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Efforts to Minimize Mileage and LPG Gas Fuel Costs for XYZ Distributors

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ABSTRACT

The distributor has a maximum tamping capacity of 290 units of 3 kg of LPG gas. Currently, 14 gas agents subscribe to this distributor, and it is part of the initial four-route distribution system. The initial route results in a daily total distance traveled of 114.6 km and a total fuel cost of Rp. 77,947. We obtain the total fuel costs per day based on the typical fuel usage of the product distribution vehicle type. Next, through the initial route and the spread of agents who subscribe to this distributor in various areas of Jakarta, the author finally sees the potential for savings in mileage and fuel costs, which is even better to be able to cut company operations in the form of mileage and fuel costs. To solve this distribution problem, you can use the saving matrix method to find the optimal route, and then use the nearest neighbor method to determine the order of arrival of vehicles for each route. The results of this research include four proposed routes. The total distance traveled in a day amount to 92.5 km, and the total fuel costs amount to IDR 62,991. If calculated in one month, there is a savings of 19.28% on the proposed route. The savings amount to IDR 448,680 in fuel costs and a distance traveled of 663 km.

ABSTRAK

Distributor XYZ yang terletak di Tanjung Priok, Jakarta Utara ini merupakan distributor gas LPG 3 kg yang akan mengirimkan produk berupa gas LPG 3 kg ke agen-agen gas yang tersebar di wilayah Jakarta setiap hari nya dengan menggunakan mobil pick up Mitsubishi L300 yang berjumlah 1 unit dengan daya tamping maksimal sebanyak 290 unit gas LPG 3 kg. Saat ini terdapat 14 agen gas yang berlangganan dengan distributor ini yang kemudian dimasukkan kedalam pembagian 4 rute awal. Berdasarkan rute awal, total jarak tempuh per hari sebesar 114,6 km dan total biaya BBM per hari sebesar Rp. 77.947. Total biaya BBM per hari didapatkan berdasarkan pemakaian BBM normal sesuai dengan tipe kendaraan yang dipakai untuk pendistribusian produk. Berikutnya melalui rute awal dan tersebarnya agen – agen yang berlangganan dengan distributor ini di berbagai wilayah Jakarta, sehingga akhirnya penulis melihat adanya potensi penghematan pada jarak tempuh dan biaya BBM yang lebih baik lagi untuk dapat memangkas operasional perusahaan berupa jarak tempuh dan biaya BBM. Untuk menyelesaikan permasalahan distribusi ini dapat menggunakan metode saving matrix untuk mendapatkan rute yang optimal, berikutnya menggunakan metode nearest neighbor untuk menetapkan urutan kedatangan kendaraan untuk setiap rutenya. Hasil dari penelitian ini yaitu mendapatkan 4 rute usulan. Dalam sehari, total jarak tempuh sebesar 92,5 km dan total biaya BBM yang akan dikeluarkan sebesar Rp. 62.991. Jika dikalkulasikan dalam sebulan, maka terdapat penghematan pada rute usulan sebesar 19,28%. Rincian penghematan tersebut terdapat pada jarak tempuh sebesar 663 km dan biaya BBM sebesar Rp.448.680.

DOI:	**Keywords:** Saving Matrix, Nearest Neighbor, Route Determination, Mileage Savings, Fuel Cost Savings
	Kata kunci: Saving Matrix, Nearest Neighbor, Penentuan Rute, Penghematan Jarak Tempuh, Penghematan Biaya BBM

INTRODUCTION

Recently, the government has been actively promoting the transition from kerosene to LPG (Liquid Petroleum Gas) through socialization efforts. This is attributed to the utilization of gas, which is more cost-effective, uncomplicated, and efficient in comparison to kerosene. Due to evolving circumstances, an increasing number of individuals are now considering and utilizing gas fuel for their household, business, and day-to-day requirements. Following the transition from kerosene to LPG gas, there has been a surge in the demand for LPG gas. PT. Pertamina has long anticipated this by establishing agent centers in each region, supported by sub-agencies and locations, to simplify the transportation of LPG gas throughout Indonesia (Ahsan & Lukmandono, 2021).

Considering heightened rivalry in the industrial realm, organizations must strive to remain competitive and adequately equipped to confront any potential hazards. Undoubtedly, corporations are obligated to offer assurances to their clients as a means of deterring them from switching to alternative competitors (Sugiarta, 2021). As a result, organizations offer a guarantee to fulfill client requirements by implementing effective planning and logistics, ensuring that products are delivered in the correct amount, without any damage or defects, within the agreed-upon timeline, and at a fair cost. Operational expenditures are a crucial expense that firms must consistently monitor. Operational costs refer to various expenses incurred by a company, regardless of its industry, and can also provide insights about the company's organizational framework. The presence of high or low operating costs in a company has a substantial influence on the determination of product pricing and the overall income of the organization (Firdaus & Putra, 2020). The company should seek the most efficient point of inventory for its products or goods, ensuring that the inventory aligns with supply and demand criteria and maximizes the cost-effectiveness of the company's invested capital (Sudirga et al., 2021).

The transportation and distribution processes are the primary factors that impact the company's spending. Supply chain management is a collaborative network of distributors that work together to efficiently distribute items to consumers (Nurprihatin et al., 2021). A corporation can accomplish cost minimization by implementing an effective and efficient sales procedure. An essential measure for enhancing the efficiency of a company's distribution process is to accurately ascertain the distribution routes, ensuring timely and cost-effective delivery of items to clients. In order to effectively conduct distribution, it is important to ascertain the customers to be visited and those to be included in the sequence of client visits utilizing the designated distribution vehicle (Dermawan, 2022).

To decrease the transportation costs for product distribution, organizations might identify existing logistics networks. In order to address this issue, organizations employ a technique to obtain suggestions for minimizing the expenses associated with product delivery (Noor et al., 2018). This transportation technique tries to optimize the variables involved in solving transportation challenges, namely the task of moving products from one location to another, with a focus on minimizing costs (Kurnia et al., 2021). The reason for this is that transportation expenses constitute the most significant portion of overall logistics expenditures, making up 70% of the total logistics costs. When distributing items, it is crucial to consider the transportation routes. Efficient product distribution can be achieved by selecting the most optimal route. The contractor bears full responsibility for the completely unacceptable delays (Regina et al., 2020).

The distributor has a surface area of 3.88 square meters and can hold a maximum weight of 2,345 kg. At now, there are 14 gas agents who are customers of this distributor. They are responsible for dividing the initial 4 routes, which collectively traverse a total distance of 114.6 km every day. The entire cost of fuel for these routes amounts to Rp. 77,947. The overall gasoline expenses per day are calculated based on the average fuel consumption of the specific kind of vehicle used for product distribution. Next, we will examine the initial route, which includes information on the distance covered and the daily fuel expenses. Additionally, we will analyze the distribution of agents subscribed to this distributor in different areas of Jakarta. This analysis aims to identify potential opportunities for reducing mileage and fuel costs, ultimately leading to further operational cost-cutting. The company gains advantages from reductions in terms of distance covered, expenses on fuel, time spent on travel, and energy use. To address this distribution problem, one can employ the saving matrix and nearest neighbor approaches. These methods ascertain the routes for distributing products to different delivery locations by considering the number of vehicles and their capacity. This ensures that the routes are optimized, and the transportation costs are suitable. minimized to the smallest extent.

METHODS

The first step was to identify issues pertaining to "BBM waste" due to the diminishing availability of fuel. This scarcity poses a significant threat to the global community, as it could lead to catastrophic consequences such as severe global warming. Consequently, researchers have taken an interest in investigating this matter. We conducted a survey of multiple companies involved in the distribution of products for the purpose of firsthand observation. It is essential to consider enterprises engaged in product distribution that are now experiencing significant and pressing fuel waste problems. We were intrigued by the XYZ Distributor, a research facility situated in Tanjung Priok, North Jakarta, because of its potential to achieve greater fuel efficiency and cost savings. This might lead to substantial reductions in the distance traveled, fuel expenses, travel time, and energy consumption associated with company operations. Upon identifying a research site for additional investigation, the researcher proceeded to conduct a face-to-face interview with the supervisor of distributor XYZ. This individual has comprehensive knowledge of the overall operations, distribution processes, and challenges encountered at distributor XYZ. After doing the supervisor interview, the researcher then begins to collect primary data, which is the process commonly referred to as data collection.

Upon completion of data gathering, we will proceed to analyze the data utilizing the saving matrix and nearest neighbor algorithm in the following manner:

1. *Saving Matrix*
   This stage represents the initial phase in the data processing procedure. In this stage, the distance matrix is calculated in the table using Google Maps. Subsequently, we will establish a savings matrix, identify the maximum value, and consolidate it into a singular route, on the condition that the load capacity is adequate. The quest for the maximum value persists until all agents discover their respective routes.

2. *Nearest Neighbor*
   This approach is employed to ascertain the sequence of visits to each agent. This method involves determining the nearest distance between the depot or prior agent and another agent located on the same route.

The outcome of data processing is the acquisition of a more efficient suggested route, resulting in reductions in both travel distance and fuel expenses for the distribution of products.

RESULTS AND DISCUSSION

Results

Table 1 displays the consumer statistics for distributor XYZ.

Table 1. Consumer Data (Distributor XYZ)

Agent Code	Agent Location	Average LPG Gas Demand	Distance (Km)
A1	Pegangsaan Dua, Kelapa Gading	60	7,4
A2	Sunter Jaya, Tanjung Priok	70	3,4
A3	Kapuk, Cengkareng	90	21
A4	Warakas, Tanjung Priok	70	6,6

A5	Rawa Bunga, Jatinegara	90	16
A6	Duri Selatan, Tambora	100	13
A7	Gambir, Gambir	50	8,5
A8	Rawa Badak Selatan, Tanjung Priok	80	8,2
A9	Pulo Gebang, Cakung	80	16
A10	Angke, Tambora	60	12
A11	Duri Kepa, Kebon Jeruk	100	17
A12	Harapan Mulya, Kemayoran	70	5,1
A13	Kwitang, Senen	70	8
A14	Pademangan Timur, Pademangan	70	3,3

Table 2 below presents the initial route data for distributor XYZ, calculated using Google Maps.

Table 2. Initial Route Data for September 2023

Initial Route	**Average LPG Gas Demand**	**Distance (Km)**	**Fuel Price / L (Rp)**	**Fuel Costs 1/10 L (Rp)**
D – A2 – A4 – A8 – A1	280	22,5	6.800	15.300
D – A9 – A5 – A13 – A7	290	41,2	6.800	28.016
D – A12 – A3 – A10	220	32	6.800	21.760
D – A14 – A6 – A11	270	18,9	6.800	12.871
Total	1.060	114,6	-	77.947

Saving Matrix

1. Distance Matrix

To carry out this computation, enter the distance between the depot and each agent, together with the distance between each agent and another agent, covering all 14 agents. To obtain this distance, you can utilize the Google Maps application, which will provide you with the desired distance. The distance matrix is presented in Table 3 below.

Table 3. Distance Matrix

Km	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11	A12	A13	A14
Depot	7,4	3,4	21	6,6	16	13	8,5	8,2	16	12	17	5,1	8	3,3
A1	0	6,4	24	12	14	16	11	7,8	8,3	17	19	8,7	12	9,7
A2		0	20	5,9	13	12	7,2	9,9	13	10	15	2,4	6,7	3,7
A3			0	18	24	9,4	14	23	31	8,9	6,4	18	15	16
A4				0	19	13	13	5,4	19	12	16	9,2	12	6,6
A5					0	14	12	16	13	17	17	10	9,6	13
A6						0	6,4	17	23	4	6,5	9,9	7,3	9,1
A7							0	16	19	7,8	11	5,2	2,6	7,1
A8								0	16	17	19	7,8	11	8,8
A9									0	24	25	14	17	19
A10										0	5,7	11	11	10
A11											0	12	9,9	15
A12												0	4,1	5
A13													0	7
A14														0

2. *Saving Matrix*

Once the distance matrix has been obtained, the subsequent task is to establish the saving matrix by consolidating two or more routes into a single route. At this stage, we calculate the total distance from the depot to agents 1 and 2, and then we deduct the distance between agent 1 and agent 2. We persist in this computation until we have enumerated all agents. The data on the savings matrix is presented in Table 4 below.

Table 4. Saving Matrix

	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11	A12	A13	A14
A1	0	4,4	4,4	2	9,4	4,4	4,9	7,8	15,1	2,4	5,4	3,8	3,4	1
A2		0	4,4	4,1	6,4	4,4	4,7	1,7	6,4	5,4	5,4	6,1	4,7	3
A3			0	9,6	13	24,6	15,5	6,2	6	24,1	31,6	8,1	14	8,3
A4				0	3,6	6,6	2,1	9,4	3,6	6,6	7,6	2,5	2,6	3,3
A5					0	15	12,5	8,2	19	11	16	11,1	14,4	6,3
A6						0	15,1	4,2	6	21	23,5	8,2	13,7	7,2
A7							0	0,7	5,5	12,7	14,5	8,4	13,9	4,7
A8								0	8,2	3,2	6,2	5,5	5,2	2,7
A9									0	4	8	7,1	7	0,3
A10										0	23,3	6,1	9	5,3
A11											0	10,1	15,1	5,3
A12												0	9	3,4
A13													0	4,3
A14														0
A11						0						10,1	15,1	5,3
A12												0	9	3,4
A13													0	4,3
A14														0

After acquiring the savings matrix data for each agent, we utilize the data to identify the most favorable path by searching for the maximum value. After identifying the agent with the best value among the others, we will establish a singular path. When deciding on the route, it is crucial to consider the load capacity of the Mitsubishi L300 vehicle. It can hold up to 290 units of 3 kg of LPG gas. If the load exceeds this capacity, even if there is an agent with the highest value, it cannot be included in the same route. In such cases, a search will be conducted to find an alternative value. Subsequent highest. The quest for the maximum value persists until all agents discover their respective routes. The complete results of the highest value determination are presented in Figure 1 below.

Figure 1. Final Results of Determining the Highest Value

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	0	4,4	4,4	2	9,4	4,4	4,9	7,8	15,1	2,4	5,4	3,8	3,4	1
2		0	4,4	4,1	6,4	4,4	4,7	1,7	6,4	5,4	5,4	6,1	4,7	3
3			0	9,6	13	24,6	15,5	6,2	6	24,1	31,6	8,1	14	8,3
4				0	3,6	6,6	2,1	9,4	3,6	6,6	7,6	2,5	2,6	3,3
5					0	15	12,5	8,2	19	11	16	11,1	14,4	6,3
6						0	15,1	4,2	6	21	23,5	8,2	13,7	7,2
7							0	0,7	5,5	12,7	14,5	8,4	13,9	4,7
8								0	8,2	3,2	6,2	5,5	5,2	2,7
9									0	4	8	7,1	7	0,3
10										0	23,3	6,1	9	5,3
11											0	10,1	15,1	5,3
12												0	9	3,4
13													0	4,3
14														0

Table 5. Saving Matrix Route Determination

Route	Color	Agent
1	Yellow	A3, A6, and A11
2	Green	A1, A5, and A9

3	Orange	A7, A10, A12, and A13
4	Blue	A2, A4, A8, and A14

Nearest Neighbor

Closest Neighbor

Once we have established the route, we use the nearest neighbor method to determine the order in which we should visit the agents. This approach establishes the sequence of agent visits by computing the shortest distance from the depot to the initial agent, and thereafter conducting another search to determine the shortest distance from the fThe table below presents the sequence of agents visited on each route using the nearest neighbor method.

Table 6. Order of Agents Visited

Route	Order of Agents Visited
1	Depot – A6 – A11 – A3
2	Depot – A1 – A9 – A5
3	Depot – A12 – A13 – A7 – A10
4	Depot – A14 – A2 – A4 – A8

Comparison of Mileage and Fuel Costs for the Initial Route and the Proposed Route

Once the route has been determined using the saving matrix and the sequence of agents to be visited has been determined using nearest neighbors, the next step is to calculate the total distance traveled and fuel expenditures incurred per day and per month on the suggested route. These calculations may be found in Tables 7 and 8.

Table 7. Proposed Mileage and Fuel Costs Per Day

Route Determination	Average LPG Gas Demand (3 Kg)	Distance (Km)	Fuel Costs (Rp)
D – A6 – A11 – A3	290	25,9	17.623
D – A1 – A9 – A5	230	28,7	19.564
D – A12 – A13 – A7 – A10	250	19,6	13.338
D – A14 – A2 – A4 – A8	290	18,3	12.466
Total	1.060	92,5	62.991

Table 8. Proposed Mileage and Fuel Costs Per Month

Route Determination	Average LPG Gas Demand (3 Kg)	Distance (Km)	Fuel Costs (Rp)	Route Determination
D – A6 – A11 – A3	8.700	777	528.690	D – A6 – A11 – A3
D – A1 – A9 – A5	6.900	861	586.920	D – A1 – A9 – A5
D – A12 – A13 – A7 – A10	7.500	588	400.140	D – A12 – A13 – A7 – A10
D – A14 – A2 – A4 – A8	8.700	549	373.980	D – A14 – A2 – A4 – A8
Total	31.800	2.775	1.889.730	Total

We derive the suggested monthly mileage and fuel expenses from the data shown in Table 8. Each month, we must travel a total distance of 777 km on route 1, 861 km on route 2, 588 km on route 3, and 549 km on route 4. Our monthly target is to go a distance of 2,775 kilometers. During this period, we will have monthly gasoline expenses amounting to IDR 528,690 for route 1, Rp. 586,920 for route 2, Rp. 400,140 for route 3, and Rp. 373,980 for route 4. Our monthly fuel expenses will amount to IDR 1,889,730.

To proceed, it is necessary to compare the monthly mileage and fuel expenses of both the original route and the suggested route, as depicted in Table 9.

Table 9. Comparison of Mileage and Fuel Costs for Initial and Proposed Routes Per Month

Initial Route				**Proposed Route**			
Route Determination	**Average LPG Gas Demand (3 Kg)**	**Distance (Km)**	**Fuel Costs (Rp)**	**Route Determination**	**Average LPG Gas Demand (3 Kg)**	**Distance (Km)**	**Fuel Costs (Rp)**
D – A2 – A4 – A8 – A1	8.700	675	459.000	D – A6 – A11 – A3	8.700	777	528.690
D – A9 – A5 – A13 – A7	6.900	1.236	840.480	D – A1 – A9 – A5	6.900	861	586.920
D – A12 – A3 – A10	7.500	960	652.800	D – A12 – A13 – A7 – A10	7.500	588	400.140
D – A14 – A6 – A11	8.700	567	386.130	D – A14 – A2 – A4 – A8	8.700	549	373.980
Total	31.800	3.438	2.338.410	Total	31.800	2.775	1.889.730

By analyzing Table 9, we can observe that the recommended route offers savings in terms of both distance traveled and fuel expenses when compared to the initial route over the course of a month. The following is a calculation of the savings gained, expressed as a percentage.

The distance savings can be calculated by subtracting the total proposed distance from the entire initial route, dividing the result by the total initial route, and then multiplying by 100%. In this case, the calculation is as follows: (3,438 - 2,775) / (3,438) x 100% = 19.28%.

The suggested path leads to a monthly reduction in distance traveled by 19.28%, which is equivalent to 663 km. Additionally, the suggested route will result in a monthly gasoline expense reduction of IDR 448,680.

CONCLUSION

The original route spans a distance of 3,438 kilometers and incurs a monthly fuel cost of IDR 2,338,410. In contrast, the suggested route covers a distance of 2,775 kilometers and has a monthly fuel cost of IDR 1,889,730. In contrast to the original route, this suggested route is more efficient as it offers reductions in both miles and fuel expenses. By implementing this suggested path, XYZ distributors will enhance their effectiveness and efficiency in executing operational duties. On a monthly basis, the initial route achieves a 19.28% reduction in both mileage and fuel expenses as compared to the proposed route.

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