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Breaking The Limitations of Distribution: Creating an Integrated Solution with Saving Matrix and Net Present Value

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ABSTRACT

PT BCD is one of the large pharmaceutical companies in Bandung, West Java, which plays the main distributor role. PT BCD is facing a problem related to its company logistics. The problem in question is in the form of customer complaints that reflect a bad image for the company, especially regarding on-time delivery. Many of these complaints came from outlets in the central rayon area consisting of RS A, RS B, RS C, Pharmacy D, Pharmacy E, Pharmacy F, PBF G, PBF H, and PBF I. In an effort to overcome this problem, the management plans to launch a program called same-day delivery service, so it is necessary to carry out research that integrates the saving matrix method to determine the most optimal distribution route for pharmaceutical products so that the distance traveled in delivery is the shortest as well as carrying out mathematical considerations regarding fleet investment decisions based on which offers are available. Provides the greatest savings using the total cost of ownership (TCO) net present value method approach. From the results of the analysis of the two integrated methods, a picture of the decision in the form of the most optimal route based on the saving matrix analysis is obtained, namely PT BCD – RS A – RS B – PBF G – PBF H – PBF I – Apotek F – RS C – Apotek E – Apotek D – PT BCD with the decision to procure a fleet in the form of purchasing an L300 type box car.

Keywords: Logistic, Net Present Value, Same Day Delivery, Saving Matrix

Introduction

Logistics has become vital in the modern world, supporting smooth operations and customer satisfaction in various industries. PT BCD is one of the large pharmaceutical companies in Bandung, West Java, which plays an important role in the distribution of various types of products. The products distributed by PT BCD are medicines, pharmaceutical products, and other consumer goods. Logistics is crucial in realizing the company's vision of "we deliver cool solutions with hot sales distribution."

Similar to other companies, PT BCD is also often faced with various challenges in its distribution process. The data in Figure [1] shows that in 2023, a number of customer complaints have been recorded regarding distribution to West Rayon (BR), Cimahi (CM), Majalengka (MJ), South (SL), Sumedang (SM), Soreang (SO), Central (TE), East (TM) and North (UT). This reflects the existence of inefficiencies and deficiencies in the logistics system, directly impacting the company's image and customer satisfaction.

To maintain the company's good image, all complaints that are linear to customer dissatisfaction must be resolved immediately. As seen in Figure [1], most complaints are caused by customers feeling that the goods they ordered did not arrive on time or were late. After further research, the source of most complaints came from customers located in Central Rayon consisting of Hospital A, Hospital B, Hospital C, Pharmacy D, Pharmacy E, Pharmacy F, PBF G, PBF H, and PBF I. PT BCD is necessary to immediately optimize its logistics system to increase customer satisfaction, strengthen the company image, increase sales and profitability that focuses on this area. To overcome this problem, the management team added the same-day delivery parameter to the expedition team's KPI to ensure the area could be reached on time according to the customer's wishes.

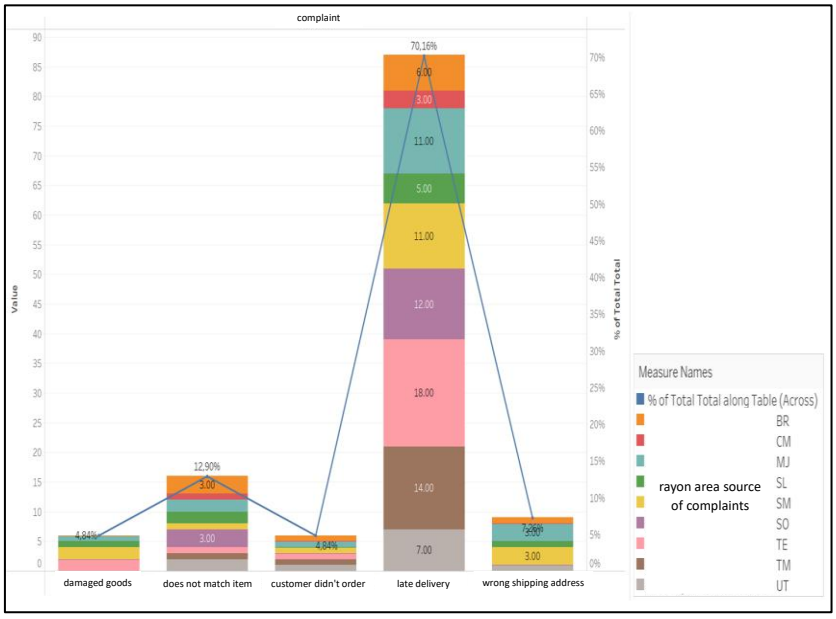


Figure 1. Percentage of complaints submitted to the PT BCD customer service team in 2023

There are several previous studies related to saving matrices, such as in a study. [1] This section discusses the total costs incurred for the initial distribution route, namely IDR. 875,932.00 per month, the total cost incurred for the proposed route using the Saving Matrix method is Rp. 297,732 per month, or a savings of 66.01%. Meanwhile, the total costs incurred using the Cross-Entropy method were Rp. 280,441.00 or savings of 67.98%. In addition, in study [2], distance optimization with delivery routes with Route 1: Badung - duration 64 minutes (1 hour 4 minutes) with a Grand Max Box truck, Route 2: Klungkung - Bangli - Karangasem - duration 186 minutes (3 hours 6 minutes) by Volt Diesel Engkel Box truck. Route 3: Buleleng - Jembrana - duration 419 minutes (6 hours 59 minutes) by Vienna Box 1 truck. In study [3], these two (2) main routes were chosen from the 2 route allocations traveled. The Nearest Neighbor method adds the closest destinations from the last destination, resulting in the shortest total distance traveled. Route 1 is shorter (9.3 km) than Route 2 (17.1 km). Study [4] Discusses that the distance traveled was reduced by 752.2 km (45.91%), and transportation costs were IDR 1,041,285 (45.91% savings). In study [5]The longest route was G-D39-D36-D35-D33-D34-D8-D40-D9-G, which had a distance of 700 km and a load of 700 units. This route requires a fleet of 5 L300 units with a total shipping cost of IDR 1,624,982. The shortest route is G-D32-G, with a distance of 3.2 km and a load of 12 units. This route only requires a fleet of 1 L300 with a total shipping cost of IDR 6,502. As for study [6], the Clarke and Wright Savings Matrix algorithm achieved a distance reduction of 33.58% and a delivery time reduction of 15.27%. This means a more efficient 7-day delivery schedule (Monday-Saturday) with significant cost savings. In study [7], distance savings were significant compared to the initial route, with the shortest route being 40 KM and the farthest being 86 KM. Load per route varies between 445 to 560 LPG. With this shortest route and optimization, the study cannot be separated from determining the feasibility value, where in the study. [8], a positive NPV of IDR 130 million shows that this project is profitable. Payback Period 1.01 year means capital returned in 1 year 1 month, faster than expectations. Profitability Index 2.06 shows a profit of 2x capital. A study also supports this finding. [9], a positive NPV of IDR. 135,571,145.53 shows that this business's future net cash flow can cover the initial investment costs and generate profits. Then, the findings of the study [10], manual (monthly) solar panel tilt adjustments can increase electricity production by 4.53-5.3% compared to static panels. This results in a faster payback period of 8-10 months and an increase in NPV of 12.4-14.9%.

From the description of previous research in the previous paragraph, the use of the saving matrix and NPV methods is still carried out separately so that an idea or novelty emerges that will be raised in this research. This research offers a model for developing a comprehensive same-day delivery framework that considers all factors using both methods. This framework will enable companies to make better decisions regarding what advice to take regarding the optimal route for same-day delivery and procurement of transportation modes in the TE rayon, which has unique characteristics and challenges. This research also offers an innovative solution to the problem of same-day delivery in TE rayon, which can be applied to other rayons and other companies. It contributes to the development of knowledge

about same-day delivery, especially regarding optimal route selection and transportation mode procurement decisions using these two methods.

This research aims to provide suggestions regarding the most optimal route and decisions on procuring transportation modes for same-day delivery in TE rayon, using the total cost of ownership (TCO) method, net present value (NPV) approach to procure transportation modes, and a savings matrix to determine routes. The most efficient. Thus, it is hoped that this research can help expedition teams improve delivery performance through punctuality.

Research Methods

This research was conducted using the Saving Matrix method as a determinant of the most optimal distribution route decisions based on distance. [11]–[13]. Primary data on the distance between locations is used to calculate the savings value, and the result is the optimal route. The distance calculated from determining the route is then used to calculate fuel requirements and service costs in oil changes, which are part of the Net Present Value (NPV) calculation. This NPV calculation is used to determine decisions in fleet procurement. [9], [14].

The object used in this research is the customer population of PT BCD in Central Rayon, which consists of RS A - Jl. Cicendo No. 4; Hospital B - Jl. Kebon Jati No. 38; Hospital C - Jl. Moch. Toha No. 369; APOTEK D - Jl. West Market Nos. 4-6; APOTEK E - Jl. Karapitan No. 139; APOTEK F - Jl. Batununggal Indah IV; PBF G - Jl. Astana Anyar No. 72; PBF H - Jl. Babakan Tarogong No.110 and PBF I - Jl. T. Mimosa No. 23. Saving Matrix analysis is used to help determine optimal distribution routes based on distance. Then, the total distance is used to calculate fuel and service costs in the form of oil changes for further calculations using the Net Present Value (NPV) method. This NPV method provides an overview in deciding between renting L300 transportation or purchasing L300 for fleet procurement on the same-day delivery service.

This research began with activities carried out in the field through observations accompanied by a literature study. These two activities found a gap between the real conditions in the field and generally accepted theories so that the problems that occurred were identified. To find solutions to the problems that have been identified, further stages are carried out in the form of taking and collecting data related to distance, cost components that arise, residual value components that will be obtained, the number of customers ordering services, delivery destination points, etc. [5], [15], [16] Which will later be processed and analyzed using the saving matrix method to determine the most optimal route [4], [7], [17], [18], and the net present value can be used to determine investment decisions [10], [20]The results will then be presented and published in the JTI journal. The research framework in question is more clearly seen in Figure 2.

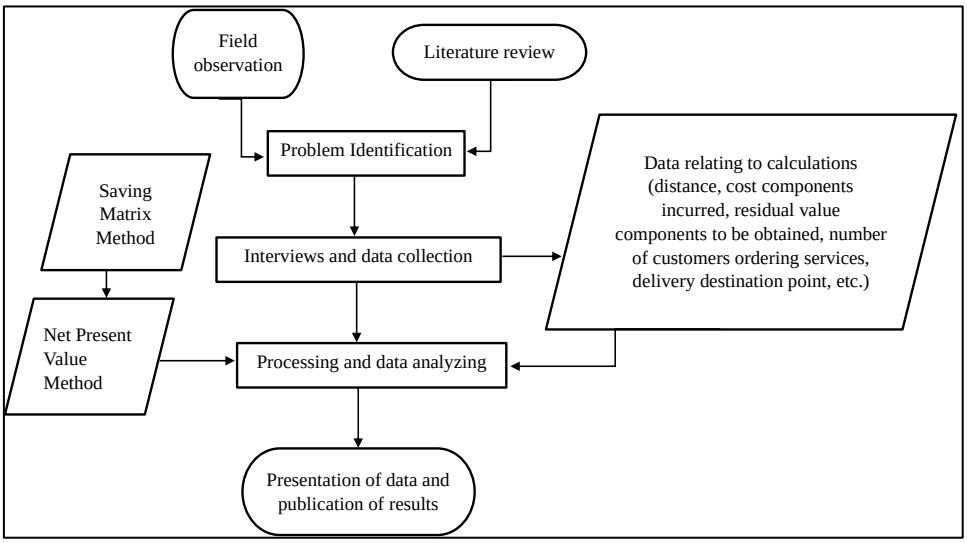


Figure 2. Research Framework

Results and Discussion

Data Collecting

The data collection process in this research begins with determining the customers who are included in the Central Rayon population in PT BCD's same-day delivery area. The data is then equipped with each customer's complete address to be later used as reference data for determining distance via the Google Maps application. The form of the data can be seen in Table 1.

Table 1. Customer data

	Customer data	Code	Demand/day (master box)
PT BCD	Jl. Purnawarman No. 47	BCD	**25**
RS A	Jl. Cicendo No.4	A	**18**
RS B	Jl. Teak Garden No.38	B	**16**
RS C	Jl. Moch. Toha No.369	C	**18**
PHARMACY D	Jl. West Market No.4-6	D	**17**
PHARMACY E	Jl. Kapitan No. 139	E	**23**
PHARMACY F	Jl. Batununggal Indah IV	F	**23**
PBF G	Jl. New Astana No.72	G	**19**
PBF H	Jl. Babakan Tarogong No.110	H	**23**
PBF I	Jl. T. Mimosa No.23	I	**25**

Apart from customer data, data related to fleet specifications is also collected to determine the maximum load amount, as can be seen in table [2]. Other required data includes costs incurred and profits received if the vehicle is used as a same-day delivery fleet. These data can be seen in table [3].

Table 2. Fleet and load specifications

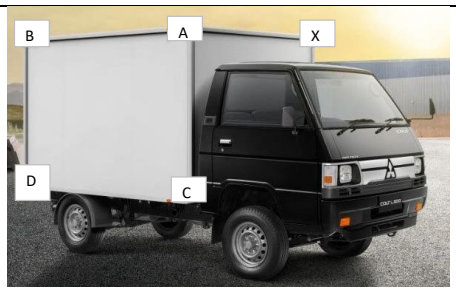
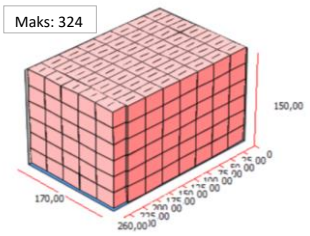
Fleet Specifications	**Fleet Type**	**MITSUBISHI L300**
Cargo Body Dimensions		 
P(A-B)	260	
L(A-X)	170	
T(A-C)	150	
Master Box Dimensions		
P	33	
L	24	
T	25	
Maximum Capacity based on Cube IQ Software Load configuration with combination arrangement		 

Table 3. L300 box car financing data

Rent L300*/year		**Buy L300*/year**	
Cost/Benefit	**Money value**	**Cost/Benefit**	**Money value**
Rental costs	IDR 52,800,000	Purchase Price	IDR 232,000,000
Car Wash Costs	IDR 2,400,000	Car Wash Costs	IDR 2,400,000
Fuel Costs**	IDR 15,301,418	Fuel Costs**	IDR 15,301,418
Service Fee**	IDR 2,400,000	Service Fee**	IDR 1,416,160
Residual value	-	Residual value	IDR 110,000,000

* Benefit period 8 years (PMK No. 72 of 2023); i = 12%

Rent L300*/year		Buy L300*/year	
Cost/Benefit	**Money value**	**Cost/Benefit**	**Money value**

**Calculation results, considering daily mileage

Data processing

From the data collected and displayed in table [2], initial data processing is carried out by determining the distance "from" and "to" for each point. The distance is determined using the Google Maps application. The results of the initial data processing can be seen in the distance matrix table [4].

Table 4. Origin to Destiny distance matrix (km)

To / From	BCD	A	B	C	D	E	F	G	H	I
BCD		1,7	3,4	7,6	3,1	4,5	8,9	4,3	7,2	9,0
A	2,4		1,8	6,9	2,1	3,9	8,6	3,4	5,4	8,1
B	2,6	2,8		5,6	0,6	3,9	7,3	1,6	5,4	6,2
C	8,1	8,3	6,3		6,5	4,5	4,1	5,1	5,0	7,1
D	2,8	3,0	1,9	4,9		2,9	6,6	1,4	4,3	6,0
E	4,3	4,7	4,0	4,1	3,4		5,0	3,4	4,2	7,4
F	8,9	8,6	7,9	4,0	7,4	4,0		6,3	6,6	9,2
G	3,9	3,0	1,1	4,6	1,4	2,9	6,3		2,2	4,7
H	5,9	5,4	3,6	4,1	3,9	3,2	5,8	2,4		4,0
I	8,9	8,1	6,2	5,7	6,5	6,2	7,4	5,5	4,7	

After determining the distance matrix, the savings matrix is determined using the saving matrix method. The saving matrix method is used to help find optimal solutions in delivery routes. This matrix shows the potential savings that can be achieved by combining a number of routes into one. [21]. This method uses a formula formulation in equation 1. The results of calculations using this formula are then entered into a matrix and sorted to determine which ones provide the highest savings [22]. The results of data processing can be seen in Table 5.

$$S(i,j) = C(i,0) + C(0,j) - C(i,j) \quad (1)$$

Information:

S(i,j) : Saving the distance from point *i* to *j*
C(i,0) : Distance from point *i* to the starting point
C(0,j) : Distance from starting point to route *j*
C(i,j) : Distance from route *i* to route *j* before merging

Table 5. Savings Matrix (km)

BCD	A	B	C	D	E	F	G	H	I	Priority	Saving Order From - To
A		**3,3**	2,4	2,7	2,3	2,0	2,6	3,5	2,6	**1**	**F – C**
B	2,2		5,4	5,9	4,0	5,0	**6,1**	5,2	6,2	**2**	**H – I**
C	2,2	4,4		4,2	**7,6**	12,4	6,8	9,8	9,5	**3**	**I – F**
D	2,2	3,5	6,0		4,7	5,4	6,0	6,0	6,1	**4**	**G – H**
E	2,0	2,9	8,3	**3,7**		8,4	5,4	7,5	6,1	**5**	**C – E**
F	2,7	3,6	**13,0**	4,3	9,2		6,9	9,5	8,7	**6**	**B – G**
G	3,3	5,4	7,4	5,3	5,3	6,5		**9,3**	8,6	**7**	**E – D**
H	2,9	4,9	9,9	4,8	7,0	9,0	7,4		**12,2**	**8**	**A – B**
I	3,2	5,3	11,3	5,2	7,0	**10,4**	7,3	10,1			

From the results of data processing using the saving matrix method in Table [5], a same-day delivery service distribution route was obtained, as can be seen in Figure [3]. This route is the most optimal route based on the total distance savings. Distributing this sequence of points produces a total distance of 33.4 km every day.

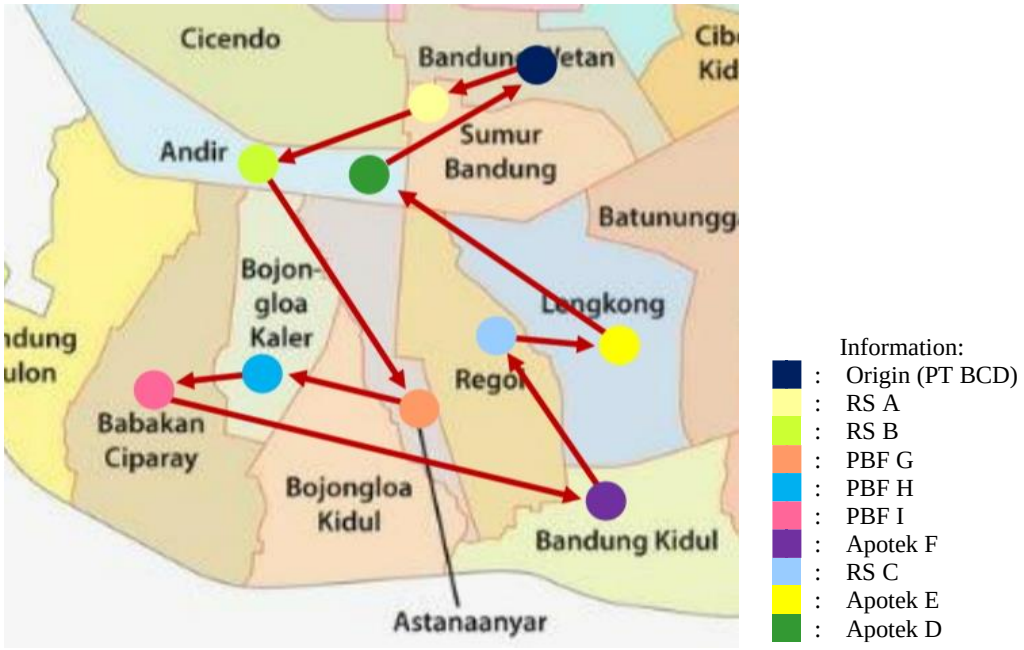


Figure 3. PT BCD same-day delivery service distribution route

After obtaining the total distance traveled each day, the fuel and service costs for oil changes are calculated. The equation used to calculate fuel costs is equation [2], while to determine service or oil replacement costs, you can use equation [3].

$$Gasoline\ costs\ per\ year = diesel\ price \times working\ days \times (mileage \times ratio) \quad (2)$$

$$BO_i = IS_i \times TO_j \quad (3)$$

Information [23]:

BOi	:	Oil consumption costs for vehicle type i, in rupiah/km.
KOi	:	Oil consumption for vehicle type i, in liters/km
HOj	:	The oil price for type j, in rupiah/liter
i	:	Transportation type
j	:	Oil type

From data processing using equation 2, the value of fuel costs per year is obtained, namely IDR 15,301,418.00. For service costs in the form of oil changes, which are calculated using equation 3, the value is IDR 1,416,160.00. This data is also presented in Table 3. These data are then mapped into a cash flow diagram, as shown in Figures 4 and 5, for calculations using the NPV method approach.

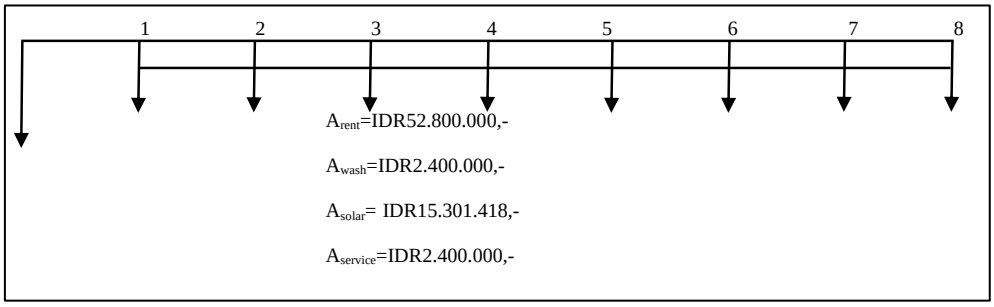


Figure 4. Cash flow diagram for L300 rent

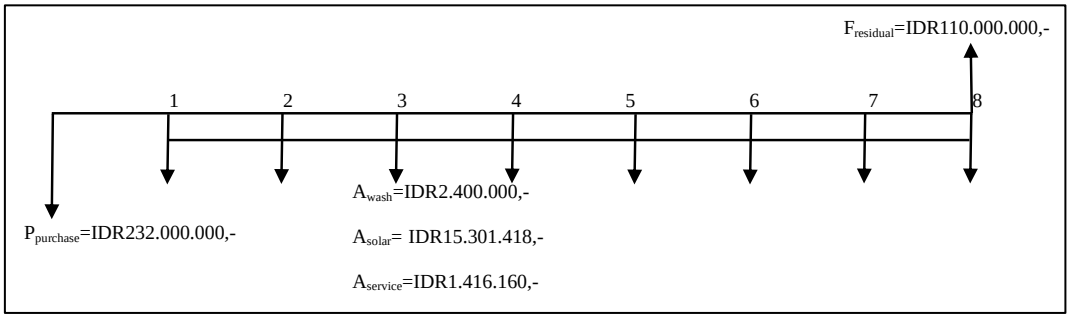


Figure 5. Cash flow diagram for L300 purchases

Calculations using the NPV method are carried out using Equation 4. Values still in periods other than P0 must be converted to make the values uniform in the present value period. The conversion value in question can be obtained from the interest table by determining the interest value and paying attention to the period. In more detail, these calculations can be seen in Table 6 and Table 7.

$$NPV = PVkeuntungan - PVbiaya \quad (4)$$

Table 6. Calculation of rental NPV

Cost/Benefit	Money value	Conversion	Money Value Conversion	Current Value of Money
Rental costs	IDR 52,800,000.00	P/A;12%;8	4,968	IDR 262,310,400.00
Car Wash Costs	IDR 2,400,000.00	P/A;12%;8	4,968	IDR 11,923,200.00
Fuel Costs	IDR 15,301,418.00	P/A;12%;8	4,968	IDR 76,017,444.62
Service Fees	IDR 2,400,000.00	P/A;12%;8	4,968	IDR 11,923,200.00
				IDR 362,174,244.62

Table 7. Purchase NPV calculation

Cost/Benefit	Money value	Conversion	Money Value Conversion	Current Value of Money
Purchase Price	IDR 232,000,000.00	P/P	1	IDR 232,000,000.00
Car Wash Costs	IDR 2,400,000.00	P/A;12%;8	4,968	IDR 11,923,200.00
Fuel Costs	IDR 15,301,418.00	P/A;12%;8	4,968	IDR 76,017,444.62
Service Fees	IDR 1,416,160.00	P/A;12%;8	4,968	IDR 7,035,482.88
Residual value	IDR 110,000,000.00	P/F;12%;8	0,404	IDR 44,440,000.00
				IDR 282,536,127.50

Based on the calculation results in Table 6 and Table 7, it can be seen that the decision to buy an L300 vehicle results in the lowest investment costs. Based on these results, it is best to procure an L300 fleet for same-day delivery by purchasing an L300 car. By buying a company, you can save IDR 79,638,117.12 when compared to renting. Apart from providing the lowest investment value, purchasing a fleet can provide benefits in the form of asset ownership. [24], [25].

Conclusion

Based on the results and discussions that have been outlined, conclusions can be drawn regarding the most optimal route. The route that should be taken is PT BCD – RS A – RS B – PBF G – PBF H – PBF I – Apotek F – RS C – Apotek E – Apotek D – PT BCD, as seen in Figure 3. Then, it is

best to procure fleets by purchasing for delivery on these routes. This is because apart from the company owning assets, the decision to buy provides a lower investment value, IDR 282,536,127.50, and can provide savings of IDR 79,638,117.12 when compared to renting with investment costs of IDR 362,174,244.62. Similar efforts related to integrating the saving matrix and net present value methods can also be applied to companies related to logistics systems, especially those that play a role in the distribution of pharmaceutical products. This can help companies determine the most profitable and optimal decisions so that their distribution activities can run effectively and efficiently in terms of time, energy, and costs.

Apart from applying the same thing to similar companies, this research can be further developed. Research that can be developed further could be adding other parameters, such as how the contour of the road is traversed and what the traffic is like during rush hour. The purpose of adding these parameters is to calculate service costs in more detail, such as tire replacement costs and employee costs for overtime. Not only for product distribution activities from companies to customers. This research can also be developed for raw material procurement activities, transportation between plans in factories, and other relatable activities

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