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DETERMINATION OF DELIVERY FUEL DISTRIBUTION ROUTES TO MINIMIZE TOTAL DISTRIBUTION COSTS WITH THE SAVING MATRIX METHOD AT PT. ENERGI NIAGA UTAMA

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ABSTRACT

Transportation and distribution are two components that affect a company's competitive advantage because a decrease in distribution costs can indirectly increase the company's profits. The higher the level of competition, it requires companies to be able to make good distribution strategies. Some of the problems that exist in PT. Energi Niaga Utama in distributing diesel fuel to companies is the delay in the distribution process, in which diesel fuel uses a 16 KL tank car. Therefore, this study wants to minimize the total route and distribution costs to provide profits and minimize company losses. In this study, the determination of the saving matrix method helps solve distribution problems. Based on the calculation using the saving matrix method, two stages of delivery were obtained with as many as 12 shipping routes so that each company did not delay the delivery of diesel fuel for the company's initial route distance of 2,018.6 km with a total distribution cost of Rp. 11.959.158, by using the saving matrix method, can provide distance savings of 1,552.8 km with a total distribution cost of Rp. 11.300.240, the percentage of distance savings is 23.07%, and the percentage of distribution cost savings is 5.5%.

Keywords: distribution, distribution cost, routes, saving matrix

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1. INTRODUCTION

In the world of industry, distribution plays a vital role for companies. Distribution is a set of dependent organizations involved in the processes that make a product or service available for use or consumption by consumers or business users. So, in this case, distribution has the task of delivering products or services produced by companies or producers to consumers or industrial consumers (Heryanto, 2015). In the world of distribution, industry plays a vital role for companies. Distribution is a set of dependent organizations involved in the processes that make a product or service available for use or consumption by consumers or business users. So, in this case, distribution has the task of delivering products or services produced by companies or producers to consumers or industrial consumers (Supardi and Sianturi, 2020). The process of doing this distribution, of course, using a vehicle as a means of transporting goods with different loading capacities and distances in determining the route that the vehicle takes in one way where the road that is passed must be a passable road for large vehicles.

PT. Energi Niaga Utama has served many consumers from various regions of East Java. The company is having delays in delivering diesel fuel to consumers, where the delivery or distribution of diesel fuel has a delivery route from the company to the consumer and back to the company again. Determining the road in the allocation of diesel fuel is very important for any small-scale or large-scale distribution company, errors in determining distribution routes and delivery delays can reduce profits and cause many losses.

The research was conducted to minimize the total route distance and distribution costs by using the saving matrix method at PT. Main Commercial Energy. The saving matrix method determines the distance, route, time, or cost of shipping goods from the company to the consumer.

Based on this, the saving matrix method is expected to contribute to solving the problem of delays in the delivery of diesel fuel products so that the shortest distance or route can be obtained, which will become an effective and efficient diesel fuel delivery route at PT. Energi Niaga Utama can minimize the distribution costs of diesel fuel so that there is no swelling in distribution costs.

2. LITERATURE REVIEW

2.1 Distribution

The general definition of distribution is the movement of goods through physical channels to distributors and retailers for sale to end users. Prospective customers can get information and consultation from a service agent, either face-to-face, online, by telephone, or via email, then customers can place an order(Aziza and Rahayu, 2019).

2.2 Transportation

Transportation is the movement of people or goods from one place to another using a vehicle that a machine or human drives. Transportation is used to make it easier for humans to carry out their daily activities. Transportation is closely related to lifestyle, reach, location of productive activities, and goods and services available for use (Wahab, 2019).

2.3 Vehicle Routing Problem

VRP is a problem scope in which there is a problem where there are many routes for many vehicles in one or more depots which must be determined to be geographically dispersed to serve dispersed consumers. Every vehicle has a carrying capacity, and every consumer has a demand. The purpose of VRP is to deliver products to consumers at a minimum cost through vehicle routes in and out of the depot Fakhturahman, 2021).

2.4 Shortest Path

The minimum path is the minimum path needed to approach a location from a specific place. The minimum path can be solved by applying a graph. The graph used is a value graph, where each edge of the chart has a value. The shortest route problem is finding the route of two or more valuable graph points, a combination of the importance of the graph sides that are passed with the least amount. Value can show the distance from one place to another, travel time, travel costs, and others (Retnowati and Lutfiyana, 2018).

2.5 Nearest Insert

This method is the opposite of the farthest insert method, where this procedure starts by determining the vehicle's route to the consumer who has the closest distance. Then this procedure

will continue to repeat until all consumers enter the route (Andi, 2017).

2.6 Saving Matrix

A Saving matrix is a method used to determine the distance, route, time, or cost in the delivery of goods from the company to consumers. This method aims to make the delivery of goods according to consumer orders can be done effectively and efficiently so that companies can save costs, energy, and delivery time. The saving matrix method consists of several steps. The steps in the saving matrix method are as follows:

1. Determine the distance matrix
   Data on the distance between companies and locations and locations to other sites is essential in determining this distance matrix.
2. Determine the savings matrix
   In finding the savings matrix, can use the following formula:
   s(x,y) = J(G,y) + J(G,y) – J(x,y)
   S(x,y) It is a distance saving that is from merging route x with route y.
   J : distance
   G : company
   x : first customer distance
   y : second customer distance
3. Vehicle and route allocation
   Once the savings matrix is known, the next step is to allocate locations to routes or vehicles. This means that in this step, a new shipping route will be determined based on the merging of routes in the second step above.
4. Ordering Destination Locations in a Route
   This step determines the order of visits
   In this study, the order of visits using the nearest insert method is used (Suparjo, 2017).

3. FINDINGS AND DISCUSSION

3.1 Data Collection Process

The request data used is using past data for 1 month. The distance data between customers is obtained from interviews with the company with 14 customers.

Table 1*. Demand for Diesel Fuel*

No	Customer	Demand	
		Stage I	Stage II
1	PT. Mitra Dharma Laksana	8.000	12.000
2	PT. Dewata Cipta Semesta	8.000	6.000
3	PT. Bandar Bahari Permai	8.000	4.000
4	PT. Petro Jordan Abadi	8.000	12.000
5	PT. Golfindo Intikayu Pratama	8.000	2.000
6	PT. Petrokopindo Cipta Selaras	8.000	4.000
7	PT. Harang Bumi Energi	8.000	12.000
8	PT. Integra Indocabinet	8.000	8.000
9	PT. Berkah Aneka Laut	8.000	0
10	PT. Mitra Indonesia Makmur Sejahtera	8.000	0
11	PT. Bahana Multi Teknik	8.000	0
12	CV. Building Material Construction (BRICON)	8.000	12.000
13	PT. Mulia Grand Manufacture	8.000	4.000
14	PT. Duta Bangsa	8.000	0

3.2 Method Of Collecting Data

The data collection methods carried out are as follows:

1. Study Of Literature
   It is a method used by researchers to collect reliable and relevant materials and information for conducting an assessment related to what is being studied.
2. Field Study
   It is a way to collect or obtain data in the form of primary data or secondary data obtained.

The data used are as follows:

1. Customer location
2. Distance between customers
3. Each customer's demand
4. Company starting route
5. Transport vehicle

6. Distribution cost

4. RESULT AN DICUSSION

4.1 Distance Between Depot and Customer

PT. Energi Niaga Utama distributed 14 customers in the East Java area. Distribution is done from the depot and then distributed to companies on demand. The mode of transportation used by PT. Energi Niaga Utama distributes diesel fuel to customers in tank trucks. The capacity of the tanker truck used at the time of the study was 16 kl. The fuel costs incurred depend on the vehicle size. The greater the cost per kilometre. The price per kilometre for each capacity can be seen in the table.

Each tanker truck requires one driver. The driver's salary is included in the cost of transportation in this study.

***Table 2**. Distance from Depo to Customer*

No	Customer	Distance (km)
1	PT. Mitra Dharma Laksana	2,3
2	PT. Dewata Cipta Semesta	9,1
3	PT. Bandar Bahari Permai	4,6
4	PT. Petro Jordan Abadi	32
5	PT. Golfindo Intikayu Pratama	24
6	PT. Petrokopindo Cipta Selaras	31
7	PT. Harang Bumi Energi	93
8	PT. Integra Indocabinet	30
9	PT. Berkah Aneka Laut	116
10	PT. Mitra Indonesia Makmur Sejahtera	182
11	PT. Bahana Multi Teknik	122
12	CV. Building Material Construction (BRICON)	63
13	PT. Mulia Grand Manufacture	24
14	PT. Duta Bangsa	86

***Table 3** Address Customer*

No	Customer	Address
1	PT. Mitra Dharma Laksana	Jl. Nilam Utara, Gudang 502, Surabaya
2	PT. Dewata Cipta Semesta	Jl. Tanjungsari No. 38, Surabaya
3	PT. Bandar Bahari Permai	Jl. Kalimas Timur No. 222, Surabaya
4	PT. Petro Jordan Abadi	Jl. Raya Roomo, Manyar, Gresik
5	PT. Golfindo Intikayu Pratama	Jl. Raya Kepatihan No.7, Gresik
6	PT. Petrokopindo Cipta Selaras	Jl. Dr. Wahidin SH. No.126, Gresik
7	PT. Harang Bumi Energi	Desa Menyunyur Kec Grabangan,Tuban
8	PT. Integra Indocabinet	Jl. Raya Betro, Sidoarjo
9	PT. Berkah Aneka Laut	JL. Lingkar Utara, Probolinggo
10	PT. Mitra Indonesia Makmur Sejahtera	Jl. Maospati – Solo, Kec. Geneng, Ngawi
11	PT. Bahana Multi Teknik	Jl. Bojonegoro - cepu KM 8 Leran - Kalitidu - Bojonegoro
12	CV. Building Material Construction (BRICON)	Jl. Raya Mojosari KM 4,3 Trawas, Mojokerto
13	PT. Mulia Grand Manufacture	Jl. Raya Kepatihan No. 89, Gresik
14	PT. Duta Bangsa	Jl. Raya Bromo, Kec. Pasrepan, Pasuruan

4.2 Starting Route and Distance

Based on Table 1 customer requests, the total distance travelled for the initial route for diesel fuel distribution is as follows:

Table 4 *Starting Route and Distance*

No	Customer	Distance (km)
1	Depo - PT. Mitra Dharma Laksana - Depo	9,2
2	Depo - PT. Dewata Cipta Semesta - Depo	18,2
3	Depo - PT. Bandar Bahari Permai - Depo	9,2
4	Depo - PT. Petro Jordan Abadi - Depo	128
5	Depo - PT. Golfindo Intikayu Pratama - Depo	48
6	Depo - PT. Petrokopindo Cipta Selaras - Depo	62
7	Depo - PT. Harang Bumi Energi - Depo	372
8	Depo - PT. Integra Indocabinet - Depo	60
9	Depo - PT. Berkah Aneka Laut - Depo	232
10	Depo - PT. Mitra Indonesia Makmur Sejahtera - Depo	364
11	Depo - PT. Bahana Multi Teknik - Depo	244
12	Depo - CV. Building Material Construction (BRICON) - Depo	252
13	Depo - PT. Mulia Grand Manufacture - Depo	48
14	Depo - PT. Duta Bangsa - Depo	172

In table 4, the initial route of diesel fuel distribution, the company distributes from the depot to the customer and then back to the depot again with a total distance of 2,018.6 km.

4.3 Initial Route Distribution Costs

Below is a formula for calculating total distribution costs and Table 5 types of transportation equipment or fleets that will be used in distributing diesel fuel to customers. Table 6 distribution cost data such as fuel, food fees, user fees, and others are as follows:

Fuel cost:

: Total Mielage × 1/5 × Fuel price

total route distribution cost :

: Fuel cost + table money + Retribution fee + Driver salary

Table 5 *Transport Vehicle Data*

Transportation Type	Fuel	Consumtion	Capacity	Information
Truk Tangki Isuzu Giga	Solar	1 : 5	16.000 liter	One's Own

Table 6 *Distribution Cost Data*

No	Fee Type	Quantity
1	Fuel Cost	Rp. 5.150,-/liter
2	Table Money	Rp. 30.000,- / person
3	Retribution fee	Rp. 250.000,- / day
4	Driver salary	Surabaya Rp.200.000,- / delivery Gresik Rp. 230.000,- / delivery Sidoarjo Rp.260.000,- / delivery Mojokerto Rp. 310.000,- / delivery Pasuruan Rp. 340.000,- / delivery Tuban Rp. 340.000,- / delivey Bojonegoro Rp. 330.000,- / delivery Probolinggo Rp. 350.000,- / delivery Ngawi Rp. 460.000,- / delivery

Description: 1-litre tank truck can cover a distance of 5 km

Based on Table 4 of the initial route of distribution and Table 6 of distribution cost data, the total cost of distribution of the initial route is as follows:

Based on the calculation using the above formula, the recapitulation of the distribution costs of all routes can be seen in the table below:

Table 7. *Initial Distribution Cost*

No	Customer	Distributon Cost
1	Depo - PT. Mitra Dharma Laksana - Depo	Rp. 869.576

2	Depo - PT. Dewata Cipta Semesta - Depo	Rp. 448.746
3	Depo - PT. Bandar Bahari Permai - Depo	Rp. 439.476
4	Depo - PT. Petro Jordan Abadi - Depo	Rp. 1.151.840
5	Depo - PT. Golfindo Intikayu Pratama - Depo	Rp. 559.440
6	Depo - PT. Petrokopindo Cipta Selaras - Depo	Rp. 573.860
7	Depo - PT. Harang Bumi Energi - Depo	Rp. 1.623.160
8	Depo - PT. Integra Indocabinet - Depo	Rp. 601.800
9	Depo - PT. Berkah Aneka Laut - Depo	Rp. 1.164.920
10	Depo - PT. Mitra Indonesia Makmur Sejahtera - Depo	Rp. 1.164.920
11	Depo - PT. Bahana Multi Teknik - Depo	Rp. 868.960
12	Depo - CV. Building Material Construction (BRICON) - Depo	Rp. 1.439.560
13	Depo - PT. Mulia Grand Manufacture - Depo	Rp. 559.440
14	Depo - PT. Duta Bangsa - Depo	Rp. 797.160
	Total	Rp. 11.959.158

4.4 Distribution of Saving Matrix Method

4.4.1 Identify The Savings Matrix

	Depo (C0)	T1	T2	T3	T4	T5	T6
Depo (C0)	0						
T1	2,3	0					
T2	9,1	9,5	0				
T3	4,6	5	8,4	0			
T4	30	27,3	22,2	24,4	0		
T5	116	115	112	116	98	0	
T6	86	84	82	85	68	61	0

In calculating the distance savings from the depot to each customer and from one customer to another, use the following formula:

	Depo (C0)	B1	B2	B3	B4	B5	B6	B7	B8
Depo (C0)	0								
B1	32	0							
B2	24	19,3	0						
B3	31	1,8	20,7	0					
B4	93	76,5	79,4	75	0				
B5	182	181	162	179	105	0			
B6	122	106	109	104	36	69	0		
B7	63	59,1	53,1	57	119	170	131	0	
B8	24	20,8	2	21	78	175	107	37	0

Table 8. *East Line Distance Matrix (km)*

Table 9. *West Line Distance Matrix (km)*

Information:

The following code is used to be an indication of the company, namely : T1, T2, T3, T4, T5, T6, B1, B2, B3, B4, B5, B6, B7, B8

T1: PT. Mitra Dharma Laksana
T2: PT. Dewata Cipta Semesta
T3: PT. Bandar Bahari Permai
T4: PT. Integra Indocabinet
T5: PT. Berkah Aneka Laut
T6: PT. Duta Bangsa
B1 : PT. Petro Jordan Abadi
B2: PT. Golfindo Intikayu Pratama
B3: PT. Petrokopindo Cipta Selaras
B4: PT. Harang Bumi Energi
B5: PT. Mitra Indonesia Makmur Sejahtera
B6: PT. Bahana Multi Teknik
B7 : CV. Building Material Construction (BRICON)
B8 : PT. Mulia Grand Manufacture

4.4.2 Make Distance Matrix

Based on Table 8 and Table 9, the distance matrix can be calculated as follows:

Example of calculating the distance east line from the location T1 to T2

S(T1,T2) = J(D T1)+ J(D T2)-J(T1 T2)

S(T1,T2) = 2,3 + 9,1 – 9,5 = 1,9 km.

Calculation of distance savings from location T1 to T3

S(T1,T3) = J(D T1)+ J(D T3)-J(T1 T3)

S(T1,T3) = 2,3 + 4,6 – 5 = 1,9 km.

Example of calculating the distance saving for the west line from location B1 to B2

S(B1,B2) = J(D B1)+ J(D B2)-J(B1 B2)

S(B1,B2) = 32 + 24 – 19,3 = 36,7 km.

Calculation of distance savings from location B1 to B3

S(B1,B3) = J(D B1)+ J(D B3)-J(B1 B3)

S(B1,B3) = 32 + 31 – 1,8 = 61,2 Km

The summary of the results of the calculation of distance savings is shown in Table 10 and Table 11 below:

Table 10. *East Line Distance Saving Matrix*

	T1	T2	T3	T4	T5	T6
T1	0					
T2	1,9	0				
T3	1,9	5,3	0			
T4	5	16,9	10,2	0		
T5	3,3	13,1	4,6	48	0	
T6	4,3	13,1	5,6	48	141	0

Table 11. *West Line Distance Saving Matrix*

	B1	B2	B3	B4	B5	B6	B7	B8
B1	0							
B2	36,7	0						
B3	61,2	34,3	0					
B4	48,5	37,6	49	0				
B5	33	44	34	170	0			
B6	48	37	49	179	235	0		
B7	35,9	33,9	37	37	75	54	0	
B8	35,2	46	34	39	31	39	50	0

4.4.3 Allocating and Sequencing Customers into Routes

Based on the data in Table 1, Table 10 and Table 11, the ordering of the distribution of diesel fuel from the depot to the customer to returning to the depot uses the nearest insert method, with the order of visits as follows:

Table 12. *Alternative Route Formed*

Stage	Route	Alternative Route	Total Distance (Km)
1	1.	D – T6 – T5 – D	263
	2.	D – T2 – T4 – D	61,3
	3.	D – T1 – T3 – D	11,9
	4.	D – B6 – B5 – D	373
	5.	D – B3 – B1 – D	64,8
	6.	D – B8 – B7 – D	124
	7.	D – B2 – B4 – D	196,4
2	1.	D – T2 – T4 – D	61,3
	2.	D – T1 – T3 – D	11,9
	3.	D – B3 – B1 – D	64,8
	4.	D – B8 – B7 – D	124
	5.	D – B2 – B4 – D	196,4
	Total		1.552,8

Table 8 is an alternative route to be traversed using the nearest insert method. In stage I route one covers a distance of 263 km, route two a distance of 61.3 km, route three a distance of 11.9 km, route four a distance of 373 km, route five a distance of 64.8 km, route six a distance of 124 km and on route seven a distance of 196.4 km.

Furthermore, in stage II, on route one a distance of 61.3 km, route 2, a distance of 11.9 km, route three a distance of 64.8 km, route four a distance of 124 km and route five a distance of 196.4 km, for a total distance of 1,552.8 km.

Based on Table 8 route distribution distance of the saving matrix method and Table 6 transportation cost data, the total transportation costs incurred by the company in distributing diesel fuel to customers using the saving matrix method are as follows:

Table 13. *Distribution Cost Saving Matrix*

No	Customer	Distribution Cost
1	Depo - PT. Mitra Dharma Laksana - Depo	Rp. 869.576
2	Depo - PT. Dewata Cipta Semesta - Depo	Rp. 448.746
3	Depo - PT. Bandar Bahari Permai - Depo	Rp. 439.476
4	Depo - PT. Petro Jordan Abadi - Depo	Rp. 1.151.840
5	Depo - PT. Golfindo Intikayu Pratama - Depo	Rp. 559.440
6	Depo - PT. Petrokopindo Cipta Selaras - Depo	Rp. 573.860
7	Depo - PT. Harang Bumi Energi - Depo	Rp. 1.623.160
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9	Depo - PT. Berkah Aneka Laut - Depo	Rp. 1.164.920
10	Depo - PT. Mitra Indonesia Makmur Sejahtera - Depo	Rp. 1.164.920
11	Depo - PT. Bahana Multi Teknik - Depo	Rp. 868.960
12	Depo - CV. Building Material Construction (BRICON) - Depo	Rp. 1.439.560
13	Depo - PT. Mulia Grand Manufacture - Depo	Rp. 559.440

14	Depo - PT. Duta Bangsa - Depo	Rp. 797.160
	Total	Rp. 11.959.158

4.5 Comparison of Distance and Distribution Costs from Companies with Distance and Distribution Costs using The Saving Matrix Method

Comparing the distance and distribution costs from the start of the company with the distance and distribution costs using the saving matrix method. The following are the results of the comparison of distance and distribution costs after and before using the saving matrix method:

Table 14. *Comparison of The Total Distance and Initial Route Distribution Cost with The Saving Matrix Method*

Distance and Distribution Cost Comparison		
Route	Distance	Distribution Cost
Company Start	2.018,6 km	Rp. 11.959.158,-
Saving Matrix	1.552,8 km	Rp. 11.300.240,-
Savings	465,8 km	Rp. 658.918,-
Savings Precentage	23,07 %	5,5%

Distance saving :
: ((JAP – JSM))/(JAP)×100%
: (465,8 km)/(2.018,6 km) ×100%
: 23,07 %
Distribution cost savings :
: ((BDAP – BDSM))/(BDAP))×100%
: (Rp.658.918,-)/(Rp.11.959.158,-) ×100%
: 5,5 %
Information:
JAP : Company starting distance
JSM : Distance saving matrix
BDAP : Company initial distribution costs
BDSM : Distribution cost saving matrix

Based on Table 9, the calculation results above are obtained by distance savings of 465.8 km with a percentage of distance savings of 23.07% and distribution cost savings of Rp. 658,918 with a percentage of distribution cost savings of 5.5%.

5. CONCLUSION AND SUGGESTION

Company's initial route with a total distance of 2,018.6 km and a total distribution cost of Rp. 11.959.158, the route with the saving matrix method produces a total distance of 1,552.8 km and a total distribution cost of Rp. 11.300.240, the saving matrix method provides a shorter total distance and cheaper distribution costs with a distance savings of 465.8 km and a distance savings percentage of 23.07%, as well as the distribution cost savings of Rp. 658.198, with a cost-saving percentage of 5.5%, the saving matrix method provides the optimal solution for reducing the total distance and distribution costs.

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