International Journal of Social Discussion
Volume 2, No. 1, 2025 - ISSN: 3063-3036
Website: http://ijsd.seevalue.org/index.php/ijsd/index

Analysis of Spare Parts Distribution System Using Nearest Neighbor Method and Saving Matrix Method

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Keywords:
Distribution System,
Industrial Spare Parts,
Operational Costs,
Mileage,
Nearest Neighbor,
Saving Matrix.

Abstract

Distribution is an important part of a company's operational activities, especially in ensuring timely delivery at an economical cost. PT XYZ is an industrial spare parts provider company located in Bekasi. The main problems faced are high operational costs and late delivery due to less than optimal distribution route selection. The distribution routes used often do not consider the shortest distance between the initial point of collection of goods and consumers, so that travel time and fuel costs increase significantly. This is exacerbated by traffic congestion in the Jabodetabek area so that fuel costs increase, especially in the period from July to December 2024, where distribution costs soared. This distribution problem is further complicated by the initial routes that are not well organized. PT XYZ initially used 10 distribution routes that were inefficient and unstable. These routes are often excessive in covering certain areas without optimizing delivery to adjacent areas, resulting in wasted travel distance and time. In addition, changes to routes made without data-based analysis increase the risk of increasing operational costs, especially uncertain traffic conditions. This study aims to improve PT XYZ's distribution system by applying two methods, namely Nearest Neighbor and Saving Matrix. The Nearest Neighbor method focuses on selecting the closest route from the starting point gradually until all deliveries are completed. The Saving Matrix method helps increase efficiency by combining adjacent delivery points, so that the distance traveled can be minimized. After implementing both methods, the distribution routes that initially numbered 10 were successfully simplified into 9 more efficient routes. The results of the study showed that the implementation of this method significantly reduced the total distribution distance traveled, from 218.1 km to 98.8 km. In addition, operational costs that previously reached IDR 18,750,000 during the period from July to December 2024 were successfully reduced to IDR 11,082,240, resulting in savings of 40.89%. This reduction in the number of routes and distance traveled not only reduces fuel costs but also increases the timeliness of delivery, thereby increasing customer satisfaction.

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INTRODUCTION

Transportation is the process of moving people, goods, or services from one location to another. This process involves various modes of transportation, including land transportation (such as cars, buses, and trains), sea

transportation (ships and boats), and air transportation (airplanes). Transportation plays a crucial role in supporting economic, social, and cultural activities, as well as facilitating trade and mobility (Harrison & Van Hoek, 2022).

Distribution involves the delivery of products from factories or distribution centers to customers through a transportation network. During the distribution process, it is crucial to consider the determination of delivery schedules and the routes taken by the fleet. The delivery schedule and the route selected will affect the total distance traveled, which in turn influences travel time and transportation costs. The main goal of determining the schedule and route is to minimize costs, which is related to minimizing the distance traveled (Kasih and Maulidina, 2023).

PT. XYZ is a company that provides various types of industrial spare parts, such as ball valves, pipes, fittings, pneumatic systems, hydraulics, and other industrial spare parts. A ball valve is a spherical valve used to open or close the flow of fluid in pipes by rotating the handle. Pipe fittings are components used to connect, adjust, or change the direction of flow in a piping system. Pneumatics is a technology that uses compressed air to operate or control various mechanical tools and systems. Hydraulics is a technology that utilizes pressurized liquid to generate power or mechanical movement. This system is commonly used to lift, push, or move heavy loads with high precision. These components support industries such as oil, automotive, chemicals, and energy, ensuring that production processes run efficiently, safely, and on time.

PT. XYZ is located in Bekasi, West Java, and the company supplies factories in the Greater Jakarta area (Jabodetabek) with an average distribution of 4 times per month, operating from 8 AM to 4 PM. Distribution is carried out using Daihatsu Grandmax vehicles with a load capacity of 907.185 kg, or equivalent to 1 ton. In the distribution system at PT. XYZ, frequent delays and cost increases are experienced due to uncertainties in costs caused by choices of toll entry and exit points, as well as potential increases in fuel costs due to unpredictable traffic in the Jabodetabek area. Selecting the right route can help save operational costs, maintain timely delivery, and improve customer satisfaction. With good distribution planning, unnecessary expenses can be reduced, and operational costs can be optimized. A comparison of operational costs for the years 2023 and 2024 can be seen in Figure 1.

Figure 1. Operational Costs for 2023-2024

(Source: PT. XYZ)

From the image above, a comparison of operational costs for 2023 and 2024 can be seen. There is a significant increase from July to December in 2024, with an amount of IDR 18,750,000 shown in the blue graph, compared to IDR 3,200,000 in 2023 as seen in the orange graph. Based on the data presented above, an optimal and effective distribution system is needed to minimize the costs incurred during the distribution process.

The determination of the best distribution system is conducted using the Saving Matrix and Nearest Neighbor methods, as distribution problems often relate to how to determine the most efficient delivery route to minimize travel distance and operational costs. To address this issue, the Nearest Neighbor and Saving Matrix methods were chosen for the following reasons:

The Nearest Neighbor method is selected because of its simplicity and ease of application. This method works by selecting the closest delivery point sequentially, thus generating a fairly efficient route with fast computation time.

The Saving Matrix method is chosen because of its ability to optimize delivery routes better than the Nearest Neighbor method. This approach combines several routes by considering the potential savings in distance, which can significantly reduce the total travel distance and costs.

Other methods such as brute force were not chosen because they require extensive computation time and are not practical for a large number of delivery points. Meanwhile, metaheuristic methods like genetic algorithms or simulated annealing, although capable of providing excellent solutions, have high complexity, require longer implementation time, and demand complicated parameter adjustments. Therefore, these methods are less suitable when quick and easy-to-apply solutions are needed.

The Nearest Neighbor method is used to determine the distribution system by selecting visit points based on the shortest distance from the starting point. In each iteration, this method searches for the nearest customer location from the last visit to continue (Wulandari, 2020).

The Saving Matrix method is used to determine the distribution system with limited vehicles and different maximum capacities. This method determines the shortest route and lowest transportation costs by combining customers into one route based on the greatest distance savings. Additionally, this method takes into account the demand volume at each destination to ensure that the vehicle's capacity is not exceeded (Mahmud et al., 2022).

The objective of this research, based on the problem formulation presented, is to analyze the current distribution system for industrial spare parts. The study aims to determine a shorter distribution system using the Nearest Neighbor method and to compare this system with an optimized distribution model using the Saving Matrix method, with the goal of reducing operational costs and total travel distance. Additionally, the research seeks to compare the existing distribution system with the systems generated by both the Nearest Neighbor and Saving Matrix methods to identify reductions in operational costs and travel distance.

The benefits of this research are twofold. For the researcher, it provides valuable insights into the Saving Matrix and Nearest Neighbor methods for optimizing distribution routes. For the company, the findings, particularly the optimized distribution routes, can serve as a consideration when determining the most efficient delivery paths for their products.

METHOD

Initial Observation

The initial observation is the first step in this research, aimed at understanding the current state and condition of the company. This observation is conducted to determine the distribution process at PT. XYZ.

Literature Review

The literature review is necessary to address the distribution issues at PT. XYZ, particularly route determination. This review includes theoretical foundations, journals, articles, and books that support the research.

Problem Formulation

The problem formulation in this research is to determine the most accurate route in distribution and the associated costs to make the company's distribution more efficient.

Research Objectives

The research focuses on selecting the most efficient route and optimizing the distribution costs in the distribution process.

Data Collection

Data collection for this report was obtained through direct observation and interviews. The researcher conducted direct Q&A sessions with individuals related to the distribution problems to gather data that supports the research objectives. The following data was collected:

1. The cause of increased distribution costs in 2024.
2. Analysis of the distribution process flow.
3. Total distance between the company and customers.
4. Observations and interviews.
5. Data on the number of vehicles and drivers.
6. Monthly demand from July to December 2024.

Data Processing Using the Nearest Neighbor Method

The Nearest Neighbor method is a simple algorithm used to solve routing or optimization problems. In this method, the route is selected iteratively by always choosing the closest point from the current location that hasn't been visited yet. This method is intuitive and fast but does not always provide an optimal solution as it only considers local solutions, not global ones.

Detailed steps of the Nearest Neighbor method:

1. Prepare the Distance Matrix: This matrix shows the distances between all points, including the depot (starting point).
2. Choose the Starting Point: Typically, the depot is used as the starting and ending point.
3. Find the Nearest Point: From the current point, find the nearest point that hasn't been visited yet using the smallest distance value in the distance matrix row.
4. Mark the Point as Visited: After selecting the nearest point, add it to the route and mark it as visited.
5. Repeat Until All Points Are Visited: Continue the process of selecting the nearest point until all points are visited.
6. Return to the Starting Point: After all points are visited, return to the starting point (depot) to complete the route.

Data Processing Using the Saving Matrix Method

The Saving Matrix method is used to solve routing optimization problems, aiming to reduce the total travel distance or costs by combining smaller routes into one more efficient route.

Detailed steps of the Saving Matrix method:

1. Prepare the Distance Matrix: This matrix shows the distances between all points, including the depot (starting point).
2. Calculate the Savings for Each Point Pair: The saving value for each pair of points can be calculated using the Saving Matrix formula (see Formula 2.2).
3. Create the Saving List: Sort the saving values from highest to lowest.
4. Merge Routes Based on Savings Values: Start with the pair with the largest saving value, merging points into the route if no conflict arises with existing routes.
5. Repeat Until All Points Are in the Route: Continue the process until all points are included in valid routes.

Analysis Results

The analysis is conducted to find a solution after data processing. The results of the analysis are used as suggestions for improving the distribution system by minimizing total travel distance, thus reducing operational costs and increasing distribution efficiency.

Conclusion and Recommendations

After data collection and processing, the results are linked with existing theories, and conclusions are drawn. The research ends with suggestions for improvements based on the findings. The results can be used as considerations by the company for refining the distribution system to reduce operational costs and improve distribution efficiency.

RESULT AND DISCUSSION

Company Overview

PT. XYZ is a company engaged in the procurement of industrial spare parts. PT. XYZ is located at Graha Prima M 10 No. 21 RT 01/ RW 25, Bekasi Regency, Mangun Jaya Subdistrict, Tambun Selatan Village, West Java.

Company Organizational Structure

The company's organizational structure can be seen in Figure 4.1.

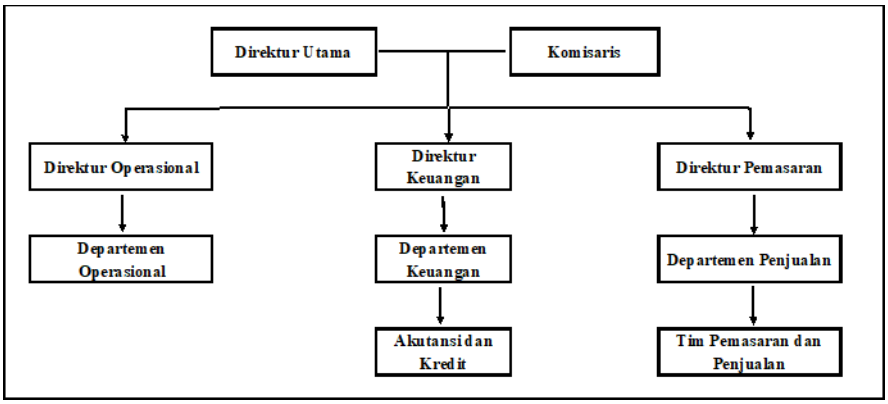

Figure 2. Organizational Structure

(Source: Data Collection)

Order Data from July to December 2024

The order data for PT. XYZ from July to December 2024 is shown in the table below.

Table 1. Order Data for July 2024

No. Invoice (CT)	INVOICE NOTE	Part Code	QTY
285	KABEL IFM	KIFM	1
286	FLOATING SS	FS	70
287	SEAL CAMLOCK VTN	SCVTN	25
288	SENSOR DAN SEAL	S & S	30
289	SEAL CAMLOCK DAN HOSE	SC&HS	10
290	FILTER SMC	FSMC	2
291	RCBO	RCBO	25
292	PERTINAX	PI	24
293	FLEXIBLE HOSE	FH	13
294	FITING	FT	10
295	V.BUTTERFLAY	VBR	22
296	REGULTOR NITROGEN	RN	15
297	TEMBAGA	TB	1
298	HANDIL	HD	55
299	RODA JACK 10"	RJ10	80
300	GMO	GMO	35
301	PRESSURE GAUGE	PG	60

(Source: Data Collection)

Table 2. Order Data for August 2024

No. Invoice (CT)	INVOICE NOTE	Part Code	QTY
302	ROTARY LAMP	RL	70
303	TEM GAUGE	TG	35
304	KABEL TIES	KT	8
305	MCCB DAN HANDLE	MCCB & HD	15
306	HANDLE PUMP	HP	15
307	BAUT	BT	3.500
308	TERMOSTAT	TO	20
309	BUCKLE WING	BW	5
310	TOP TOL	TT	100
311	BENCH DRILL	BD	40
312	CAMLOCK	CL	5
313	DN70000	DN70000	2
314	FLUKE	FU	23
315	KABEL NYAF	KN	4
316	GMO	GMO	17
317	ADAPTER	AP	20
318	KUNCI PANEL	KP	7
319	FILTER OLI	FO	10
320	IFM TP3237	ITP3237	2
321	COVER SENSOR	CS	20
322	FDLOCK	FL	40
323	TIRAI LAS	TL	5
324	VALUE VACUM	VV	15
325	FLEXIBLE HOSE	FH	120
326	OIL SEAL	OS	1.150

(Source: Data Collection)

Table 3. Order Data for September 2024

No. Invoice (CT)	INVOICE NOTE	Part Code	QTY
327	FLOW METER	FM	12
328	RODA 10INCH	RD10INCH	8
329	ORING SEAL	OS	5
330	BAUT	BT	150
331	MATERIAL WOPP	MW	55
332	CAMLOCK	CL	30
333	TOOLS	TL	150
334	REGULTOR NITROGEN	RN	15

335	DEWALT CORDLRSS	DC	7
336	OLI DAN FESTO	O&F	10
337	OVERLOAD	OL	5
338	B.VALVE	B.V	10
339	MCCB DAN ISOLASI	BV	8
340	KABEL	KB	4
341	PROXIMITY SWITC	PS	12
342	TOPTUL	TT	35
343	NOZZLE	NZ	7
344	POTENSIO	PE	10
345	3 WAY B.VLV	3W	8
346	B.VALVE	BV	5
347	FILTER STAUFF	FS	15
348	NEW COMPRESOR	NC	50
349	BOLA PELAMOUNG	BP	70
350	PROPELER SHAFT	PS	45
351	SIRINE	SI	300

(Source: Data Collection)

Table 4. Order Data for October 2024

No. Invoice (CT)	INVOICE NOTE	Part Code	QTY
352	FLEXIBLE JOINT	FJ	120
353	FILTER SOLAR	FS	12
354	KABEL	KB	6
355	COVER MCCB	CMCCB	4
356	FLEXIBLE COUPLING RUBBER	FCR	7
357	FILTER OLI 140MICRON	FO140M	20
358	LEVEL GAUGE	LG	16
359	THERMOCOPLE	TM	9
360	OIL SEAL	OS	40
361	MALE CON	MC	12
362	B.VALVE TOMOE	BVT	4
363	TANG	TN	12
364	TOPTUL SET	TTS	5
365	PEGBOARD	PB	2
366	GUN SPARY	GS	6
367	B.VALVE	BV	12
368	FDLOCK	FL	13

369	FLEXIBLE HOSE	FH	10
370	TOOLS	TL	125
371	FILTER SMC	FSM	18
372	RCBO	RCBO	6
373	PERTINAX	PT	4
374	BOLA PELAMOUNG	BP	8
375	FITING	FT	5
376	PRESS JACK	PJ	120
377	PANEL SAMBARATA	PS	100
378	OIL SEAL DAN SOKET	OS&S	80

(Source: Data Collection)

Table 5. Order Data for November 2024

No. Invoice (CT)	INVOICE NOTE	Part Code	QTY
379	COVER MCCB	CMCCB	12
380	CHICHOGO COUPLING	CC	8
381	TIRE LEVER DAN W.CHOCK	TL&WC	30
382	ACTUATOR KITZ	AK	22
383	BEARING SET 1219K	BS1219K	14
384	WHEEL CHOOK SMELL	WCS	5
385	MECHANICAL SEAL CDLF-12	MSCDLF12	9
386	POMPA SEDOT	PS	6
387	SIRINE MS290	SMS290	55
388	ORING KIT	OK	4
389	FLEXIBLE HOSE	FH	25
390	PRESS JACK	PJ	12
391	PEGBOARD	PB	5
392	GUN SPRAY	GS	35
393	FDLOCK	FL	15
394	TOOLS	TO	15
395	DIGITAL METER	DM	7
396	EYEWASHBAND IT	EBI	30
397	ADAPTOR SOCKET	AS	15
398	MOTOROLA	MR	8
399	RELAY OMRON	RO	12
400	B. VALVE SANKYO	BVS	2
401	POMPA SEDOT	PS	14
402	SIRINE MS290	SMS290	130

403	ORING KIT	OK	35
404	APD	AD	450

(Source: Data Collection)

Table 6. Order Data for December 2024

No. Invoice (CT)	INVOICE NOTE	Part Code	QTY
405	MATERIAL MSM	MMSM	25
406	TERMOCOPLE	TC	10
407	TRANSMITER	TM	32
408	SOCKET IMPACT	SI	15
409	OLI DELTALUBE	OD	135
410	FILTER Y STAINER 3"	FYS3	7
411	BSS TOOL IMPACT	STI	5
412	IFM TP3237	ITP3237	2
413	TERMO.TYPE K	TTK	8
414	HI	HI	10
415	BAUT	BT	70
416	TERMOSTAT	TM	25
417	BUCKLE WING	BW	3
418	TOP TOL	TT	15
419	BENCH DRILL	BD	4
420	CAMLOCK	CL	15
421	DN70000	DN70000	7
422	FLUKE	FU	10
423	KABEL NYAF	KN	3
424	GMO	GMO	13
425	ADAPTER	AP	25
426	PRESSURE GAUGE	PG	14
427	KUNCI PANEL	KP	430
428	FILTER OLI	KO	15
429	IFM TP3237	ITP3237	12
430	ADAPTOR SOCKET	AS	25
398	MOTOROLA	MR	3

(Source: Data Collection)

Distribution Cost Increase Data for 2024

Can be seen in Table 7. Distribution Costs for the period July to December 2024.

Table 7. Distribution Costs July-December 2024

No	Month	Distribution Costs July-December 2024
1	July	Rp10.900.000
2	August	Rp10.250.000
3	September	Rp10.550.000
4	October	Rp11.200.000
5	November	Rp12.550.000
6	December	Rp11.900.000

(Source: Data Collection)

When compared with the distribution costs in the period from July to December 2023, the results obtained were quite high, namely Rp. 18,750,000. The distribution costs in the period from July to December 2023 can be seen in Table 8.

Table 8. Distribution Costs July-December 2023

No	Month	Distribution Costs July-December 2023
1	July	Rp8.200.000
2	August	Rp8.100.000
3	September	Rp8.000.000
4	October	Rp8.100.000
5	November	Rp8.100.000
6	December	Rp8.100.000

(Source: Data Collection)

Company Location Data with Consumers Based on Coordinate Points

Can be seen in Table 9. Company location data based on coordinate points.

Table 9. Company Location Data Based on Coordinate Points

No	Outlet Name	Location X	Location Y
1	Company Location	-6,22806116273296	107,059975793907
2	LTC Glodok Jaya	-6,14509821421098	106,817519822742
3	Mangga Dua Square	-6,13867742069341	106,831702068767
4	Depot Tanto	-6,11343155477059	106,875653426715
5	PT. Dnx Indonesia	-6,25689663925063	106,810399024591
6	PT. Cipta Krida Bahari	-6,29211527702542	106,814160613185

7	PT. Sinar Mulia Ekpres	-6,15756479770071	106,681673948612
8	PT. Sanggar Sarana Baja	-6,25121434820269	106,497695724591
9	PT. Multi Equipment Indonesia	-6,26527341661543	106,597427611812
10	Intan Pertiwi Industri	-6,15645432511543	106,656888538084

(Source: Data Collection)

Vehicle Data and Transport Capacity

Can be seen in Table 10. Vehicle transport capacity data.

Table 10. Vehicle Data

Vehicle Type	Carrying Capacity	Number of Units
Daihatsu Grand Max	907,185 Kg / 1 Ton	2

(Source: Data Collection)

The type of vehicle used by PT. XYZ is a Daihatsu Grand Max Pickup with a carrying capacity of 907.185 kg or equivalent to 1 ton, with 2 vehicles, and 2 drivers and 2 assistant drivers. With a delivery time of 4 times within 1 month, due to damage and uncertain consumer needs.

Data on the Distance of the Company's Location to the Consumer's Location

Can be seen in Table 11. Data on the distance between the Company's location and the consumer's location.

Table 11. Data on the distance between company location and consumer location

	Consumer	Distance/Km
LTC Glodok Jaya	Mangga Dua Square	4,2
	Depot Tanto	10,5
	PT. Dnx Indonesia	14,9
	PT. Cipta Krida Bahari	16,3
	PT. Sinar Mulia Ekpres	22,5
	PT. Sanggar Sarana Baja	19,6
	PT. Multi Equipment Indonesia	34,6
	Intan Pertiwi Industri	31,3

Initial Distribution Route

The initial distribution route is the first route taken by a driver. The distribution system that has been implemented by PT. XYZ.

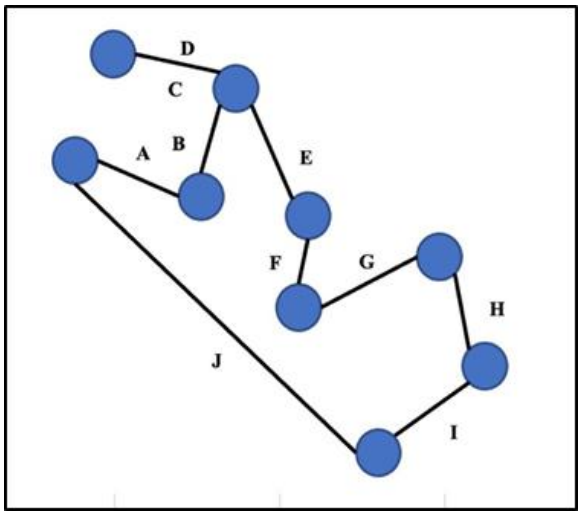

Figure 3. Initial Distribution Route

(Source: Data Collection)

From Figure 3. the initial distribution route is explained as follows:

1. Route A = 4.2 kilometers
2. Route B = 6.7 kilometers
3. Route C = 2.8 kilometers
4. Route D = 2.8 kilometers
5. Route E = 45.6 kilometers
6. Route F = 46.7 kilometers
7. Route G = 36.1 kilometers
8. Route H = 17.1 kilometers
9. Route I = 24.8 kilometers
10. Route J = 31.3 kilometers

From the initial distribution route above, the total distance obtained is 218.1 kilometers.

Distance Matrix

A distance matrix is a tabular representation that shows the usual distances between locations. It can be seen in Table 12.

Table 12. Distance Matrix

	Warehouse	C1	C2	C3	C4	C5	C6	C7	C8
C1	4,2	0							
C2	10,5	6,7	0						
C3	14,9	24,7	28,7	0					
C4	16,3	17,3	45,6	7,9	0				

C5	22,5	24,7	31,2	35,9	46,7	0			
C6	19,6	37,2	45,5	6,4	1	36,1	0		
C7	34,6	48	54,5	47,8	18,5	32,9	17,1	0	
C8	31,3	2,5	39,7	16,2	37,9	11,2	37,8	24,8	0

(Source: Data Processing)

Total Distribution Costs from July to December 2024

Total distribution costs from July to December 2024 can be seen in Table 13.

Table 13. Total Distribution Costs from July to December 2024

Route	Distance	Distance per 1 Liter	Fuel Cost	Etoll	Total cost
Route A	4,2	12,5	Rp 10.000	Rp 150.000	Rp 324.480
Route B	6,7				
Route C	2,8				
Route D	2,8				
Route E	45,6				
Route F	46,7				
Route G	36,1				
Route H	17,1				
Route I	24,8				
Route J	31,3				
Total Overall Distance	218,1	17,448	Rp 174.480		

(Source: Data Collection)

can be seen in Table 13. the total distribution cost in 1 week is Rp 324,480. Within a period of 6 months the total distribution cost required is Rp 15,574,040.

With the additional cost of one dinner for drivers who work overtime of Rp 15,000. From the results of the interview session within a period of 6 months the driver has worked overtime for the last 4 months with a total cost of consumption and fuel costs wasted due to traffic jams of Rp 3,174,960. From the total results obtained, the results are the same as the results of the initial observation and from the results of the interview session, namely Rp 18,750,000.

Data Processing

Nearest Neighbor Method

It can be seen in Figure 4. The initial distribution route proposal uses the Nearest Neighbor method.

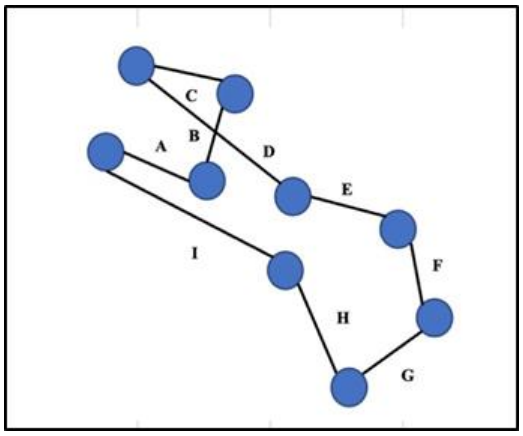

Figure 4. Proposed Distribution Route

(Source: Data Processing)

From Figure 4. the proposed distribution route using the Nearest Neighbor method, the explanation is as follows:

1. Route A = 4.2 Kilometers
2. Route B = 6.7 Kilometers
3. Route C = 2.8 Kilometers
4. Route D = 7.9 Kilometers
5. Route E = 1 Kilometer
6. Route F = 17.1 Kilometers
7. Route G = 24.8 Kilometers
8. Route H = 11.2 Kilometers
9. Route I = 22.5 Kilometers

The total distance of the proposed distribution route using the Nearest Neighbor method is 98.8 Kilometers, compared to the initial distribution route distance of 218.1 Kilometers. With a total distance savings of 119.9 Kilometers.

Saving Matrix Method

Can be seen in Table 14. Saving Matrix Calculation.

Table 14. Saving Matrix Calculation

Location Pair	*d(i, G)*	*d(j, G)*	*d(i, J)*	*S(i, J)*
Mangga Dua Square - Depot Tanto	4,2	10,5	6,7	8,0
Depot Tanto - PT. Dnx Indonesia	10,5	14,9	27,7	-2,3
PT. Dnx Indonesia - PT. Cipta Krida Bahari	14,9	16,3	39,8	-8,6
PT. Cipta Krida Bahari - PT. Sinar Mulia Ekpres	16,3	22,5	40,6	-1,8
PT. Sinar Mulia Ekpres - PT. Sanggar Sarana Baja	22,5	19,6	36,1	6,0

PT. Sanggar Sarana Baja - PT. Multi Equipment Indonesia	19,6	34,6	36,4	17,8
PT. Multi Equipment Indonesia - Intan Pertiwi Industri	34,6	31,3	20,7	45,2

(Source: Data Processing)

From the calculation results of the Saving Matrix in Table 14. an example of calculating the Saving value is as follows:

1. 4.2+10.5-6.7=8.0
2. 10.5+14.9-27.7=-2.3
3. 14.9+16.3-39.8= -8.6
4. 16.3+22.5-40.6= -1.8
5. 22.5+19.6-36.1=6.0
6. 19.6+34.6-36.4=17.8
7. 34.6+31.3-20.7=45.2

From the calculation results of the Saving Matrix above, the largest to the smallest saving values can be obtained.

1. PT. Multi Equipment Indonesia - Intan Pertiwi Industri with a saving value of 42.5
2. PT. Sanggar Sarana Baja - PT. Multi Equipment Indonesia with a saving value of 17.8
3. Mangga Dua Square - Depot Tanto with a saving value of 8
4. PT. Sinar Mulia Ekpres - PT. Sanggar Sarana Baja with a saving value of 6
5. PT. Cipta Krida Bahari - PT. Sinar Mulia Ekpres with a saving value of -1.8
6. Depot tanto – PT. Dnx Indonesia with a saving value of -2.3
7. PT. Dnx Indonesia – PT. Cipta Krida Bahari with a saving value of -8.6

The negative result in the calculation of savings shows that visiting the two locations simultaneously does not provide savings in terms of distance. The savings are negative, it is more efficient to visit the locations separately than to combine them in one route.

The following are routes formed based on the Saving Matrix method and the order of highest to lowest savings:

1. LTC Glodok Jaya
2. Mangga Dua Square
3. Depot Tanto
4. PT. Dnx Indonesia
5. PT. Cipta Krida Bahari
6. PT. Sinar Mulia Ekpres
7. PT. Sanggar Sarana Baja
8. PT. Multi Equipment Indonesia
9. Intan Pertiwi Industri

Total Distribution Cost Using Nearest Neighbor and Saving Matrix Methods

Table 15. Total Distribution Costs Using the Nearest Neighbor and Saving Matrix Methods

Route	Distance	Distance per 1 Liter	Fuel Cost	Etoll	Total cost
Route A	4,2	12,5	Rp 10.000	Rp 150.000	Rp 230.880
Route B	6,7				
Route C	2,8				
Route D	7,9				
Route E	1				
Route F	17,1				
Route G	24,8				
Route H	11,1				
Route I	25,5				
Total Overall Distance	101,1	8,088	Rp 80.880		

(Source: Data Processing)

It can be seen in Table 15. the calculation of the total distribution cost that has been obtained using the Nearest Neighbor Method and Saving Matrix in one week is Rp 230,880. In a period of one year, the total distribution cost required is Rp 11,082,240 with the following calculation example:

1. (Total overall distance) / (Distance / Liter) = Result
2. 101.1 / 12.5 = 8,088
3. Distance / Liter X Price of 1 Liter Fuel = Result
4. 8,088 X 10,000 = Rp 80,880
5. Total Price of Fuel + Etoll = Result
6. Rp 80,880 + Rp 150,000 = Rp 230,880

Research Results and Discussion

Based on the results of data collection and processing above, it can be proven that the Nearest Neighbor method and the Saving Matrix method have proven effective in the spare parts distribution system at PT. XYZ. Where the initial distribution route has a total distance of 218.1 kilometers, and the total distribution cost for one year reaches Rp 18,750,000. The application of the Nearest Neighbor method has succeeded in reducing the distance traveled to 98.8 kilometers, saving 119.9 kilometers compared to the initial route. The Saving Matrix method also shows significant distance savings. The total distribution cost using the Nearest Neighbor and Saving Matrix methods is Rp 230,880 per week, or Rp 11,082,240 per year, much lower than the initial cost. In conclusion, the application of these two methods is effective in reducing distance and distribution costs, so it is recommended to be implemented by PT. XYZ in the future.

CONCLUSION

Based on the analysis conducted in this study, several conclusions can be drawn. The initial distribution system used had a total distance of 218.1 kilometers with 10 delivery routes, and a weekly distribution cost of Rp 324,480. The annual distribution cost amounted to Rp 15,574,040, with additional costs for driver overtime and fuel due to traffic congestion totaling Rp 3,174,960. As a result, the total distribution cost from July to December 2024 was Rp 18,750,000.

By implementing the Nearest Neighbour method, the total distribution distance was optimized to 98.8 kilometers, resulting in a saving of 119.9 kilometers compared to the initial route. The number of delivery routes decreased to 9, and the weekly distribution cost was reduced to Rp 230,880, with the total distribution cost from July to December 2024 amounting to Rp 11,082,240.

Similarly, the Saving Matrix method produced an equally efficient distribution route, with a total distance of 98.8 kilometers and a reduction in the number of routes to 9. The weekly distribution cost remained at Rp 230,880, resulting in a total of Rp 11,082,240 for the last six months of 2024.

The implementation of either of these methods led to an annual distribution cost saving of Rp 7,667,760. Additionally, the reduction in total distribution distance directly contributed to fuel efficiency, shorter travel times, and lower operational costs.

Suggestion

It is recommended that the company implement the Nearest Neighbour or Saving Matrix optimization methods for distribution routes to reduce travel distance and distribution costs. Additionally, optimizing the operational schedule to prevent driver overtime will help minimize extra costs associated with fuel consumption and excessive working hours. Regular evaluations of the distribution methods should be conducted to ensure their effectiveness and make adjustments as needed based on changes in operational conditions or routes. Providing training for drivers on fuel management and utilizing more efficient routes will further support the successful application of these new methods. By adopting these steps, the company can enhance distribution efficiency, reduce operational costs, and improve its competitiveness in the market.

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