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Solving the Travelling Salesman Problem (Tsp) Using Saving Matrix Method (Case Study at Company of Xyz)

Muchammad Fauzi[1], Arief Rahmana[2], Verani Hartati[3]

Abstract: *One of the keys to success in implementing Supply Chain Management is to implement a good distribution and transportation network strategy. Transportation and distribution management is designing, organizing, commanding, coordinating, and controlling the process of moving objects or goods from the point of origin to point of destinations to facilitate the delivery of goods and or services from producer to consumers. The purpose this study is to show the best routes taken by considering the demand and transport capacity. Saving Matrix Methods to obtain the most appropriate and optimal product shipping routes to minimize transportation costs and obtain transportation cost savings. Based on the results of the discussion on the application of the Saving matrix method, the distribution route by considering the demand per week and the transport capacity per one transport is O → B → C → O → D → A → O. Because of the once transport capacity of 105 gallons, then after pickup send to destination B and C, pickups must return to O to load gallons to be distributed to destinations D and A.*

Keywords: *distribution, transportation, saving values*

I. INTRODUCTION

In an effort to minimize transportation costs, companies must attention to the existing transportation network system (Suparjo, 2017). Transportation is defined as the transfer of goods and people from the place of origin to the destination (Nasution, 2004) . One of the keys to success in implementing Supply Chain Management is to implement a good distribution and transportation network strategy. The role of distribution and transportation networks is very vital for the company. The company's ability to deliver products to consumers in a timely and accurate way determines the success of a product on the market (Sianipar, Fu'ani, Sutopo, & Hisjam, 2017).

XYZ Company is a mineral water distributor company in Bandung with gallon packing. Distributors must send gallons to four mini markets every day at different locations and return to the distributor's point (Fauzi & Anwar, 2019). The results of (Fauzi & Anwar, 2019) show the total optimal distance of XYZ company is 38.5 km. In this study not yet considering consumer demand and transport capacity. In this study aims to determine the distribution sequence route to produce the optimal total mileage by considering consumer demand and transport capacity.

Based on these problems, one of the methods used to solve the problem of shipping routes, namely the method of Saving Matrix, and the method is considered the best procedure among The Nearest Neighbor, Farthest Insert and Nearest Insert (Sarjono, 2014) . The use of Saving Matrix and Nearest Neighbor Methods in this study aims to obtain the most appropriate and optimal product shipping routes to minimize transportation costs and obtain transportation cost savings (Momon S & Ardiatma, 2018). The benefits of this research are expected to be used as a reference in the application of the savings matrix method in minimizing shipping costs and providing input for companies to design an effective distribution

[1] Industrial Engineering Department, Engineering Faculty, Widyatama University
muchammad.fauzi@widyatama.ac.id
arief.rahmana@widyatama.ac.id
verani.hartati@widyatama.ac.id

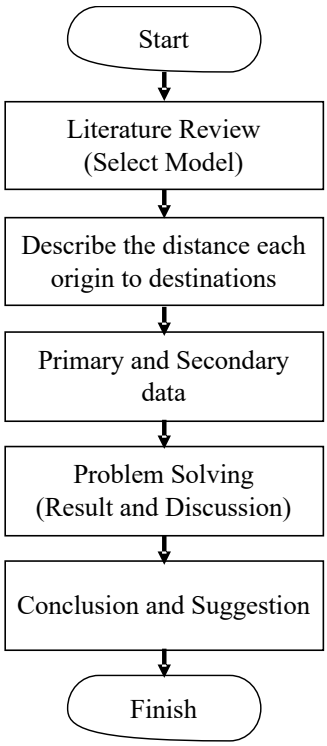
schedule to minimize transportation costs, determine capacity, and use the right number of vehicles (Supriyadi, Mawardi, & Nalhadi, 2017).

Formulating of The Problem

In previous studies (Fauzi & Anwar, 2019) the determination of distribution routes did not consider the demand for each destination and transport capacity. In this study, we want to show the route taken by considering the demand and transport capacity.

II. METHODOLOGY

The data needed in this study is a road map, distance data for each trip, the type of vehicle being hammered, the carrying capacity of the type of vehicle and demand data. The flow of the research methodology is shown in Figure



1.

Figure 1. Flow of the research methodology

III. RESULT AND DISCUSSION

Based on (Fauzi & Anwar, 2019), XYZ Company is located at Jl. Soekarno Hatta No. 608E Bandung and destination locations are shown in Table 1.

Tabel 1. Data Location of Destination

No	Name of Destination	Road Name of Destination	Location Code
1	Point Braga 52	Jl. Braga No. 52	A
2	Point Ciumbuleuit	Jl. Ciumbuleuit No. 153 Hegarmanah	B
3	Point Dipati Ukur 85	Jl. Dipati Ukur No. 85	C
4	Point Stasiun Selatan	Jl. Stasiun Selatan	D

Based on the results (Fauzi & Anwar, 2019), the optimal total distance from Table 1 data is 38.5 km with the route shown in Figure 2.

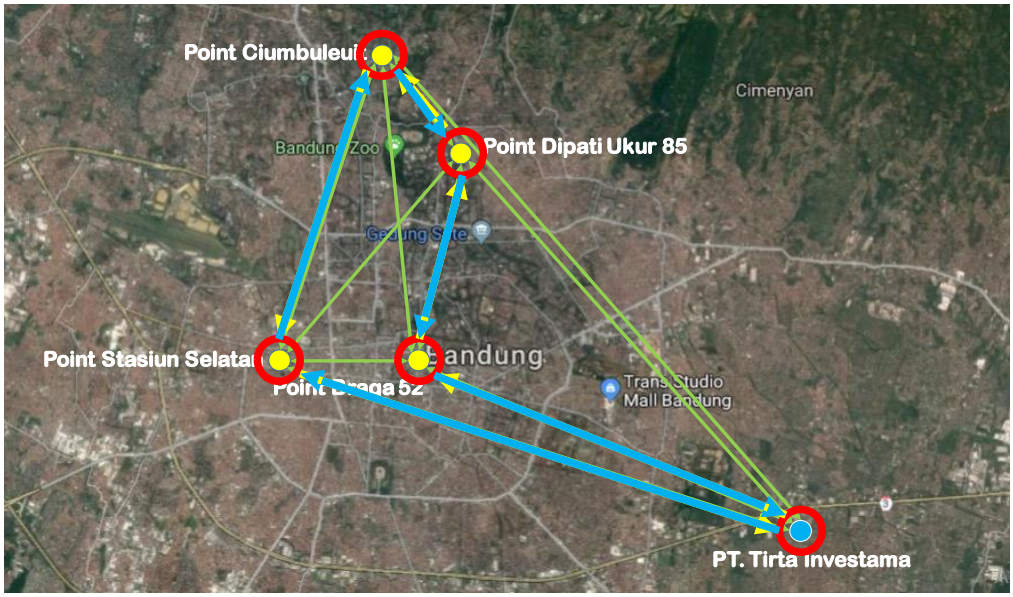


Figure 2. The optimal route with Branch and Bound Method

Based on analysis and discussion on implemented the Branch and Bound Method, it can be concluded the best routes with shortest distance are:

1. Route 1: O-A-C-B-D-O

Jln. Soekarno Hatta No. 608E (origin) → Jln. Braga No. 52 → Jln. Dipati Ukur No. 85 → Jln. Ciumbuleuit No. 153 Hegarmanah → Jln. Stasiun Selatan → Jln. Soekarno Hatta No. 608E (origin), total distance 38,5 km.

2. Route 2: O-D-B-C-A-O Jln. Soekarno Hatta No. 608E (origin) → Jln. Stasiun Selatan → Jln. Ciumbuleuit No. 153 Hegarmanah → Jln. Dipati Ukur No. 85 → Jln. Braga No. 52 → Jln. Soekarno Hatta No. 608E (origin), total distance 38,5 km.

In the research of (Fauzi & Anwar, 2019), the mileage is symmetrical. In this research the distance is not symmetrical. Mileage data is shown in Table 2.

Table 2. Distance matrix data

		Destination (km)				
		O	**A**	**B**	**C**	**D**
Origin (km)	**O**	0	9,9	15,1	13,3	12,6
	A	11,8	0	6,4	4,7	5,2
	B	17,5	7,1	0	2,5	8,8
	C	14,5	6,1	2,7	0	9,6
	D	13,4	2,5	7,7	5,9	0

Source: google.maps

According to (Tirtawening PDAM Kota Bandung, 2020), the average production from January to March 2012 is 15.119 gallons, so the average monthly production is 5.067 gallons. Based on these data, this study predicts the demand for gallon bottled water at each retailer's point by multiplying the average monthly production multiplied by the percentage of population in each district as shown in Table 3.

Tabel 3. Possible Demand

No	Name of Destination	Percentage of population	Average of demand (gallon per month)	Possible demand (gallon per month)	Possible demand (gallon per week)
1	Point Braga 52 (Sub district Sumur Bandung)	1,29%	5.067	66	17
2	Point Ciumbuleuit (Sub district Cidadap)	2,47%	5.067	125	32
3	Point Dipati Ukur 85 (Sub district Coblong)	5,12%	5.067	260	65
4	Point Stasiun Selatan (Sub district Andir)	3,49%	5.607	177	45

Source: (Badan Pusat Statistik Kota Bandung, 2020)

In the process of moving and distribution gallons from the origin point to the destination point, a mode of transportation is required. Transportation and distribution management is designing, organizing, commanding, coordinating, and controlling the process of moving objects or goods from the point of origin to point of destinations to facilitate the delivery of goods and or services from producer to consumers. Distribution is one aspect of marketing that seeks to expedite and facilitate the delivery of goods and services from producers to consumers, so that users are in accordance with the type, quantity, price, place, and when needed (Chois, Kurniawan L, & Sihombing, 2018). The appropriate mode of transportation for this case is the mode of road transportation using a truck transport. The trucks used in the distribution process are pickup gallon rack custom pickups as in Figure 3 and gallon specifications as in Figure 4.

Figure 3. Gallon Rack Custom Open Tub Pickup

Source: (Adicitra Bhirawa, 2020)

Figure 2 has specifications of length 260 cm, width 170 cm, and height 120 cm with a maximum load of 2.000 kg.

Figure 4. Gallon 19 litters

Source: (Sejahtera Houseware, 2020)

Figure 4 has a size of 50 cm high, 24 cm in diameter, and weighs 19 litters. The pickup in Figure 3 has a gallon carrying capacity of 19 litters as follows:

$$\frac{Pickup\ Length}{Gallon\ diameter} \times \frac{Pickup\ Width}{Gallon\ diameter} \times Pickup\ level\ \times One\ gallon\ load \leq Maximum\ load\ pickup$$

$$\frac{260\ cm}{24\ cm} \times \frac{170\ cm}{24\ cm} \times 2\ level \times 19\ litters\ \leq 2000\ kg$$

$$10 \times 7 \times 2 \times 19\ litters * \ \leq 2000\ kg$$

$$2660\ kg\ \neq 2000\ kg$$

*1 litters = 1 kg

Because the transport load exceeds the maximum capacity of pickup, the total carrying capacity must be reduced to the maximum limit of pickup transport to 105 gallons (1.995 kg). To determine the distribution order route to produce the optimal total mileage by considering consumer demand and transport capacity. The following is the discussion:

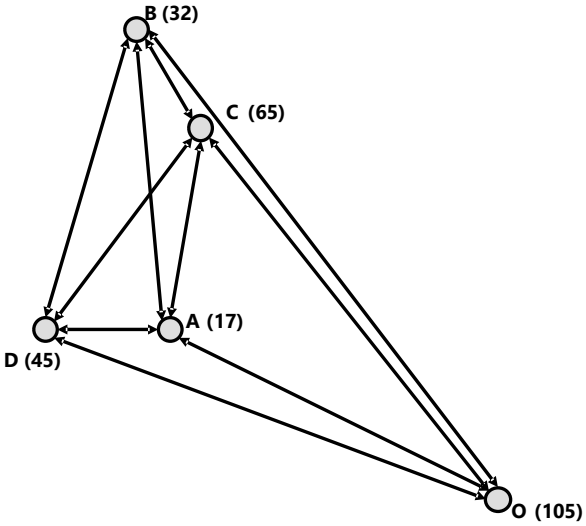


Figure 5. Possible route

Based on Figure 5 can calculate the mileage savings for each route as in Table 4.

Table 4. Saving values of distance

		Destination (km)				
		O	A	B	C	D
Origin	O					
	A			20,5	20,4	19,2
	B		20,3		28,3	21,3
	C		18,3	26,9		17,5
	D		20,8	20,8	20,8	

Based on Table 4, then the value of distance savings is sorted based on the highest saving value as in Table 5. The first order becomes the priority of the route to be taken because it produces the biggest distance savings. Next, each route is tested taking into account the demand for each destination and the carrying capacity from the starting point.

Table 5. Order of saving values of distance

No	**Routes**	**Saving values (km)**
1	O – B – C – O	28,3
2	O – C – B – O	26,9
3	O – B – D – O	21,3
4	O – D – A – O	20,8
5	O – D – B – O	20,8
6	O – D – C – O	20,8
7	O – A – B – O	20,5
8	O – A – C – O	20,4
9	O – B – A – O	20,3
10	O – A – D – O	19,2
11	O – C – A – O	18,3
12	O – C – D – O	17,5

Based on Table 5, the optimal distribution route is O → B → C → O → D → A → O with a total distance of 59 km shown in Figure 6.

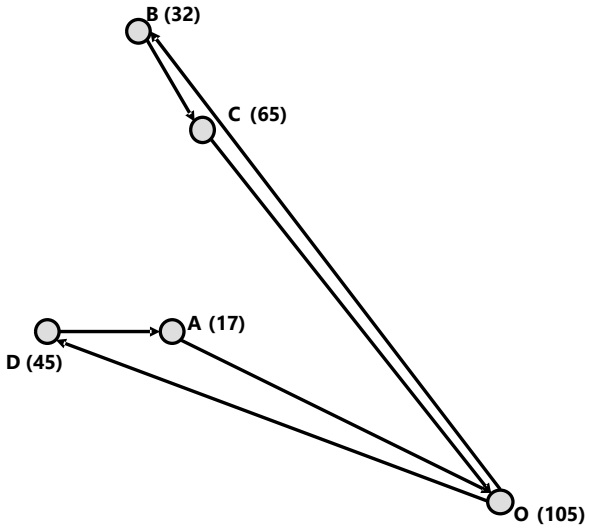


Figure 6. Best route

IV. CONCLUSION

Based on the results of the discussion on the application of the Saving matrix method, the distribution route by considering the demand per week and the transport capacity per one transport is O → B → C → O → D → A → O. Because of the once transport capacity of 105 gallons, then after pickup send to destination B and C, pickups must return to O to load gallons to be distributed to destinations D and A. The following is the order of the route:

(O) Jl. Soekarno Hatta No. 608E (origin) → (B) Jl. Ciumbuleuit No. 153 Hegarmanah → (C) Jl. Dipati Ukur No. 85 → (O) Jl. Soekarno Hatta No. 608E (origin) → (D) Jl. Stasiun Selatan → (A) Jl. Braga No. 52 → (O) Jl. Soekarno Hatta No. 608E (origin).

Suggestion

The suggestion for this research is to analyze the total transportation costs.

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