked.	Batch	8
	Corn picking	Rent a machine	The number (kg) of corn	Unit	9
	Transportation of corn shipments from the field to the farmer's homes.	Type of vehicle and vehicle fuel	Delivery distance	Batch	10
	Depreciation of agricultural equipment	Depreciation of agricultural equipment	Frequency of use	Facility	11
	Loss during handling	Reduction in the number of corn	The number (kg) of damaged corn, sprawling, and shrinkage.	Batch	12
Maintenance	Maintenance of agricultural equipment and vehicles	Maintenance cost of agricultural equipment and vehicles	The number of agricultural equipment and vehicles	Batch	13
Inventory	Storage	Building rental and electricity cost	The number of electricity bills	Facility	14
Transportation	Transportation of shipping	Type of vehicle and vehicle fuel	Delivery distance	Batch	15
	Vehicle depreciation	Vehicle depreciation	Frequency of use	Facility	16

	Loss during delivery	Reduction in the number of corn	The number (kg) of corn.	Batch	17
Costumer communications	Sales communications	Communication tools and credits	The number of credit purchased and the frequency of communication	Customer	18

Table 3 *A Recapitulation of corn logistics cost structure in East Java*

Activity	Cost Component	Farmer	Collecto r Trader	Large Trader	Total Cost	Logistic Cost (IDR/kg)			Cost Proporti on (%)
						Mean	Max	Min	
Procurement	Cost of Purchasing goods	1031,703	0	0	1031,703	343,901	1031,703	0	39,463
	Procurement communications cost	2,266	0,463	0,102	2,831	0,944	2,266	0,463	0,108
	Procurement transportation cost	5,443	15,935	0,893	22,271	7,423	15,935	0,893	0,853
	On-farm cost	592,499	0	0	592,499	197,50	592,499	0	22,663
Total		1631,911	16,398	0,995	1649,304	549,768	1642,403	1,356	63,087
Material Handling	Post-harvest cost	509,213	27,009	23,977	560,199	186,733	509,213	23,977	21,428
	Cost of depreciation of agricultural equipment	151,752	1,125	0,985	153,862	51,287	151,752	0,985	5,885
	Cost of loss during handling	9,619	0,56	0,278	10,457	3,486	9,619	0,278	0,4
Total		670,584	28,694	25,24	724,518	241,506	670,584	25,24	27,713
Maintenance	Maintenance cost of agricultural equipment and vehicles	10,87	1,857	1,715	14,442	4,814	10,87	1,715	0,552
Total		10,87	1,857	1,715	14,442	4,814	10,87	1,715	0,552
Inventory	Holding cost	2,596	2,943	0,572	6,111	2,037	2,943	0,572	0,234
Total		2,596	2,943	0,572	6,111	2,037	2,943	0,572	0,234
Trans-portation	Shipping cost	18,466	28,108	120,094	166,668	55,556	120,094	18,466	6,375
	Vehicle depreciation cost	0	27,066	19,427	46,493	15,498	27,066	0	1,778
	Cost of loss during shipping	0	0,057	0,306	0,363	0,121	0,306	0	0,014
Total		18,466	55,231	139,827	213,524	71,175	147,466	18,466	8,167
Customer communication	Cost of sales communication	5,886	0,462	0,102	6,45	2,15	5,886	0,102	0,247
Total		5,886	0,462	0,102	6,45	2,15	5,886	0,102	0,247
Total		2340,313	105,585	168,451	2614,349	871,450	2480,152	47,451	100

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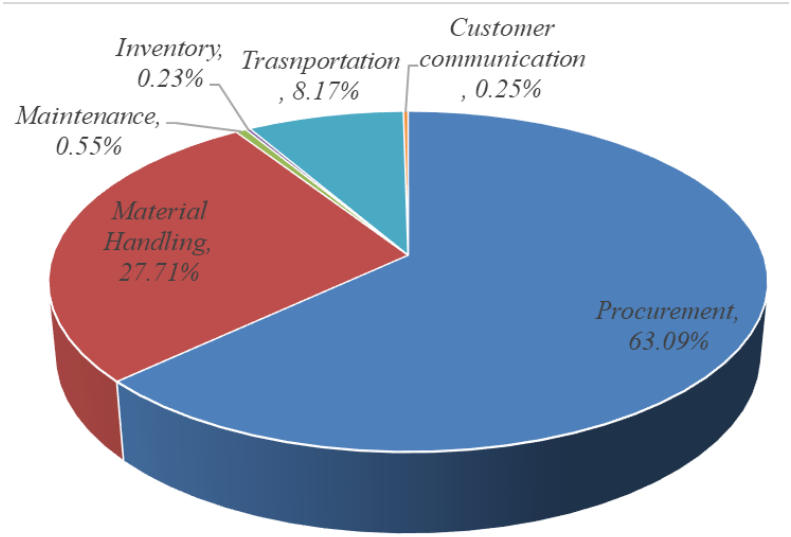

Fig. 2 *Proportion of corn logistics costs in East Java*

Table 4 *Proportion of logistics costs in each logistics activity at each level*

Tier	Procurement (%)	Material Handling (%)	Maintenance (%)	Inventory (%)	Transportation (%)	Customer communication (%)
Farmer	98,95	92,56	75,27	42,48	8,65	91,26
Collector Trader	0,99	3,96	12,86	48,16	25,87	7,16
Large Trader	0,06	3,48	11,87	9,36	65,48	1,58
Total	100	100	100	100	100	100

4. Conclusion

There are four supply chain patterns for corn commodities in East Java. The flow of products in all supply chain patterns is the same. Important information for all supply chain actors is corn prices, estimated delivery time, quantity of corn, corn packaging, and corn standardization. The payment methods are cash and tempo methods in term. The analysis of the logistic cost structure showed that the most significant proportion of logistic cost was procurement activity, with a percentage of 63,09%. The activity at the farmers' tier with the most significant cost proportion was procurement activity, with a percentage of 69,73%. Transportation was the activity with the most considerable logistic cost proportion in the collector trader and large trader tiers, with each proportion amounting to 52,31% and 83,01%. The appropriate supply chain strategy for corn commodities in East Java is a push-based strategy and an efficiency strategy.

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Conflict of Interest

Authors declare that there is no conflict of interests regarding the publication of the paper.

Author Contribution

The authors confirm contribution to the paper as follows: ***study conception and design:*** *A Y Heryanto;* ***data collection:*** *A Y Heryanto;* ***analysis and interpretation of results:*** *A Y Heryanto, N E Kristanti, K H Widodo;* ***draft***

manuscript preparation: *A Y Heryanto. All authors reviewed the results and approved the final version of the manuscript.*

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