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PRODUCT DISTRIBUTION ROUTE OPTIMIZATION TO MINIMIZE TRANSPORTATION COSTS WITH THE SAVING MATRIX METHOD AT PT. XYZ

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ABSTRACT

PT. XYZ is a company engaged in the packaged cooking oil industry. In the process of marketing, the products are delivered by truck directly to each distributor location in the area of Central Java and East Java. The company has problems in terms of planning is not optimal distribution of goods to the distributor. The obstacle is the use of capacity transportation is less than the maximum. Application of the saving matrix method in this study is expected to assist planning in maximizing the capacity of the conveyance and determining the optimal distribution channel so that the process of distributing the product can be run either every product shipped, both the number of products and the route of destination with low distribution costs. The results of the research conducted show that this method produces better efficiency, with an efficiency rate range of 13.4%, distribution costs Rp. 1,972,500,-, fuel costs 12.5% and some sub routes into 4 routes.

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1. Introduction

In the era of globalization like today, one aspect that can affect the success of a company in surviving and competing is product distribution activities. Product distribution activities are activities that manage the movement of products from one location to another where the movement of these products can form a distribution network.

Distribution is often associated as part of the marketing mix, namely *price, place, product,* and *promotion* by placing the product in the right place for purchase (Kotler, 2000). Distribution is often a problem for every company, the wider the marketing area, the more problems arise. In an effort to minimize the cost of effective and efficient product distribution transportation, the company must pay attention to the route network system in transportation.

PT. XYZ is a company engaged in the packaging cooking oil industry, which is inseparable from distribution and transportation activities in its marketing process. In the marketing process, the product is sent using trucks directly to each distributor location in Central Java and East Java. Due to the large number of product requests needed by consumers, PT. XYZ is required to be able to manage the distribution process efficiently, so that the product arrives at the distributor according to the specified time at an efficient cost.

So far, the product distribution process that has been carried out by PT XYZ has been quite good, but not yet optimal. This problem arises because there is no determination of a good route network system in the distribution process, resulting in the use of less effective routes. This causes inefficient transportation and fuel costs. Another problem is the use of transportation capacity in the distribution process is not yet optimal.

To overcome this problem, the author uses the *savings matrix method* , which is a method used to determine the product distribution route to the marketing area. how to determine the distribution route that must be passed and the number of vehicles based on vehicle capacity in order to obtain the shortest route and minimal transportation costs (Erlina P, 2009) . By using the *savings matrix method* , it is expected to help planning in maximizing the capacity of transportation equipment and determining optimal distribution routes so that the product distribution process can run well for each product sent, both regarding the number of products and the destination route with low distribution costs.

The purpose of this study is to determine the maximum capacity of the transportation equipment used, to determine the optimal distribution route, and to minimize distribution and fuel costs incurred by the company. The expected benefits of this study include the company being able to determine the maximum capacity of the transportation equipment, obtaining the most effective distribution route, and being able to reduce distribution costs and fuel usage so that the company's operational efficiency can increase.

2. Review Literature

Logistics Management

According to (Kessy & Rahmansari, 2017), Logistics management is part of supply chain management that plans, implements, and controls the forward flow and reverse flow as well as the storage of products, services and related information between the point of origin and the point of consumption to meet consumer needs effectively and efficiently.

Transportation System

The system is a form of relationship between one variable and another in a structured order. While transportation itself is the activity of moving goods/passengers from one place to another. So that the transportation system can be interpreted as a combination of several components or objects that are interrelated in terms of transporting goods/people by various types of vehicles in accordance with technological advances.

Vehicle Routing Problem

Vehicle Routing Problem (VRP), is a problem that involves the construction of routes from a number of vehicles starting from a main depot to the location of a number of consumers with a certain number of requests. The goal is to minimize the total cost without exceeding the vehicle capacity. VRP is a goods distribution management that considers service, a certain time period, a group of consumers with a number of vehicles located at one or more depots operated by a group of drivers using the appropriate road network.

Saving Matrix Method

saving matrix method is essentially a method to minimize distance or time or cost by considering existing constraints . According to (Pujawan, I. & Mahendrawathi, 2010) , the steps that must be taken are as follows:

1. Identifying the distance matrix
   In this step, the distance between the warehouse and each store and the distance between stores are required. The distance from the warehouse to each store and the distance between stores will be used to determine the saving matrix *that* will be worked on in the next step.
2. Identifying the *savings* matrix
   Saving matrix represents the savings that can be realized by combining two customers into one route. To calculate the distance savings, you can use the equation:
   $S(x,y) = J(G, x) + J(G,y) – J(x,y)$
   Where :
   $S(x,y)$ = Distance Saving

J (G,x) = Distance from warehouse to store x
J (G,y) = Distance from warehouse to shop y
J (x,y) = Distance from shop x to shop y

3. Allocate distributors to routes
   By using the distance saving table, it is possible to allocate stores to vehicles or routes. The merger will start from the largest saving value because it is attempted to maximize savings.

4. Sort distributors into predefined routes
   In this step, there are several methods/procedures for determining the order *of customers* in one route:
   a. Farthest Insert
   Includes consumers who travel the furthest.
   b. Nearest Insert
   Enter the consumer who provides the shortest trip.
   c. Nearest Neighbor
   The nearest neighbor method is the first method used to obtain a solution to *the vehicle routing problem* . The *nearest neighbor method* is a method for classifying objects based on learning data that is closest to the object (Widiarsana et al., 2011) .

3. Methodology

Data collection

a) Observation (Direct Observation)
Data collection technique where researchers obtain data by seeing and observing activities in the field.

b) Interview
Data collection techniques where researchers obtain data by conducting direct interviews with company field supervisors and parties related to the information needed by researchers at PT. XYZ

c) Documentation
Data collection technique where researchers obtain data by collecting and studying documents in the company that is the object of research.

d) Literature review
Data collection techniques where researchers obtain data by reading, studying and reviewing literature, journals, the internet, previous research and books related to the research being conducted.

Data processing

The stages carried out in data processing are:

a) Calculate the theoretical time required to serve total requests.
b) Calculate the total distance from PT. XYZ to each distributor and back to PT. XYZ according to the best route solved by the nearest neighbor method.
c) Calculate the minimum limit for the number of minimum means of transport required using the formula: Nmin = total time/availability time of transport vehicles
d) Divide the route into sub-routes and try to make each sub-route balanced. The formation of this sub-route uses the saving matrix method by considering the number of requests and the capacity of the transport vehicle.
e) Calculation of distribution costs on the distribution routes formed.

4. Results and Discussion

Distribution Sub Route Analysis

The comparison between the initial distribution sub-routes and the proposed distribution sub-routes is described in Table 1. It can be seen that there is a reduction in the sub-routes formed on the proposed distribution route compared to the previous sub-routes. On the proposed distribution route, there are 4 selected sub-routes while the distribution route passed by the company has 5

sub-routes. This can happen because in the formation of the proposed sub-routes using the saving matrix method which has considered the travel distance and the use of transportation capacity.

Table 1. Comparison of Distribution Sub Routes

Initial Route	*Order*	*Saving Matrix* Route	Order
1	Factory → D11 → D12 → D14 → Factory	1	Factory → D13 → D12 → D14 → D15 → Factory
2	Factory → D4 → D7 → D10 → Factory	2	Factory → D6 → D8 → D11 → D9 → Factory
3	Factory → D9 → D13 → D15 → Factory	3	Factory → D3 → D4 → D7 → D10 → Factory
4	Factory → D1 → D3 → Factory	4	Factory → D1 → D2 → D5 → Factory
5	Factory → D2 → D5 → D6 → D8 → Factory		

Source: Data Processing

Transportation Cost Analysis

On a distribution route, the shorter the distance, the lower the transportation cost or the savings in transportation costs. Comparison of transportation costs for the proposed sub-route with the sub-route used by the company can be seen in Table 4.

Table 4. Comparison of Transportation

Initial Route		Proposed Route	
Sub Route	Cost (Rp)	Sub Route	Cost (Rp)
1	Rp. 7,050,000	1	Rp9,065,000
2	Rp. 3,405,750	2	Rp6,067,500
3	Rp. 6,740,000	3	Rp3,825,750
4	Rp. 1,077,500	4	Rp1,567,500
5	Rp. 4,225,000		
Total	**Rp22,498,250**	**Total**	**Rp20,525,750**

Source: Data Processing

From Table 4. it can be seen that the planned/proposed sub-route has a lower transportation cost than the sub-route used by
the company. The closer the distance, the more transportation cost savings will occur. By using the savings matrix method, the company can save distribution costs of Rp. 1,972,500. - By using the company's initial costs, the cost efficiency obtained is:

$$\text{Efisiensi Biaya} = \frac{22.498.250 - 20.525.750}{22.498.250} \times 100\% = 0{,}087 = 8{,}7\ \%$$

There was a transportation cost efficiency of 8.7% from previous costs .

Fuel Cost Analysis

On a distribution route, the shorter the distance, the less fuel is used or there is a saving in fuel costs. A comparison of fuel costs on the proposed sub-route with the sub-route used by the company can be seen in Table 5.

Table 5. Comparison of Fuel Costs

Initial Route			Proposed Route		
Sub Route	Fuel Requirement(ℓ)	Fuel Requirement (rupiah)	Sub Route	Fuel Requirement(ℓ)	Fuel Requirement (rupiah)

1	197	Rp. 1,014,550	1	227.6	Rp. 1,172,140
2	113.4	Rp. 584,010	2	148.2	Rp. 763,230
3	191	Rp. 930,650	3	128.2	Rp. 660,230
4	32.6	Rp. 167,890	4	50.2	Rp. 258,530
5	106.4	Rp. 547,960			
Total	**640.4 ℓ**	**Rp. 3,265,060**	**Total**	**554.2 ℓ**	**Rp. 2,854,130**

Source: Data Processing

From Table 5. it can be seen that the planned/proposed sub-route has a lower transportation cost than the sub-route used by the company. The closer the distance, the more transportation cost savings will occur. By using the savings matrix method, the company can save distribution costs of Rp. 410,930, - By using the company's initial costs, the cost efficiency obtained is:

$$\text{Efisiensi Biaya Bahan Bakar} = \frac{3.265.060 - 2.854.130}{3.265.060} \times 100\% = 0{,}12 = 12{,}5\,\%$$

There was a 12.5% fuel cost efficiency resulting from the proposed route.

5. Conclusion

The formation of sub routes on the proposed distribution route using the *Saving Matrix method* resulted in fewer sub routes compared to the company's current distribution system, which is only 4 sub routes compared to the previous 5 sub routes. In addition, the combination of the *Saving Matrix* and *Nearest Neighbor methods* was able to produce distribution distance savings of 431 km. By using the proposed route, a distance efficiency of 13.4% and fuel efficiency of 12.5% were obtained. The use of the *Saving Matrix method* also contributed to distribution cost savings of Rp1,972,520. Based on these results, it is recommended that the company socialize this method to all employees in order to increase knowledge and understanding regarding its use. In addition, the company needs to form an implementation team tasked with determining the priority of improving distribution activities and testing this method against the problems faced. To ensure the success and consistency of its implementation, the company is also advised to conduct periodic evaluations of the performance of the distribution system produced through the *Saving Matrix method* .

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