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Route Optimization and Green Logistics With VRP in the Distribution of Pharmaceutical Products From PT DFO Central Warehouse to Branches in Jakarta, Banten, and West Java

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ABSTRACT

Tourism destinations require adequate supporting facilities, including healthcare services such as hospitals, clinics, and pharmacies. The availability of pharmaceutical products in these facilities depends on an efficient distribution system. Therefore, optimizing pharmaceutical distribution routes becomes essential to ensure product availability while minimizing operational costs and environmental impacts. This includes providing services at healthcare facilities located in tourist areas such as Banten – Tanjung Lesung and West Java – Pangandaran, which, despite being far from urban centers, can still offer competitive prices and minimize environmental impact. PT DFO, as one of the pharmaceutical distributors, requires operational cost efficiency in running its business. This efficiency aligns with the demand to uphold environmental sustainability principles. Route optimization aims to achieve efficiency in the routes used, consolidate distribution routes between branches, reduce distribution costs, minimize fuel consumption, and optimize vehicle emissions. One of the methods used in this study is the Capacitated Vehicle Routing Problem (CVRP). This method calculates the optimal use of vehicle capacity by combining the required capacities of the routes integrated into inter-branch deliveries. This study resulted in a reduction in delivery frequency of 4 trips (44.44%), a reduction in the number of vehicles used to 1 vehicle per week, and a cost reduction of 30.66% (Rp 4,475,840) in the weekly distribution process. In terms of emission reduction, a decrease in fuel consumption of 17.373 L (8.14%) was achieved, resulting in a reduction of CO2 emissions by 28.7 kg. These findings demonstrate that CVRP can improve operational efficiency and support green logistics practices in pharmaceutical distribution to supporting the tourism sector.

Keywords: *Capacitated Vehicle Routing Problem, Emissions, Delivery, Efficiency, Sustainability, Tourism Sector*

1. INTRODUCTION

The pharmaceutical industry plays a vital role in the national healthcare system, where an effective and efficient drug distribution process remains the key to ensuring product availability for the public. Additionally, product availability is a critical consideration, as suppliers must be able to meet the desired quantities and delivery schedules. Quality will also be a primary consideration, beyond cost considerations, which can be a major factor, although decisions should not be based solely on financial aspects [1].

From a tourism perspective, healthcare facilities and measures to mitigate health impacts will influence tourist visits to those destinations [2]. This needs to be addressed within the supply chain, which must be a primary focus and concern for the tourism industry as it affects the balance and sustainability of tourism [3].

Pharmaceutical companies often face a dilemma between reducing operational costs and enhancing customer satisfaction by adopting more environmentally friendly practices. This poses a challenge, especially considering that many consumers today prefer brands that

demonstrate a commitment to environmental sustainability [4].

PT DFO, as a pharmaceutical distributor, can integrate environmental sustainability concepts with operational optimization to achieve operational efficiency and enhanced customer satisfaction. Moving toward *green* logistics practices not only helps reduce the carbon footprint but also lowers long-term operational costs through resource efficiency.

One operational activity where PT DFO can achieve efficiency is the distribution of pharmaceutical products from the central warehouse in Jakarta to branches in the Banten, Jakarta, and West Java regions. In the distribution process, selecting the optimal route is a crucial factor as it directly impacts operational costs, delivery time, and customer satisfaction. One of the key elements determining efficiency in the distribution process is the distance traveled by vehicles [5]. The method of determining the shortest route must be the primary focus in improving distribution efficiency, indirectly leading to operational cost savings and contributing to a reduction in the carbon footprint. Optimizing routes not only reduces travel time but also contributes to lower fuel consumption and carbon emissions [6].

One method that can be implemented for route optimization is the *Vehicle Routing Problem* (VRP). The VRP is an optimization problem focused on determining the most efficient routes for vehicles delivering goods to various locations. In selecting the VRP method, a case study was conducted at PT DFO, which has optimization potential in the selected routes by maximizing delivery capacity from the Central Warehouse to the KFTD Branch Warehouse. One variation of VRP is the *Capacitated Vehicle Routing Problem* (CVRP). CVRP is a VRP constrained by vehicle capacity. CVRP is an optimization method to find the route with the minimum cost (*minimum cost*) traveled by vehicles with capacity constraints, serving a number of agents with known demand quantities prior to the distribution process. Distribution for each vehicle is performed once, starting from the depot to each agent and then returning to the depot after completing the distribution [7].

The distribution process uses standard transport vehicles, namely CDD Box Trucks, to each branch without considering the maximum utilization of the trucks' capacity. Therefore, the company requires a specialized method to help maximize capacity and determine product distribution routes from the Central Warehouse to Branch Warehouses, so that the resulting routes maximize truck capacity while having the shortest possible routes. This will result in faster travel times, reduced delivery frequency, and lower vehicle fuel costs. PT DFO's distribution problem can be modeled using the *Capacitated Vehicle Routing Problem* (CVRP).

This research implementation uses the CVRP method, with the outputs generated by CVRP consisting of the selection of the shortest route, a reduction in delivery frequency, and a reduction in fuel consumption. The expected outcomes include reducing operational costs for product delivery to the 9 branches under study and contributing to a reduction in carbon emissions from this distribution process.

2. LITERATURE REVIEW

To complement tourism activities, supporting facilities are essential, as these facilities play a vital role in sustaining tourism operations and ensuring their long-term viability through the comfort they provide [8]. Supporting facilities, such as healthcare facilities, are crucial for enhancing tourism activities and fostering further tourism development.

Green logistics is the process of integrating environmentally friendly practices into logistics management systems and supply chains. This concept encompasses all aspects of logistics, from procurement to delivery, with the aim of minimizing negative impacts on the environment. The implementation of green logistics is becoming increasingly important as awareness of environmental issues, such as climate change and pollution, grows [9].

One of the primary goals of green logistics is to reduce carbon emissions generated during the distribution process. The transportation sector is one of the largest contributors to greenhouse gas emissions worldwide, and logistics plays a significant role in this regard. According to a study by He et al. (2022), the implementation of eco-friendly technologies in logistics can reduce CO2 emissions by up to 30% in some cases, thereby providing dual benefits for both the environment and businesses.

The Vehicle Routing Problem (VRP) is an optimization challenge aimed at determining the most efficient route for vehicles used to deliver goods to a number of locations. This problem was first identified in 1959 by Dantzig and Ramser, and since then has become an important research topic in the fields of logistics and supply chain management [10]. VRP not only helps companies reduce transportation costs but also contributes to improved customer service through delivery reliability and speed.

VRP encompasses various variants, each with its own characteristics and challenges. One of the most well-known variants is the Capacitated Vehicle Routing Problem (CVRP), which accounts for vehicle capacity constraints in transporting goods [11]. In CVRP, the objective is to minimize total travel distance and operational costs while ensuring that vehicles do not exceed their maximum capacity.

3. METHOD

This study falls under the category of quantitative research using a case study approach. Quantitative research involves the use of numerical data (such as distance, tonnage, volume, and frequency) and applies a mathematical optimization model, namely the Capacitated Vehicle Routing Problem (CVRP), to analyze and solve problems. The Case Study approach was chosen because this research focuses deeply and intensively on a single object, namely the distribution operational system from the PT DFO Central Warehouse in Jakarta to the PT DFO Branch Warehouses in the Banten, Jakarta, and West Java areas.

In its implementation, given its objectives, this research constitutes applied research, where optimization theories and models are directly applied to provide practical solutions to real-world problems faced by the company, particularly in efforts to enhance operational efficiency and support Green Logistics by reducing emissions in operations.

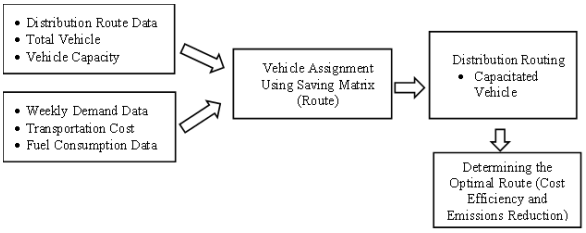


Figure 1. Research Flowchart

Emissions measurements are conducted quantitatively using the greenhouse gas emission calculation methods outlined in the 2006 IPCC Guidelines for National Greenhouse Gas Inventories. Emissions from fuel sources can be calculated based on fuel quantity and average emission factors. CO2 emissions can be calculated using the following formula:

$$Emissions = \sum_{a} \left(Fuel_a \times EF_a \right)$$

Figure 2. Emissions Measurement Formula [12] [14]

Notes:

Emissions = CO2 Emissions (kg)

$Fuel_a$ = Fuel Quantity (TJ)

EF_a = Emission Factor (kg/TJ)

a = Fuel Type (diesel fuel, diesel oil, etc.)

4. FINDINGS AND DISCUSSION

DFO Operations

PT DFO, a company engaged in the distribution of healthcare products, distributes contracted products to healthcare facilities through its branch warehouses. The branch warehouses require supplies from the Central Warehouse in the Jakarta area. In its operations, the Central Warehouse makes regular shipments to branch warehouses on a weekly basis for branch warehouses located in the Banten, Jakarta, and West Java regions, with a total of 9 branches (Serang, Tangerang, Jakarta 1, Jakarta 2, Bekasi, Bogor, Bandung, Cirebon, and Tasikmalaya).

ID	*Branch Name*	Average Demand / Week (Kg)	Average Volume / Week (m3)
BDG	BANDUNG	3.263	12.495
BKS	BEKASI	775	3.103
BGR	BOGOR	2.293	7.961
CRB	CIREBON	2.359	8.477
JK1	JAKARTA 1	1.225	4.514
JK2	JAKARTA 2	1.969	7.576
SRG	SERANG	2.032	7.645
TGR	TANGERANG	1.677	5.799
TSM	TASIKMALAYA	2.007	7.265

Table 1. History of Cubic Tonnage by Distribution in 2024

Distribution activities begin with shipments from the Central Warehouse to Branch Warehouses individually. The average weekly shipment volume of products over the past year, measured in kilograms, is already known.

Vehicle Type

The Company makes routine deliveries using two Colt Diesel Double Box Trucks, both manufactured in 2024. The vehicles have a capacity of 4,000 kg. Distribution takes place during business hours from 7:30 AM to 4:00 PM, starting from the Central Warehouse to the Branch Warehouse and returning to the Central Warehouse. Distribution occurs once a week. A problem arising from this operation is that shipments have not maximized the capacity of a single truck, resulting in suboptimal distribution costs. Therefore, this study aims to minimize shipment frequency and total distance traveled while accounting for the capacity constraints of the vehicles used.

History of PT DFO's Existing Distribution Routes

The following are the initial weekly distribution routes operated by PT DFO:

Route	Detail of Route	Tonage (Kg)	Distance (Km)	Cost of Delivery
Route 1	DC --> Bandung --> DC	3.263	284	2.000.000
Route 2	DC --> Bekasi --> DC	775	44,6	1.100.000
Route 3	DC --> Bogor --> DC	2.293	114,8	1.300.000
Route 4	DC --> Cirebon --> DC	2.359	436	2.500.000
Route 5	DC --> Jakarta 1 --> DC	1.225	31,4	1.050.000
Route 6	DC --> Jakarta 2--> DC	1.969	3,4	1.050.000
Route 7	DC --> Serang --> DC	2.032	208	1.700.000
Route 8	DC --> Tangerang --> DC	1.677	122	1.300.000
Route 9	DC --> Tasikmalaya --> DC	2.007	500	2.600.000
	Total	17.600	1.744	14.600.000

Table 2. Cargo Volume and Distribution Route Costs in 2024

The distribution routes are served by two CDD trucks, which are divided into the following distribution routes

	Truck	Detail of Route	Distance (d0i)	Total of Distance (PP)	Fuel Consumption (L)	Cost of Fuel (Rp 6.800/L)
Monday	CDD 01	DC - Tasikmalaya - DC	247.0 km	494,0	61,8	Rp420.240
	CDD 02	DC - Serang - DC	105.0 km	210,0	26,3	Rp178.840
Tuesday	CDD 01	DC - Cirebon - DC	215.0 km	430,0	53,8	Rp365.840
	CDD 02	DC - Tangerang - DC	58.3 km	116,6	14,6	Rp99.280
Wednesday	CDD 01	DC - Bandung - DC	142.0 km	284,0	35,5	Rp241.400
	CDD 02	DC - Bogor - DC	64.7 km	129,4	16,2	Rp110.160
Thursday	CDD 01	*Standby / Maintenance*	0 km	-	0	Rp0
	CDD 02	DC - Bekasi - DC	21.5 km	43,0	5,4	Rp36.720
Friday	CDD 01	DC - Jakarta 1 - DC	15.4 km	30,8	3,9	Rp26.520
	CDD 02	DC - Jakarta 2 - DC	1.5 km	3,0	0,4	Rp2.720
TOTAL	2 Truck	9 Trip of Delivery	-	1.740,8	217,9	Rp1.481.720

Table 3. Distance and Fuel Consumption on Distribution Routes in 2025

Emissions and Fuel Emission Factors

Emissions resulting from combustion are calculated using an emission formula that accounts for the amount of fuel and the emission factor. The emission factor (kg/TJ) represents the pollutants produced by the combustion of a specific amount of fuel, which is calculated using the fuel's calorific value (TJ/kg), thereby allowing the total emissions (kg) to be determined. The following data on emission factors and calorific values of fuels are based on IPCC 2006,

Type of Fuel	Emissions Factor of CO2	Heating Value
	(kg/TJ)	(TJ/Kg)
Gasoline	69.300	0,0000443
Diesel Fuel	74.100	0,000043
LPG	63.100	0,0000473
Kerosene	71.900	0,0000438
Lubricants	73.300	0,0000402
Biodiesel	70.800	0,000027
Bioetanol	70.800	0,000027
Other Fuel	79.600	0,0000274

Table 4. Emission Factors and Calorific Values by Fuel Type [12] [14]

The fuel used in the calculations is based on the fuel currently available in Indonesia, namely B35 biodiesel, which consists of 35% vegetable oil and 65% diesel. When calculating the calorific value of B35 biodiesel, an adjustment must be made for its density of 0.8475 kg/liter.

Type of Fuel	Emissions Factor of CO2	Heating Value	Density of Biosolar	Heating Value
	(kg/TJ)	(TJ/Kg)	(kg/liter)	(TJ/Liter)
Biodiesel B35	70.800	0,000027	0,8475	0,0000228825

Table 5. Emission Factors and Calorific Value of Biodiesel B35 [13]

For the initial distribution route using two trucks, the following emissions were recorded:

Truck	Fuel Consumption	Emissions Factor of CO2	Heating Value	Density of Biosolar	Heating Value	Emissions
	(Liter)	(kg/TJ)	(TJ/Kg)	(kg/liter)	(TJ/Liter)	(Kg)
1	155	70.800	0,000027	0,8475	0,0000228825	251,11256
2	62,9	70.800	0,000027	0,8475	0,0000228825	101,9031
					Total Emisi	353,0157

Table 6. Emissions on the 2025 Distribution Route

Distance Matrix Data

In performing route optimization, the following distance matrix is used to calculate and determine new routes with optimal distances. Distance calculations include the distance from the central warehouse to branch warehouses, as well as the distances between branch warehouses in the Banten, Jakarta, and West Java regions.

Table 7. Distance Matrix for the Distribution of PT DFO's 9 Branches

	GP1	BDG	BKS	BGR	CRB	JK1	JK2	SRG	TGR	TSM
GP1	-	142	21,5	64,7	215	15,4	1,5	105	58,3	247
BDG	142	-	123	168	157	153	142	232	173	124
BKS	22,3	123	-	64,6	195	33,2	22,6	112	69,4	228
BGR	57,4	170	65,2	-	243	61,8	58,7	116	48,2	278
CRB	218	147	198	244	-	228	217	307	248	106
JK1	15,7	155	29,1	58,9	226	-	13,7	84,2	21,5	257
JK2	1,7	142	21,8	54,7	215	15,7	-	105	49,4	247
SRG	104	232	112	131	305	85,5	105	-	76,1	337
TGR	61	173	68,1	61,7	246	23,8	59,9	75,5	-	278
TSM	250	114	230	276	105	260	250	339	280	-

Determining Distribution Routes Using the Capacitated Vehicle Routing Problem

The method used in route planning takes into account the distribution of distances between branches, with the constraint that the load carried must not exceed the carrying capacity of the vehicle used. In the route planning process, each branch will be visited by one truck, resulting in 36 different routes

The route optimization to minimize total distance can be calculated using the following formula:

$$S(i,j) = d0i + d0j - dij \quad [15]$$

Notes :

S (i,j) = Distance Savings
d0i = Distance from the Central Warehouse to Branch Warehouse i
d0j = Distance from the Central Warehouse to Branch Warehouse j
dij = Distance from Branch Warehouse i to Branch Warehouse j

For the selected route, the total demand is calculated to ensure that the demand for each warehouse does not exceed the vehicle's capacity. The assumptions used are based on the average weekly demand, as per 2024 data, measured in kilograms. The capacity formula is as follows:

$$\sum wiwj \leq 4000$$

Notes:

$\sum$ wiwj = Total demand capacity of Branch Warehouse i and Branch Warehouse j
$\sum$ wiwj $\leqslant$ 4000 = Ok
$\sum$ wiwj $\geqslant$ 4000 = Overload

No	Route (i - j)	Tonage i (kg)	Tonage j (kg)	Total Tonage i+j (kg)	Capacity Status (<4000 kg)	d0i	d0j	dij	Savi (d0i+d0
1	CRB - TSM	2,359	2,007	4,366	OVERLOAD	215	247	105	356
2	BDG - TSM	3,262	2,007	5,269	OVERLOAD	142	247	114	265
3	BDG - CRB	3,262	2,359	5,622	OVERLOAD	142	215	147	200
4	SRG - TGR	2,032	1,676	3,708	OK	105	58,3	75,5	87,2
5	BGR - TGR	2,293	1,676	3,969	OK	64,7	58,3	61,7	74,8
6	BGR - SRG	2,293	2,032	4,325	OVERLOAD	64,7	105	131	53,7
7	JK1 - TGR	1,224	1,676	2,9	OK	15,4	58,3	23,8	52,2
8	BKS - CRB	775	2,359	3,134	OK	21,5	215	198	41,5
9	BDG - BKS	3,262	775	4,037	OVERLOAD	142	21,5	123	40,5
10	BKS - TSM	775	2,007	2,782	OK	21,5	247	230	40,5
11	BDG - BGR	3,262	2,293	5,556	OVERLOAD	142	64,7	170	38,7
12	BGR - CRB	2,293	2,359	4,652	OVERLOAD	64,7	215	244	36,7
13	JK1 - SRG	1,224	2,032	3,256	OK	15,4	105	85,5	36,2
14	BGR - TSM	2,293	2,007	4,3	OVERLOAD	64,7	247	276	33,7
15	BDG - TGR	3,262	1,676	4,939	OVERLOAD	142	58,3	173	27,3
16	TGR - TSM	1,676	2,007	3,683	OK	58,3	247	280	27,3
17	CRB - TGR	2,359	1,676	4,035	OVERLOAD	215	58,3	246	25,3
18	BKS - BGR	775	2,293	3,068	OK	21,5	64,7	65,2	21,6
19	BGR - JK1	2,293	1,224	3,517	OK	64,7	15,4	58,9	18,3
20	BDG - SRG	3,262	2,032	5,294	OVERLOAD	142	105	232	15
21	SRG - TSM	2,032	2,007	4,039	OVERLOAD	105	247	339	15
22	BKS - SRG	775	2,032	2,807	OK	21,5	105	112	14,5
23	CRB - SRG	2,359	2,032	4,391	OVERLOAD	215	105	305	13
24	JK2 - TGR	1,969	1,676	3,645	OK	1,5	58,3	59,9	10,4
25	BKS - TGR	775	1,676	2,451	OK	21,5	58,3	68,1	10,4
26	BGR - JK2	2,293	1,969	4,262	OVERLOAD	64,7	1,5	54,7	7,5
27	JK1 - TSM	1,224	2,007	3,231	OK	15,4	247	260	5,4
28	BDG - JK1	3,262	1,224	4,487	OVERLOAD	142	15,4	155	4,4
29	BKS - JK1	775	1,224	1,999	OK	21,5	15,4	29,1	3,7
30	JK1 - JK2	1,224	1,969	3,193	OK	15,4	1,5	15,7	3,2
31	CRB - JK1	2,359	1,224	3,583	OK	215	15,4	226	2,4
32	BDG - JK2	3,262	1,969	5,231	OVERLOAD	142	1,5	142	1,5
33	JK2 - SRG	1,969	2,032	4,001	OVERLOAD	1,5	105	105	1,5
34	JK2 - TSM	1,969	2,007	3,976	OK	1,5	247	250	1,5
35	BKS - JK2	775	1,969	2,744	OK	21,5	1,5	21,8	0,4
36	CRB - JK2	2,359	1,969	4,328	OVERLOAD	215	1,5	215	-0,5

Table 8. Route savings are calculated based on the savings rate and the status of eligible capacity

Route	Detail of Route	Total Tonage (Kg)	Capacity Status (Km)	Total Distance (Km)	Saving (Km)	Cost of Delivery (Rp)
Route 1	DC --> Bandung -->	3.263	OK	284	0	2.000.000
Route 2	DC --> Serang --> Tangerang --> DC	3.709	OK	242,1	87,2	1.775.000
Route 3	DC --> Bekasi --> Cirebon -->DC	3.134	OK	434,5	41,5	2.575.000
Route 4	DC --> Bogor --> Jakarta 1 --> DC	3.518	OK	142,2	18,3	1.375.000
Route 5	DC --> Jakarta 2 --> Tasikmalaya --> DC	3.976	OK	498,5	1,5	2.675.000
			Total	1.601,30	148,50	10.400.000

Table 9. Route Selection Based on Capacity and Route Optimization

The table above shows that the distribution route for delivering medicines from PT DFO's Central Warehouse to its 9 branch warehouses can be managed using just one vehicle from the CDD fleet, with deliveries made once a day, seven days a week. The total distance covered is 1,601.3 km, with shipping costs amounting to Rp 10,400,000 per week.

After determining the route savings achieved in moving toward Green Logistics, it was found that fuel savings could be realized for the CDD trucks used. Based on records of the CDD trucks used, the fuel consumption per liter of the B35 biodiesel used can reach 1:8 (liters/km).

Name of Day	Truck	Detail of Route	Total of Distance (PP)	Fuel Consumption (L)
Monday	CDD 01	DC - Bandung - DC	284	35,50
Tuesday	CDD 01	DC - Serang - Tangerang - DC	242,1	30,26
Wednesday	CDD 01	DC - Bekasi - Cirebon - DC	434,5	54,31
Thursday	CDD 01	DC - Bogor - Jakarta 1 - DC	142,2	17,78
Friday	CDD 01	DC - Jakarta 2 - Tasikmalaya - DC	498,5	62,31
		Total	**1601,3**	**200,16**

Table 10. Total Distance and Fuel Consumption on the Optimized Route

The calculation of emissions generated over a total distance of 1,601.3 km yielded the following emissions:

Truck	Fuel Consumption	Emissions Factor of CO2	Heating Value	Density of Biosolar	Heating Value	Emissions
	(Liter)	(kg/TJ)	(TJ/Kg)	(kg/liter)	(TJ/Liter)	(Kg)
1	200,16	70.800	0,000027	0,8475	0,0000228825	324,2794632

Table 11. Fuel Consumption and Emissions on the Optimized Route

Comparison of Results with Existing Conditions and the Capacitated Approach

The following comparison examines both the existing initial routes and the distribution results obtained using the Capacitated Vehicle Routing Problem (CVRP) method, in terms of distance, cost, and emissions.

Performance Indicator	Baseline Condition (2024)	Improve Condition (CVRP)	Savings	Efficiency (%)
Frequency of Delivery (Unit)	9	5	4	44,44%
Total Distance (Km)	1.744,20	1.601,30	142,9	8,19%
Total Cost/Week	Rp14.600.000	Rp10.400.000	Rp4.475.840	30,66%
Fuel Consumption(Liter)	217,9	200,1625	17,7375	8,14%
Emissions (Kg)	353,0156499	324,2794632	28,73618674	8,14%

Table 12. Efficiency Comparison Between Actual Conditions in 2024 and CVRP Results

5. CONCLUSIONS

Research on optimizing the distribution of pharmaceutical products from PT DFO's Central Warehouse to its 9 Branch Warehouses in the Banten, DKI Jakarta, and West Java regions using the Capacitated Vehicle Routing Problem (CVRP) can yield more optimal recommendations compared to the existing initial routes currently in use. Using the CVRP method, the number of trips was reduced from 9 to 5, with total shipping costs amounting to Rp 10,400,000, saving 30.66% in weekly costs (Rp 4,475,840) and reducing emissions by 8.14% (28.73 kg). This study concludes that the CVRP method can serve as an efficient solution for optimizing distance, cost, and emissions in advancing green logistics and reducing operational costs for the distribution activities conducted by PT DFO, which plays a supporting role in the tourism industry's supply chain.

This research can be expanded beyond the use of the Capacitated Vehicle Routing Problem; within the field of Vehicle Routing Problems, additional research variables such as time windows can be incorporated to determine optimal routes while accounting for precise delivery times. Further development can be achieved by expanding the scope of the study to include delivery areas within the coverage range of PT DFO's Central Warehouse that utilize land-based transportation methods; for instance, by extending delivery areas to Central Java and East Java, a greater number of route combinations can be identified in terms of route efficiency.

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