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# Determination of Distribution Routes Using the Saving Matrix Method to Minimize Shipping Costs at PT. SUKUN TRANSPORT LOGISTICS

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ABSTRACT

PT. Sukun Transport Logistics is a company engaged in shipping, logistics and also transportation vehicle rental services. The problems faced by PT. Sukun Transport Logistics is a lack of transport vehicle capacity, causing the use of transport vehicles that are not suitable and the distribution of sub-routes is not balanced. Therefore, to overcome these problems, it is necessary to determine the optimal distribution route using the saving matrix method. The saving matrix method is a method to shorten mileage, estimate distribution time and minimize shipping costs at PT. Sukun Transport Logistics. From the results of the route research in this study, it is known that the route proposal with the saving matrix method opens 2 sub routes from the previous 3 sub routes, the total distance through the saving matrix method and the closest calculation method is 299 km. While the total distance of the actual route delivery to the company is 313 km. The distance saving of this research with the company's actual route is 14 km or 4.47%. At the time of saving of 164 minutes or 20.97%, and distribution cost savings of Rp. 141,658 or 25.53%.



## INTRODUCTION

In the industrial world, shipping or distribution has an important function in a company. One of the important things is distribution in determining the schedule and route that will be passed by shipping from one location to the location to be addressed (Zuhdi *et al.*, 2017). Distribution is a way of distributing goods used by producers to consumers so that they can be accepted by consumers quickly, precisely and in good conditions (Suparjo, 2017).

The optimal distribution process in an industry, be it manufacturing or service, is an important issue and one of optimization. Route and vehicle scheduling planning is an important part of the transportation and distribution system (Kamal *et al.,* 2020). The vehicle route problem is a combinatorial problem in terms of the economic value of the vehicle which can change at any time in the logistics system, this problem is known as the Vehicle Routing Problem (VRP).

Vehicle Routing Problem (VRP) can be defined as a distribution delivery route determination problem which consists of a series of delivery routes centered on one or more warehouses to serve customers covering different delivery areas with their respective needs (Irman *et al.,* 2017).

PT. Sukun Transport Logistics is one of the companies engaged in shipping, logistics and also transportation vehicle rental services. The main activity of PT. Sukun Transport Logistics, namely carrying out cigarette delivery activities from one location to another. PT. Sukun Transport Logistics is required to be able to design reliable delivery performance, while the company is still determining the delivery sub route with the closest distance method from the warehouse. The problems faced by PT. Sukun Transport Logistics is the delivery of cigarette products only by considering the closest distance from the warehouse to other retailers based on analytical predictions. The company also does not consider the vehicle capacity, causing the use of vehicles that are not in accordance with the capacity and the distribution of sub-routes is less balanced.

**Table 1.** Utility of PT. Sukun Transport Logistics Distribution October 2021

| Sub Rute | Transport Vehicle Utility |
|---|---|
| 1 | 27,25% |
| 2 | 55,50% |
| 3 | 61% |
| Average | 48,01% |

From table 1, it can be seen that the average utility of transport vehicles used for distribution in October 2021 is relatively low, which is below 75% of the vehicle capacity of 400 bales with a utility value of 48.01%. The relative value of 75% is used for the feasibility of the goods sent according to the capacity of the vehicle (Humaira*,* 2021). This shows the use of low vehicle capacity and the use of an excessive and inappropriate number of vehicles. The application of distribution channels that have been implemented by PT. Sukun Transport Logistics has not been carried out in a balanced manner in determining the distance traveled and the number of retailers visited.

In this study, the author tries to use the Saving Matrix method which is used to determine vehicle scheduling and the Nearest Insert method tools to determine the optimal route. So as to be able to solve problems related to the Vehicle Routing Problem (VRP). Through the use of this method, it is hoped that it can minimize the distance traveled by the distribution route, distribution time, distribution costs and can increase the use of transportation vehicle utilities at PT. Sukun Transport Logistics.

## RESEARCH METHOD

In general, the research method in determining vehicle routes in the distribution of PT. Sukun Transport Logistics uses the Saving Matrix method. In processing the data of this study using quantitative methods. The first thing to do in data processing using this research is (A) the formation of sub-routes using the saving matrix method where the identification of the distance matrix, identification of the savings matrix, allocating the destination of the delivery route, and the identification of the route sequence with the nearest insert method are carried out (Yetrina dan Nainggolan, 2021). The next steps (B) calculate the standard time available, (C) determine the number of transport vehicles and (D) calculate distribution costs. The steps taken in processing this data can be seen in Figure 1.

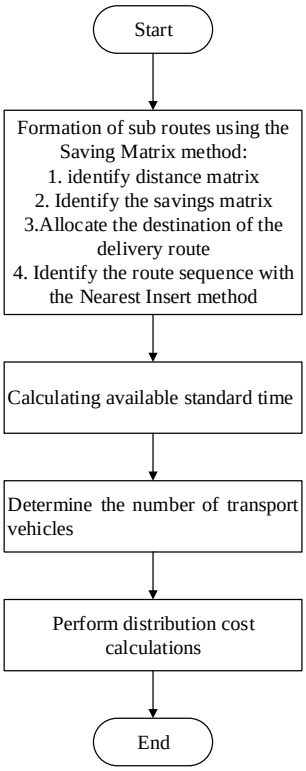


**Figure 1.** Data Processing Flowchart

### Formation of Sub Routes Using the Saving Matrix Method

In the formation of sub routes, the saving matrix method is used. The saving matrix method is essentially a method to minimize distance or costs by considering existing constraints (Supriyadi *et al.,* 2017). In the formation of the sub route is divided into several stages, including:

1. Identifying the Distance Matrix
2. Identifying the Distance Matrix is the collection of the distance between the warehouse and the location of each customer and the distance between locations. Knowing the coordinates of each location, the distance between two locations can be calculated as using the standard formula (Ahmad dan Muharram, 2018).
3. Identifying the Savings Matrix
4. Saving Matrix represents the savings that can be realized by merging 2 or more retailers in 1 route (Aprilia, 2019).
5. Allocating Destination Shipping Routes
6. Merger starts with the highest savings value, because it aims to maximize savings and classify stores (destinations) according to a predetermined route (Abdurrahman *et al.*, 2019).
7. Route Sequence Identification With Nearest Insert Method
8. In principle, the purpose of this sorting is to minimize the travel distance of the conveyance (Fitri, 2018). The method used is the nearest insert method. The Nearest Insert method is the shortest journey, using the principle of selecting a store which, inserted in the existing route, results in the minimum additional distance (Suryani *et.al.*, 2018).

### Calculating Available Standard Time

The calculation of the total time for the distribution sub-routes that have been determined is as follows.

- Vehicle setup time = 15 minutes
- Total travel time $= \frac{travel\ distance}{average\ speed}$
- Warehouse loading time = 30 minutes

- Unloading time on each sub route = number of retailers x 5 minutes
- Total time = vehicle setup time + total travel time + warehouse loading time + unloading time on each sub route

**Determining the Number of Transport Vehicles**

The number of transport vehicles needed can be formulated:

Number of transport vehicles required = $\frac{total\ time}{Availability}$

Availability of transport vehicles is the amount of time available for transport vehicles to operate. The daily availability of transport vehicles is 420 minutes.

**Calculation of Distribution Costs**

Transportation costs for transport vehicles consist of operational costs (fuel costs, parking fees, lunch costs) and maintenance costs. Maintenance costs do not need to be compared because they are not discussed in this study. In carrying out the delivery process, the company uses transport vehicles with a capacity of 400 bales. vehicles use fuel using a ratio of 1: 10, meaning that with 1 liter of material the distance traveled by the transportation equipment is 10 km (Humaira, 2021).

## RESULTS AND DISCUSSION

**Data Collection**

**1. Retailer Location Data**

The data collection carried out in this study is location data at each retailer that is the destination of delivery by PT. Sukun Transport Logistics. The data for the location of the distributor shop can be seen in table 2.

**Table 2.** Retailer Location PT. Sukun Transport Logistics 2021

| No. | Code | Retail Name | Retail Address |
|---|---|---|---|
| 1 | G | Sukun Cigarette Warehouse | Jl. PR. Sukun Gondosari Gebog Kudus |
| 2 | R1 | Core Earth Mani shop | Tawangsari, Babagan Lasem |
| 3 | R2 | gansar shop | jl. Pajeksan juwana pati |
| 4 | R3 | prosperous shop | jl. Pajeksan juwana pati |
| 5 | R4 | sidodadi shop | jl. Pajeksan juwana pati |
| 6 | R5 | long shop | jl. Pajeksan juwana pati |
| 7 | R6 | five-five toko shop | jl. Pajeksan juwana pati |
| 8 | R7 | eternal glory shop | jl. Pajeksan juwana pati |
| 9 | R8 | rene shop | Jl. Yossudarso Smberjo Rembang |
| 10 | R9 | yield shop | Jl Airlangga, Sumberjo Rembag |
| 11 | R10 | swan shop | Jl Dr. Wahidin Rembang |
| 12 | R11 | good boy shop | jl. National 17 Rembang |
| 13 | R12 | Yup Susilo shop | jl. Dr, Sutomo Pati City |
| 14 | R13 | fanny shop | Karangturi, babagan lasem |
| 15 | R14 | corner shop | Tawangsari, Babagan Lasem |
| 16 | R15 | tan soe thay shop | Jl Slamet Riyadi, Sumberjo, Rembang |
| 17 | R16 | shop 299 | stop by, city of pati |

**Product Request Data**

The following is the number of requests for Sukun cigarettes to retailers in September 2021 which is used to design distribution routes to be more optimal. The number of data on cigarette shipments to each retailer can be seen in tabel 3.

**Table 3.** Cigarette Requests PT. Sukun Transport Logistics 2021

| Store Name | demand for cigarette products | | | | | | | | | Number of Bales per Shop |
|---|---|---|---|---|---|---|---|---|---|---|
| | MW 12 | IST 10 | 2000 | SSB 12 | SPC 12 | SPC 16 | EXC 12 | EXC 16 | MGNO 12 | |
| **Core Earth Mani shop** | | | | | | | 1,600 | | | 8 |
| gansar shop | | | | 100 | 200 | 1,600 | 6,400 | 1,600 | | 49 |
| prosperous shop | 800 | | 800 | | | 400 | 18.000 | 4,400 | 200 | 123 |
| sidodadi shop | 200 | | | 10 | | | 2,400 | 400 | | 15 |
| long shop | | | | | | | 5,600 | 400 | | 30 |
| five-five toko shop | | | | | | | 5,600 | 1,200 | 200 | 35 |
| eternal glory shop | | | | | | | 1,600 | | | 8 |
| rene shop | | | | | | | 2,300 | | | 12 |
| yield shop | 200 | | | 20 | | 2,000 | | 1,600 | 100 | 19 |
| swan shop | 400 | | 200 | 400 | 200 | 2,000 | 15,400 | 5,600 | 200 | 122 |
| good boy shop | | | | | | 200 | 800 | | | 5 |
| Yup Susilo shop | | | | | | | 400 | | | 2 |
| fanny shop | 400 | | 200 | 200 | 200 | 2800 | 8.000 | | | 59 |
| corner shop | | | | | | 800 | 4,000 | 800 | | 28 |
| tan soe thay shop | 800 | | | 200 | 400 | 2800 | 17,600 | 5,600 | 200 | 138 |
| shop 299 | 800 | | 800 | 400 | | 200 | 15,000 | 4,000 | 200 | 107 |

**Data processing**

**Sub-Route Formation**

The following are the steps for establishing a cigarette delivery distribution sub route using the saving matrix method.

a. determining the delivery route for cigarette products. The distance between each retaIdentifying the Distance Matrix. The distance between warehouses and retailers owned by the company is used in iler can be seen in tabel 4.

b. Identifying the Saving Matrix

At this stage, it is assumed that each retail will be visited by one vehicle which will lead to 16 different routes and each in one destination. For the calculation of distance savings 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 retail x

J (G, y) = distance from warehouse to retail y

J(x,y) = retail distance x to retail y

The following is an example of calculating the distance for retailers R1 and R2 using the formula above:

$$S(R1, R2) = J(G, R1) + J(G, R2) - J(R1, R2)$$
$$= 79 + 45 – 35$$
$$= 89 \text{ km}$$

The calculation of distance savings for each retailer can be seen in table 5.

**Table 4.** Distance between Cigarette Warehouses and Retailers

| R (km) | G | R1 | R2 | R3 | R4 | R5 | R6 | R7 | R8 | R9 | R10 | R11 | R12 | R13 | R14 | R15 | R16 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **G** | | | | | | | | | | | | | | | | | |
| **R1** | 79 | | | | | | | | | | | | | | | | |
| **R2** | 45 | 35 | | | | | | | | | | | | | | | |
| **R3** | 45 | 35 | 0 | | | | | | | | | | | | | | |
| **R4** | 45 | 35 | 0 | 0 | | | | | | | | | | | | | |
| **R5** | 45 | 35 | 0 | 0 | 0 | | | | | | | | | | | | |
| **R6** | 45 | 35 | 0 | 0 | 0 | 0 | | | | | | | | | | | |
| **R7** | 45 | 35 | 0 | 0 | 0 | 0 | 0 | | | | | | | | | | |
| **R8** | 67 | 13 | 22.2 | 22.2 | 22.2 | 22.2 | 22.2 | 22.2 | | | | | | | | | |
| **R9** | 67.1 | 12.9 | 22.1 | 22.1 | 22.1 | 22.1 | 22.1 | 22.1 | 0.1 | | | | | | | | |
| **R10** | 67.3 | 12.7 | 22 | 22 | 22 | 22 | 22 | 22 | 0.2 | 1.5 | | | | | | | |
| **R11** | 66 | 11 | 23 | 23 | 23 | 23 | 23 | 23 | 1 | 1.7 | 1.6 | | | | | | |
| **R12** | 32 | 47 | 13 | 13 | 13 | 13 | 13 | 13 | 36 | 35 | 35 | 36 | | | | | |
| **R13** | 80 | 1.6 | 35 | 35 | 35 | 35 | 35 | 35 | 14 | 14 | 14 | 12 | 48 | | | | |
| **R14** | 79 | 1 | 34 | 34 | 34 | 34 | 34 | 34 | 13 | 13 | 13 | 11 | 47 | 1.4 | | | |
| **R15** | 68 | 14 | 25 | 25 | 25 | 25 | 25 | 25 | 24 | 1.5 | 2.6 | 3.3 | 38 | 15 | 13 | | |
| **R16** | 35 | 47.2 | 12 | 12 | 12 | 12 | 12 | 12 | 43 | 35 | 35 | 36 | 1.7 | 48 | 47 | 43 | |

(Source : Google maps)

**Table 5.** Cost Matrix between Retailers

| R (km) | R1 | R2 | R3 | R4 | R5 | R6 | R7 | R8 | R9 | R10 | R11 | R12 | R13 | R14 | R15 | R16 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **R1** | 0 | | | | | | | | | | | | | | | |
| **R2** | 89 | 0 | | | | | | | | | | | | | | |
| **R3** | 89 | 90 | 0 | | | | | | | | | | | | | |
| **R4** | 89 | 90 | 90 | 0 | | | | | | | | | | | | |
| **R5** | 89 | 90 | 90 | 90 | 0 | | | | | | | | | | | |
| **R6** | 89 | 90 | 90 | 90 | 90 | 0 | | | | | | | | | | |
| **R7** | 89 | 90 | 90 | 90 | 90 | 90 | 0 | | | | | | | | | |
| **R8** | 133 | 89.8 | 89.8 | 89.8 | 89.8 | 89.8 | 89.8 | 0 | | | | | | | | |
| **R9** | 133.2 | 90 | 90 | 90 | 90 | 90 | 90 | 134 | 0 | | | | | | | |
| **R10** | 133.6 | 90.3 | 90.3 | 90.3 | 90.3 | 90.3 | 90.3 | 134.1 | 132.9 | 0 | | | | | | |
| **R11** | 134 | 88 | 88 | 88 | 88 | 88 | 88 | 132 | 131.4 | 131.7 | 0 | | | | | |
| **R12** | 64 | 64 | 64 | 64 | 64 | 64 | 64 | 63 | 64.1 | 64.3 | 62 | 0 | | | | |
| **R13** | 157.4 | 90 | 90 | 90 | 90 | 90 | 90 | 133 | 133.1 | 133.3 | 134 | 64 | 0 | | | |
| **R14** | 157 | 90 | 90 | 90 | 90 | 90 | 90 | 133 | 133.1 | 133.3 | 134 | 64 | 157.6 | 0 | | |
| **R15** | 133 | 88 | 88 | 88 | 88 | 88 | 88 | 111 | 133.6 | 132.7 | 130.7 | 62 | 133 | 134 | 0 | |
| **R16** | 66.8 | 68 | 68 | 68 | 68 | 68 | 68 | 59 | 67.1 | 67.3 | 65 | 65.3 | 67 | 67 | 60 | 0 |

c. Allocating Retailers to Routes

Table 5 can be done to allocate retailers into routes. In the early stages, each retailer is allocated a different route. So as in table 6 below, there are 16 initial routes. On the 16 routes, it can be combined with the greatest saving value. The first biggest savings start from 157.6 km which is the distance savings from combining R13 and R 14. The total load is:

Total load = Reban R13 + Load R 14
= 59 Bal + 28 Bal
= 87 Bal

Where 87 bales 400 bales so that merging can be done and can be seen in tabel 6.

**Table 6.** Allocating retailers to routes

| R (km) | Route | R1 | R2 | R3 | R4 | R5 | R6 | R7 | R8 | R9 | R10 | R11 | R12 | R13 | R14 | R15 | R16 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **R1** | R 1 | 0 | | | | | | | | | | | | | | | |
| **R2** | R 2 | 89 | 0 | | | | | | | | | | | | | | |
| **R3** | R 2 | 89 | 90 | 0 | | | | | | | | | | | | | |
| **R4** | R 2 | 89 | 90 | 90 | 0 | | | | | | | | | | | | |
| **R5** | R 2 | 89 | 90 | 90 | 90 | 0 | | | | | | | | | | | |
| **R6** | R 1 | 89 | 90 | 90 | 90 | 90 | 0 | | | | | | | | | | |
| **R7** | R 1 | 89 | 90 | 90 | 90 | 90 | **90** | 0 | | | | | | | | | |
| **R8** | R 2 | 133 | 89.8 | 89.8 | 89.8 | 89.8 | 89.8 | 89.8 | 0 | | | | | | | | |
| **R9** | R2 | 133.2 | 90 | 90 | 90 | 90 | 90 | 90 | 134 | 0 | | | | | | | |
| **R10** | R 2 | 133.6 | **90.3** | **90.3** | **90.3** | **90.3** | 90.3 | 90.3 | **134.1** | 132.9 | 0 | | | | | | |
| **R11** | R 1 | 134 | 88 | 88 | 88 | 88 | 88 | 88 | 132 | 131.4 | 131.7 | 0 | | | | | |
| **R12** | R 1 | 64 | 64 | 64 | 64 | 64 | 64 | 64 | 63 | 64.1 | 64.3 | 62 | 0 | | | | |
| **R13** | R 1 | **157.4** | 90 | 90 | 90 | 90 | 90 | 90 | 133 | 133.1 | 133.3 | 134 | **64** | 0 | | | |
| **R14** | R 1 | 157 | 90 | 90 | 90 | 90 | 90 | 90 | 133 | 133.1 | 133.3 | 134 | 64 | **157.6** | 0 | | |
| **R15** | R 1 | 133 | 88 | 88 | 88 | 88 | 88 | 88 | 111 | 133.6 | 132.7 | 130.7 | 62 | 133 | **134** | 0 | |
| **R16** | R 1 | 66.8 | 68 | 68 | 68 | 68 | 68 | 68 | 59 | 67.1 | 67.3 | 65 | 65.3 | 67 | 67 | **60** | 0 |
| **(Bales)** | | **8** | **49** | **123** | **15** | **30** | **35** | **8** | **12** | **19** | **122** | **5** | **2** | **59** | **28** | **138** | **107** |

So that the sub-routes formed are two sub-routes, namely:
Sub route 1 selected retailer : [ G – R 1 – R6 – R7 – R11 – R12 – R13 – R14 – R15 – R16 – G]
Sub route 2 selected retailers : [ G – R2 – R3 – R4 – R5 – R8 – R9 – R10 – G ]

d. Sorting Retailers in Sub Routes

After locating the retailer to the sub route that has been done, the next step is to determine the order of visits as shown in table 7 and table 8.

**Table 7.** Distance from Warehouse to Retailer and Distance Between Retailers Sub Route 1

| Retailers (km) | G | R1 | R6 | R7 | R11 | R12 | R13 | R14 | R15 | R16 |
|---|---|---|---|---|---|---|---|---|---|---|
| G | 0 | 79 | 45 | 45 | 66 | 32 | 80 | 79 | 68 | 35 |
| R1 | | 0 | 35 | 35 | 11 | 47 | 1.6 | 1 | 14 | 47.2 |
| R6 | | | 0 | 0 | 23 | 13 | 35 | 34 | 25 | 12 |
| R7 | | | | 0 | 23 | 13 | 35 | 34 | 25 | 12 |
| R11 | | | | | 0 | 36 | 12 | 11 | 3.3 | 36 |
| R12 | | | | | | 0 | 48 | 47 | 38 | 1.7 |
| R13 | | | | | | | 0 | 1.4 | 15 | 48 |
| R14 | | | | | | | | 0 | 13 | 47 |
| R15 | | | | | | | | | 0 | 43 |
| R16 | | | | | | | | | | 0 |

The resulting sub route for sub route 1 is G – R12 – R16 – R6 –R7 – R11 – R15 – R14 – R1 – R13 – G with a distance of 32 + 1.7 + 12 + 0 + 23+ 13 + 1 + 1, 6 + 80 = 164.3 km.

**Table 8.** Distance from Warehouse to Retailer and Distance Between Retailers Sub Route 2

| Retailers (km) | G | R2 | R3 | R4 | R5 | R8 | R9 | R10 |
|---|---|---|---|---|---|---|---|---|
| G | 0 | 45 | 45 | 45 | 45 | 67 | 67.1 | 67.3 |
| R2 | | 0 | 0 | 0 | 0 | 22.2 | 22.1 | 22 |
| R3 | | | 0 | 0 | 0 | 22.2 | 22.1 | 22 |
| R4 | | | | 0 | 0 | 22.2 | 22.1 | 22 |
| R5 | | | | | 0 | 22.2 | 22.1 | 22 |
| R8 | | | | | | 0 | 0.1 | 0.2 |
| R9 | | | | | | | 0 | 1.5 |
| R10 | | | | | | | | 0 |

The resulting sub route for sub route 2 is G – R2 – R3 – R4 – R5 – R9 –R8 – R10 – G with a distance of 45 + 0+ 0 + 0 + 22.1 + 0.1 + 0.2 + 67, 3 = 134.7 km

**Troubleshooting Analysis**

**1. Distribution sub route analysis**

The proposed sub-route formation has taken into account the distance traveled and the use of the capacity of the conveyance used in distributing the goods. The formation of the sub-route starts from

the merging of two retailer areas that have the largest distance savings, but by taking into account the total load transported (Martono and Warnars, 2020). Comparison between distribution sub routes used by PT. Sukun Transport Logistics with Sub Routes proposed using the saving matrix method can be seen in table 9. When depicted in the form of a map can be seen in figure 2 - figure 4.

**Table 9.** Comparison of Distribution Sub Routes

| Company Sub Route | Order | Sub-Route Saving Matrix proposal | Order |
|---|---|---|---|
| 1 | G – R12 – R16 – G | 1 | G – R12 – R16 – R6 –R7 – R11 – R15 – R14 – R1 – R13 – G |
| 2 | G – R1 – R10 – R11 – R13 – R14 – G | 2 | G – R2 – R3 – R4 – R5 – R9 –R8 – R10 – G |
| 3 | G – R2 – R3 – R4 – R5 – R6 – R7 – R8 –R9 – R15 – G | - | - |

## 2. Company Initial Sub Route

Sub Route 1:
G – R12 – R16 – G

Sub Route 2:
G – R1 – R10 – R11 – R13 – R14 – G

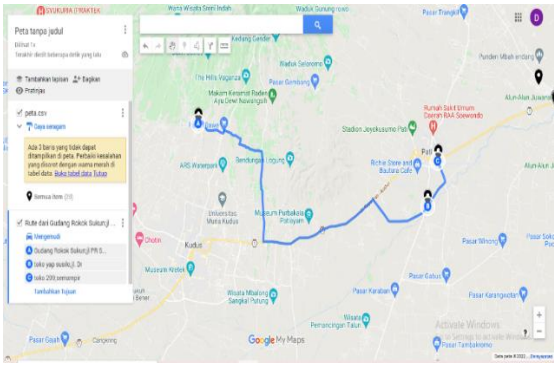

**Figure 2.** Sub route 1 company

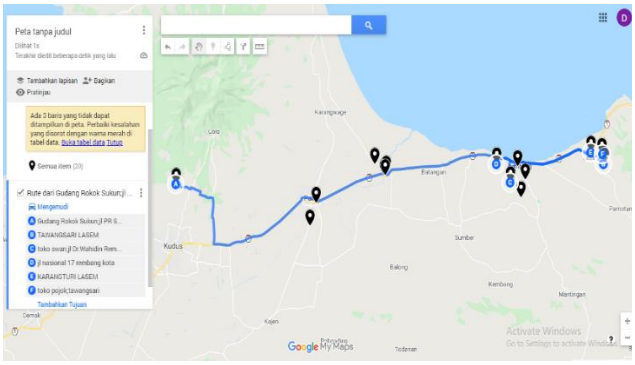

**Figure 3.** Sub-route 2 companies

Sub Route 3:
G – R2 – R3 – R4 – R5 – R6 – R7 – R8 –R9 – R15 – G

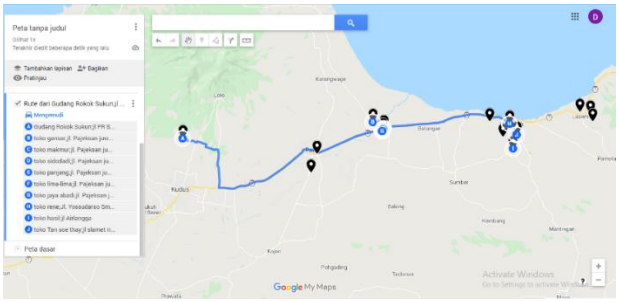

**Figure 4.** Sub-route 3 companies

## 3. Saving Matrix proposed sub route

Sub Route 1:
G – R12 – R16 – R6 –R7 – R11 – R15 – R14 – R1 – R13 – G

Sub Route 2:
G – R2 – R3 – R4 – R5 – R9 –R8 – R10 – G

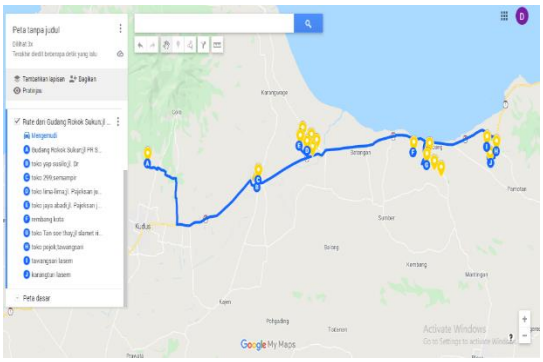

**Figure 5.** Sub-route 1 proposed saving matrix

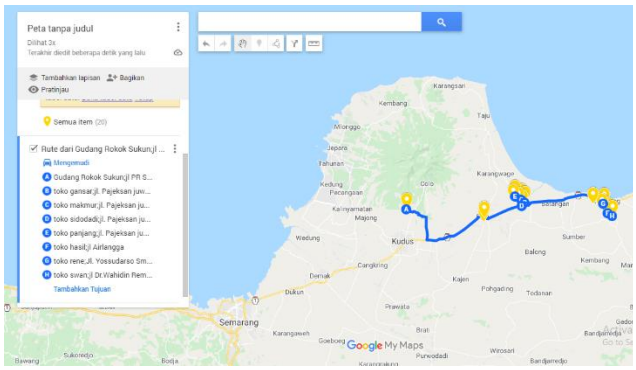

**Figure 6.** Sub route 2 proposed saving matrix

From Table 9 there is a reduction in the sub-routes built on the suggested distribution route using the Saving Matrix method compared to the sub-routes that the company has run so far. Each of the proposed distribution routes has 2 sub routes, while the company's distribution routes have 3 sub routes. All sub routes use vehicles with the same capacity. Figure 2 - 6 is the result of a comparison of the company's sub-routes with the supply sub-routes using the saving matrix method.

Determination of the optimal delivery distribution route is influenced by the distance to be traveled in the process of distributing goods. The further the distance traveled, the longer the travel time of the transport vehicle used and conversely the shorter the distance traveled, the time required to carry out the distribution process will be shorter.(Supardi and Sianturi, 2020). The distance traveled from the initial and proposed distribution sub-routes is shown in the following table:

**Table 10.** Comparison of Distribution Distance

| Company Sub Route | Company Mileage (km) | Sub-Route Saving Matrix proposal | Proposed Mileage (km) |
|---|---|---|---|
| 1 | 49.7 | 1 | 164.3 |
| 2 | 117.9 | 2 | 134.7 |
| 3 | 145.4 | - | - |
| Total | 313 | Total | 299 |

$$\text{distance saving} = \frac{total\ initial\ distance - total\ proposed\ distance}{total\ initial\ distance} \times 100\%$$

$$= \frac{313-299}{313} \times 100\%$$

$$= \frac{14}{313} \times 100\% \approx 4.47\%$$

Based on the above calculation, it can be seen that the mileage savings in cigarette shipments is 4.47% from the company's initial mileage.

## 4. Distribution Time Analysis

From the available distribution time, which is 420 minutes, a good sub route has a time below the available distribution time. The feasibility of each sub route can be seen in table 11.

**Table 11.** Comparison of Distribution Time

| Sub Route | Available Time (Minutes) | Distribution Time | | Feasibility Estimate |
|---|---|---|---|---|
| | | Company Route | Saving Matrix Proposed Route | |
| 1 | 420 | 114 | 336 | *Feasible* |
| 2 | 420 | 273 | 282 | *Feasible* |
| 3 | 420 | 395 | | |
| | Total | 782 | 618 | |

$$\text{Time saving} = \frac{total\ initial\ time - total\ proposed\ time}{total\ start\ time} \text{ x } 100\%$$
$$= \frac{782-618}{782} \text{ x } 100\%$$
$$= \frac{164}{782} \text{ x } 100\%$$
$$= 20.97\%$$

Based on the calculation above, it can be seen that the distribution time of cigarette delivery is 20.97% from the company's initial distribution time.

### 5. Distribution Cost Analysis

Comparison of the distribution costs of transport vehicles on the proposed sub-route with the sub-route used by the company can be seen in table 12.

**Table 12.** Comparison of Distribution Costs

| Sub Route | Company Distribution Costs (IDR) | Proposed Distribution Fee (IDR) |
|---|---|---|
| 1 | 50,718 | 222,442 |
| 2 | 219,800 | 190,618 |
| 3 | 284,200 | |
| Total | 554,718 | 413.060 |

$$\text{Cost savings} = \frac{total\ initial\ cost - total\ proposed\ cost}{total\ initial\ cost} \text{ x } 100\%$$
$$= \frac{554.718-413.060}{554.718} \text{ x } 100\%$$
$$= \frac{141.658}{554.718} \text{ x } 100\%$$
$$= 25.53\%$$

Based on the calculation above, it can be seen that the distribution cost savings for cigarette shipments is 25.53% from the company's initial distribution costs.

### 6. Analysis of the Number of Transport Vehicles and Utilities

The determination of the number of transport vehicles allocated by the company is influenced by the total time required for transport vehicles to distribute products and the amount of time available for transport vehicles to be operated. The less the total time required to distribute the product, the less the number of transport cars allocated to product distribution.Paillin and Kaihatu, 2018).

By using the saving matrix method, PT. Sukun Transport Logistics can save distribution costs by only allocating 2 units of transport vehicles on the type of colt diesel with a capacity of 400 bales from 2 different vehicles previously. Where the company's initial delivery used 1 unit of colt diesel vehicle with a capacity of 400 bales and 1 unit of kuzer vehicle with a capacity of 700 bales. so as to maximize the load capacity of the vehicle and minimize shipping costs.

The calculation of the utility obtained from the demand for each sub route divided by the capacity of the conveyance, the results of the calculation of the average utility are:

$$\text{Sub Route 1 Utility} = \text{x } 100\% \frac{number\ of\ goods\ transported}{conveyance\ capacity}$$
$$= \frac{370}{400} \text{ x } 100\%$$
$$= 92.5\%$$

$$\text{Sub Route 2 . Utility} = \text{x } 100\% \frac{number\ of\ goods\ transported}{conveyance\ capacity}$$
$$= \frac{390}{400} \text{ x } 100\%$$
$$= 97.5\%$$
$$\text{Average utility} = \frac{\Sigma sub\ route\ utility}{delivery\ quantity}$$
$$= \frac{92,5 + 97,5}{2}$$
$$= 95\%$$

From the calculation of the average utility is 95%, the result of this calculation is an increase from the company's actual utility which is 48.01%.

## CONCLUSION

The formation of sub-routes on the proposed route using the saving matrix method resulted in fewer sub-routes than the distribution route applied by PT. Sukun Transport logistics in product distribution to 16 retailers in the Juwana and Rembang areas while still using 2 transport vehicles, where the proposed sub-routes obtained are 2 sub-routes. First sub routeG – R12 – R16 – R6 –R7 – R11 – R15 – R14 – R1 – R13 – Gwith the total distance obtained is 164.3 km and sub route 2G – R2 – R3 – R4 – R5 – R9 –R8 – R10 – Ghas a distance of 134.7 km. The comparison of the distance on the company's initial route with 3 sub routes has a distance of 313 km while the proposed route with the saving matrix method produces a more optimal route than the total distance of the distribution route applied by the company, which obtains 2 sub routes with a total distance of 299 km. So that the mileage savings of 14 km or 4.47%. The comparison of distribution time on the company's initial route with 3 sub routes has an estimated time of 782 minutes, while the proposed route using the saving matrix method obtains 2 sub routes with a total time of 618 minutes and the estimated feasibility is feasible. So that the time savings of 164 minutes with a percentage of savings of 20.97%. Comparison of distribution costs on the company's initial route with 3 sub routes of Rp554,718. Meanwhile, the proposed route using the saving matrix method obtained 2 sub routes with a total distribution cost of Rp. 413.060. So that the distribution cost savings of Rp. 141,658 or 25.53%.

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