Supply Chain Network Design Optimization Model For Determine The Locations For Facilitation Of Procurement Auctions Commodity Machinery In Magetan Regency

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Abstract

There are many obstacles in pre, process, and post-auction activities as well as repair solutions that have been studied previously. Obstacles in implementing the auction market were also experienced by farmer groups in Magetan Regency as participants in the Forward Commodity Auction Market (PLFK) in East Java Province. This case study follows up on one of the alternative solutions from previous research. namely the procurement of machines which is a program of the TPHPKP Office to improve the quality and selling value of auction commodities in Magetan Regency. Based on this, it is necessary to make a decide to determine the location of the machine because the machine depends on the area to meet the needs of farmers who have limited accessibility based on the concept of a supply chain network. This study proposes the selection of a location for the procurement of machines for auction commodities of pamelo oranges, cassava, corn, peanuts, and rice. This study will design a supply chain network involved in the procurement of auction commodity machines in Magetan Regency and design a Gravity Model Location to determine the location of the machine placement. Relationships between entities and calculations using the Gravity Model Location can produce coordinates as the optimal location for placing the machine. Through mathematical calculations using the Gravity Model Location, it was found that the optimum location for laying the five proposed commodity auctions.

Keywords:

The Commodity Auction Market, SCND, Facilitation Location.

1. Introduction

The abundance of potential and contribution of superior commodities in East Java does not fully prosper the farmers behind it. Poverty in East Java is dominated by households working in the agricultural sector, especially smallholders (Badan Pusat Statistik Provinsi Jawa Timur, 2016). The length of the marketing chain, the lack of mastery of market information, and the low distribution activities of farmers independently make the added value of commodities obtained by farmers fluctuate, while the party who benefits is the distribution activity agency (Kementerian Perdagangan RI, 2017). Based on these problems, the Central Government through the Ministry of Trade of the Republic of Indonesia and the Commodity Futures Trading Supervisory Agency (Bappebti) provided a solution in the form of organizing a Commodity Auction Market (PLK) since 2004. Farmers as producers as well as sellers are brought together directly with buyers to create efficiency in the trade chain, means of establishing transparent prices, minimizing the series of moneylenders, achieving price stabilization, supporting farmer welfare and building and expanding business networks (Soleh, 2019). There are many obstacles in pre, process, and post auction activities as well as repair solutions that have been previously researched by (Sutopo et al., 2018; Damona et al., 2013; Heri, 2015; Wulansari et al., 2018). Obstacles in the implementation of the auction market were also experienced by farmer groups in Magetan Regency as participants in the Forward Commodity Auction Market (PLFK) in East Java Province, which were shaded by the local government and private auction organizers. This case study follows up on one of the alternative solutions from the research of Wulansari et al. (2018), namely the procurement of machines which is a program of the TPHPKP Office to improve the quality and selling value of auction commodities in Magetan Regency. Based on this, it is necessary to make a decision to determine the location of the machine because the machine depends on the area to meet the needs of farmers who have limited accessibility based on the concept of a supply chain network.

In general, supply chain network design is used to determine the location, quantity, capacity, allocation of production and distribution facilities. A supply chain network design is required to be flexible to circumstances to be able to respond to customer changes quickly without compromising performance (Chaidir, 2020; Setiyawan et al., 2021). This is considered important among various operations and strategies to address the undeveloped supply chain design and gives rise to a comprehensive approach to the development of a supply chain network design that is more flexible to change (Melnyk et al., 2014). Amalia et al. (2020) and Suryati et al. (2021) use the supply chain network design concept to determine the location of the opening of the facility to obtain an optimal design of relationships between entities and locations so that they can meet needs. Supply Chain Network Design (SCND) decisions have an impact on supply chain performance because they can affect supply chain designs and plans globally and are integrated with the long term (Zheng, et al, 2019). Location selection is one of the integrations of Supply Chain Network Design which is influenced by location characteristics, distance to customers, lot size, and the size of the possibility of expansion space as well as internal and external factors of the company (Wang, et al).

This study proposes the selection of a location for the procurement of machines for auction commodities of pamelo oranges, cassava, corn, peanuts, and rice because they are abundant commodities in Magetan Regency, have a high selling value, and are by the strategic plan of the TPHPKP Office to improve food security, production, facilities, infrastructure, and quality of raw materials in agriculture. This study will design a supply chain network involved in the procurement of auction commodity machines in Magetan Regency and design a Gravity Model Location to determine the location of the machine placement by taking into account the cost of delivering commodities to the candidate facilitation location, the coordinates of the facilitation location, and the quantity of the commodity. Amalia et al. (2020), Suryati et al. (2021), Habibie et al (2021), Khofiyah et al. (2021), and Yuniaristanto (2010) use the supply chain network design concept to determine the location of the opening of the facility to obtain an optimal design of relationships between entities and locations so that they can meet needs. The novelty of this research is following up on the results of the research by Wulansari et al. (2018) by involving the concept of supply chain network design and determining the location of the opening of facilities that have not been considered by previous research on facilitating the implementation of the auction market by (Sutopo et al., 2018).

2. Literature Review

The acceptability of machine procurement requires high reliability which is influenced by technical, regional, economic features and input conditions, then followed by a goal programming model as a decision tool (Akinnuli, 2018). Procurement can manage supply chain risks through negotiations, effective contracts, involving cost, price, quality models, as well as important drivers to improve the sustainability of the entire supply chain (Abdillah et al., 2021). Facilities are one of the main driving factors and performance of the supply chain network which must consider the role of location and capacity (Ama et al., 2015). Supply Chain Network is the most important factor for efficient

and timely delivery of products. The supply chain network design needs to consider various factors, such as facility location planning, customer allocation to facilities, and supplier selection (Tolooie et al., 2020). Gravity Model Location is a mathematical model for determining the location of a facility, namely shops, warehouses, factories, and others that are the liaison between supply sources or consumers (Pujawan & Mahendrawati, 2017).

3. Methods

The object of this research is a machine for auction commodities of pamelo oranges, cassava, corn, peanuts, and rice. The flow of this research is the initial identification in the form of study objects and literature studies, then the formulation of problems, objectives, and benefits of research, data collection, model development, processing results, analysis, and conclusions. There are 18 sub-districts in Magetan Regency that produce pamelo oranges, cassava, corn, peanuts, and rice. Farmers who have a large enough income are usually able to buy, rent, and pay for the services of using machines independently, while other farmers they will directly sell their products on the auction market which will affect the selling value. Based on previous research (Sutopo, et al 2018) facilitation of the procurement of machinery is a solution to the problem of the lack of interest of farmers to participate in the auction (L1), the absence of standard quality standards for commodities in Pre-Auction (L2) and the low bargaining position of farmers in the Auction Process (L5). So it is hoped that the facilitation of the procurement of this machine can meet the needs of farmers by placing it at an optimal location point as well as a sufficient number of tools. Figure 1 is an overview of the implementation of LFK in East Java.

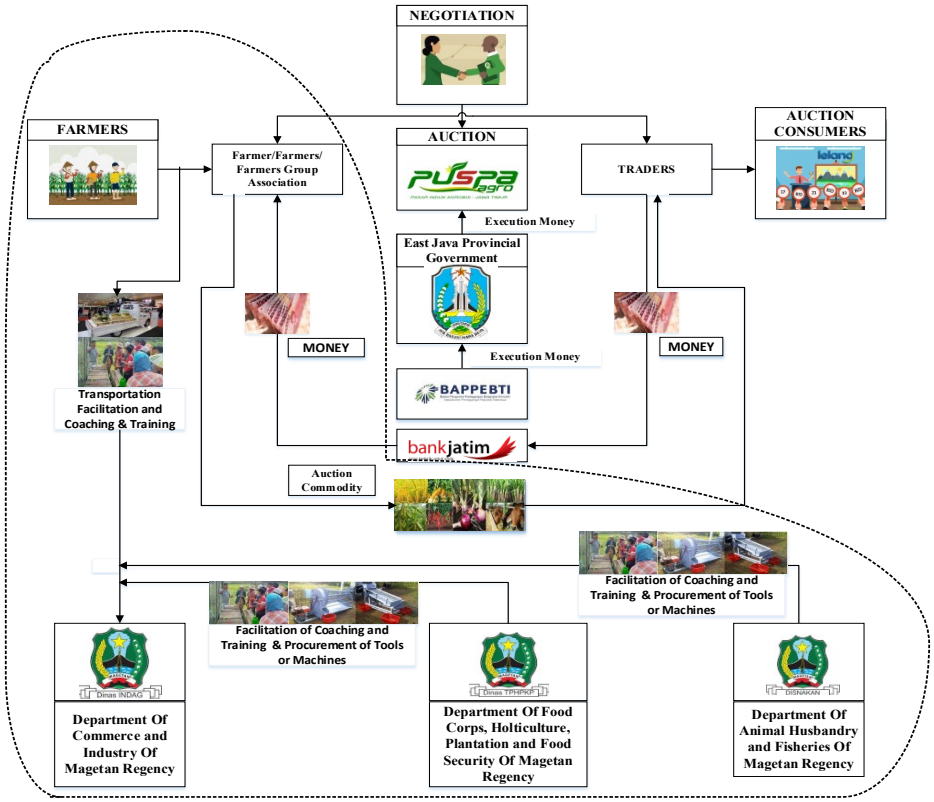

Figure 1: Commodity forward auction market (FAM) model

Based on Figure 1, it can be seen that this research is included in one of the proposals from the Magetan Regency TPHPKP Service, namely the facilitation of machine procurement. Calculations using the Gravity Model Location will be calculated repeatedly until the optimal point is obtained, which is the same coordinate point as the previous iteration in a row which is expected to minimize supply chain costs, improve commodity quality and commodity selling prices. Gravity Model Location needs to make some assumptions. First, transportation costs are assumed to increase in proportion to the volume moved. Second, sources of supply or consumers can be located on a map with clear and y coordinates. Some of the data required in this model are denoted as follows: Gravity Model Location needs

to make some assumptions. First, transportation costs are assumed to increase in proportion to the volume moved. Second, sources of supply or consumers can be located on a map with clear and y coordinates. Some of the data required in this model are denoted as follows:

C_i = Transportation cost per unit per kilometer
V_i = Load transferred
(x_i, y_i) = X and Y coordinates for the location
j_i = Distance between the location

The distance between the locations in the Gravity Model Location is calculated as the geometric distance between two locations calculated by the following formula:

$$J_i = \sqrt{(x0 - xi)(x0 - xi) + (y0 - yi)(y0 - yi)} \quad \text{.....(2.1)}$$

(x_0 , y_0) are the candidate coordinates of the facility being considered. The purpose of this model is to minimize shipping costs which are formulated as follows:

$TC = \sum C_i V_i J_i$

To get the optimal value (x_0, y_0), three steps are needed as follows:

1. Calculate the distance ji for all i
2. Determine the coordinates of the location with the formula:

$$X_0 = \frac{\frac{\sum Ci\,Vi\,Xi}{Ji}}{\frac{\sum Ci\,Vi}{Ji}} \quad \text{.....(2.2)}$$

$$Y_0 = \frac{\frac{\sum Ci\,Vi\,Yi}{Ji}}{\frac{\sum Ci\,Vi}{Ji}} \quad \text{.....(2.3)}$$

3. If two successive iterations produce almost the same coordinates, then the iteration is the optimal location coordinate of the facility, if it has not produced nearly the same coordinates, then repeat the iteration from step 1.

Figure 2 is the Influence Diagram of this research. From the diagram, it can be seen that the goal is the decision to place machine facilitation in this case, namely BUMDES and determine the amount of machine pawn facilitation which is influenced by commodity quantity, harvest location distance, BUMDES geographical location, shipping costs, and equipment capacity. The optimal solution will be calculated using the Gravity Model Location mathematical model.

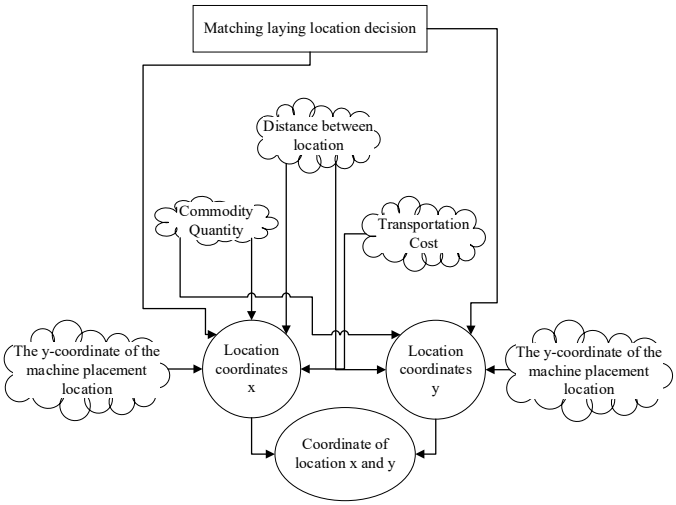

Figure 2: Influence Diagram

4. Data Collection

The data collection stage is carried out to obtain data and information needed in processing and to produce research results. The data was collected using indirect observation and interview methods that have been carried out by previous research. The TPHPKP Office as the party that provided the proposed solution to the auction problem had previously been interviewed directly by Sutopo et al. (2018). Table 1 is the data required in this study.

Table 1: Research Data Needs

Data Type	Source	Type
Coomodity Location Coordinates	Google Maps	Secondary
Auction Commodity Quantity	Researcher Process	Primary
Transportation Cost	Researcher Process	Primary
Distance to machine laying location	Researcher Process	Primary

5. Result and Analysis

This study will design a supply chain network for the procurement of machinery for auction commodities in Magetan Regency. The proposed Supply Chain Network Design (SCND) in this study consists of three entities. The first entity is a provider of machinery for agricultural commodities in the Tokopedia, Shopee, and other online agricultural machinery stores. The machine will be distributed to a second entity, namely the Village-Owned Enterprise (BUMDES) which is assumed to be the location for placing the machine because it is a government-owned location that is most easily accessed by farmers. As a third entity, farmers can use these machines to improve the quality and selling value of their commodities so that they can compete with other PLFK participants' commodities so that farmers' welfare increases. Figure 3 is a description of SCND in this study.

This study will determine the location of the machines for the five auction commodities at the optimal coordinates of 18 sub-districts in Magetan Regency. Table 2 is the result of the last iteration of the calculation of the location of the machine for the pamelo orange commodity. Table 3 is the result of the last iteration of the calculation of the location of the machine for cassava commodities. Table 4 is the result of the last iteration of the calculation of the location of the machine for corn commodity. Table 5 is the result of the last iteration of the calculation of the machine placement location for peanut commodities. Table 6 is the result of the last iteration of calculating the location of the machine for rice commodities.

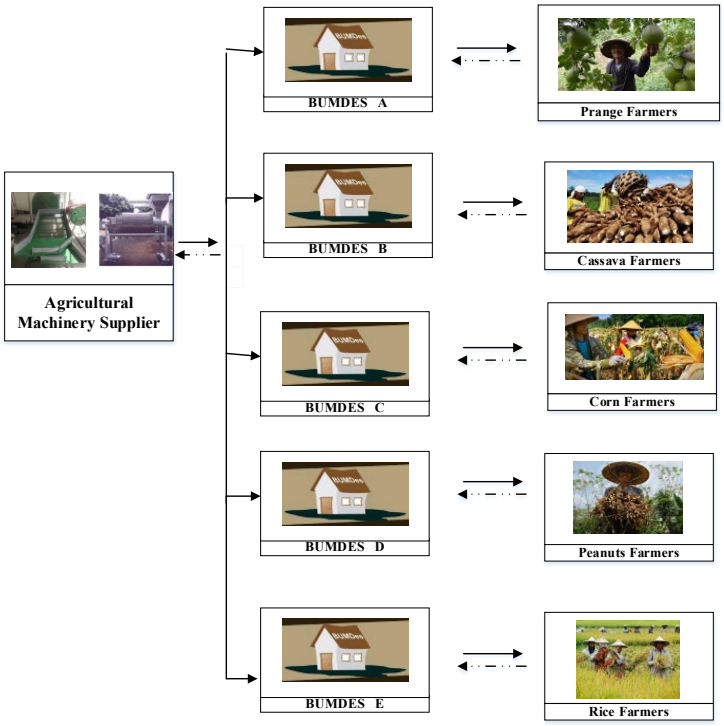

Figure 3: Proposed Design of Supply Chain Network for Machinery Procurement Facilitation

Table 2: Result of the last iteration for pamelo orange commodity

No	n-th Iteration	Coordinate Point	
		X0	Y0
1.	1st Iteration	-7.629333872	111.3782722
2.	2nd Iteration	-7.62813983	111.3757952
3.	3rd Iteration	-7.62710549	111.37339763
Location			Sukomoro, Magetan

Table 3: Result of the last iteration for pamelo cassava commodity

No	n-th Iteration	Coordinate Point	
		X0	Y0
1.	1st Iteration	-7.719178487	111.27558287
2.	2nd Iteration	-7.719180361	111.2705369
3.	3rd Iteration	-7.719171808	111.2712304
Location			Poncol, Magetan

Table 4: Result of the last iteration for pamelo corn commodity

No	n-th Iteration	Coordinate Point	
		X0	Y0
1.	1st Iteration	-7.7196164	111.2726258
2.	2nd Iteration	-7.72981137	111.3795517
3.	3rd Iteration	-7.745927436	111.3986497
Location			Lembeyan, Magetan

Table 5: Result of the last iteration for pamelo peanut commodity

No	n-th Iteration	Coordinate Point	
		X0	Y0
1.	1st Iteration	-7.737400585	111.3544993
2.	2nd Iteration	-7.740897676	111.3552983
3.	3rd Iteration	-7.742700484	111.3543722
Lokasi			Parang, Magetan

Table 6: Result of the last iteration for pamelo rice commodity

No	n-th Iteration	Coordinate Point	
		X0	Y0
1.	1st Iteration	-7.64041577	111.3951533
2.	2nd Iteration	-7.640718011	111.4023828
3.	3rd Iteration	-7.64055425	111.4055425
Location			Bendo, Magetan

6. Conclusion

This research can be a suggestion to realize the proposed solution to the problems of Magetan Regency as a participant in East Java PLFK. Determining the location of facilities is closely related to the concept of supply chain network design. This study proposes a supply chain network involving machine providers, BUMDES, and farmers. Relationships between entities and calculations using the Gravity Model Location can produce coordinates as the optimal location for placing the machine. Through mathematical calculations using the Gravity Model Location, it was found that the optimum location for laying the pamelo citrus fruit washing machine was at BUMDES Sukomoro,

Magetan. Laying cassava washing machine in Poncol, Magetan. Laying of sorting machine and corn seed moisture equipment in Lembeyan, Magetan. Laying of sorting machine and groundnut seed moisture equipment in Parang, Magetan. Laying of sorting machine and rice seed moisture equipment in Bendo, Magetan.

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