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Efficiency Analysis Of Illona Tissue Product Distribution Route With Saving Matrix & Nearest Neighbour Method

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ABSTRACT

The current era of globalization makes all components in an economic or business activity experience significant acceleration and change starting from production, distribution, and consumption. The distribution of goods and services is one of the fundamental aspects of business activities, which has a significant impact on the overall success of the company. Therefore, it is imperative for companies to plan their distribution activities in an efficient manner. The purpose of this study is to design efficient alternative routes that minimize distance, time, and distribution costs by considering customer/outlet locations, total demand, and vehicle capacity. This research was conducted at PT Juragan Gemilang Indonesia located in Purwokerto city, the research focused on Illona tissue products by using two analysis methods, namely saving matrix and nearest neighbor method which resulted in saving the number of routes from 11 to 8 and several other savings, such as 44.49% (2,540 km to 1,410 km) for distance, 33.61% (3,904 minutes to 2,592 minutes) for time, and 44.49% (IDR 1,727,200 toIDR 958,800) for cost.

Keywords: distribution, route; efficiency, saving matrix, nearest neighbor, tissue product.

1. Introduction

The current era of globalization makes all components in an economic or business activity experience significant acceleration and change starting from production, distribution, and consumption. One component, namely distribution, has a crucial role in the sustainability of business activities of manufacturing companies (Makanyeza et al. 2023), retail (Cron et al. 2023), and trade (Sutaguna et al. 2023). Efforts to win the competition in the industrial development that occurs, companies need to take actions, such as increasing customer satisfaction through existing cost efficiency and also timeliness in the distribution process (Pratama, 2020).

For companies engaged in the manufacturing, retail and distribution industries, of course, they need proper distribution route planning to deliver and market their products optimally for the success of the company. One of the companies engaged in this field is PT Juragan Gemilang Indonesia which is located in Purwokerto city, Banyumas regency, Central Java. PT Juragan

Gemilang Indonesia currently has 10 branches spread across 5 cities in Java, precisely in the cities of Purwokerto, Magelang, Pemalang, Tasikmalaya, Kuningan and Bekasi.

One of the main products that has a high demand is Illona tissue products. The high and varied number of existing requests makes the delivery process, especially the selection of distribution routes, a determining factor to meet the needs of these requests with fast and precise delivery. However, in the current practice of the Illona tissue product distribution process, there is still no route scheduling that is used as a reference in each delivery process so that there is potential for inefficiency and there is an opportunity for making routes that are more efficient in the distribution process.

The use of saving matrix and nearest neighbor methods is needed to determine the right route and reduce waste of travel time through the selection and merging of routes with the shortest distance to create an optimal route in the delivery process.

2. Literature Review

2.1 Distribution Management

Distribution management is a strategy in developing distribution channels from planning (planning), organizing (organization), operating (operation), and supervision (controlling), in order to achieve company goals. The distribution circuit itself is a means of distributing goods from producers to consumers or end users through intermediary channels.

2.2 Efficiency

According to Yudawisastra (2023), Efficiency is a comparison between the activities carried out and the results related to each other, with the aim of improving the quality of the company. Efficiency can be a criterion or tool for measuring the level of organizational performance, which identifies factors that tend to hinder organizational activities. There are several types of efficiency factors: when less input is required, it can create the same results, or with the same input, it can create greater results; when less input is required, it can also create greater results.

2.3 Saving Matrix

Saving matrix is a method used to determine the route between the product delivery process and the marketing destination point by determining the delivery process that must be passed based on vehicle capacity in order to obtain the shortest distribution route and the lowest distribution cost. Saving matrix is a tool used to create a program with a limited number of vehicles, but maximize their capacity to deliver products according to the number of destination point needs. (Soeraningsih, 2022).

2.4 Nearest Neiighbor

The Nearest Neighbor method is an algorithm used in the Vehicle Routing Problem (VRP) to determine the distribution path by selecting the nearest outlet as the next destination from the initial point visited. This method is a simple and fast way to solve VRP, but it does not guarantee an optimal solution because the decision is only based on the nearest outlet at each stage which provides limitations. Choosing the nearest outlet as the next destination, this method can minimize the total distance traveled by the vehicle in visiting all outlets.

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3. Research Methodology

3.1 Saving Matrix

Analysis using the saving matrix requires the following steps

- Identifying the Distance Matrix

- Identifying the Savings Matrix
- Allocate outlets into routes based on location
- Sort outlets into defined routes

3.2 Nearest Neighbor

According to Amri et.al. (2020) several steps are taken to apply the nearest neighbor method.

- Determine the center point to be the zero point in the delivery route.
- Determine the outlet with the closest distance from the warehouse which becomes the first destination point and merge the route.
- The last point visited becomes the starting point and find the closest point from the last point visited.
- Perform repetition by considering the maximum capacity of the vehicle.
- This point is called a delivery route, the capacity of the vehicle is a constraint in delivery.
- Do the same process, by doing the first step until the last step.

3.3 Efficiency

$$Distance\ Efficiency = \frac{Distance\ Route\ (Old) - Distance\ Route\ (New)}{Distance\ Route\ (Old)} x\ 100\%$$

$$Time\ Efficiency = \frac{Time\ Route\ (Old) - Time\ Route\ (New)}{Time\ Route\ (Old)} x\ 100\%$$

$$Cost\ Efficiency = \frac{Cost\ Route\ (Old) - Cost\ Route\ (New)}{Cost\ Route\ (Old)} x\ 100\%$$

4. Results

4.1 Saving Matrix

- Identifying the Distance Matrix

Table 1 Distance Matrix of the first 10 outlets

	G	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10
G	0										
C1	62	0									
C2	56	6	0								
C3	38	80	76	0							
C4	44	71	68	6	0						
C5	49	70	66	10	9	0					
C6	72	115	106	113	118	121	0				
C7	34	38	34	69	74	84	70	0			
C8	33	95	89	33	38	43	78	63	0		
C9	24	60	54	25	31	36	85	56	7	0	
C10	81	97	100	125	130	135	21	54	93	100	0

- Identifying the Savings Matrix

Table 2 Saving Matrix of the first 10 outlets

	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10
C1	0									
C2	112	0								
C3	20	18	0							
C4	35	32	76	0						
C5	41	39	77	84	0					
C6	19	22	-3	-2	0	0				
C7	58	56	3	4	-1	36	0			
C8	0	0	38	39	39	27	4	0		
C9	26	26	37	37	37	11	2	50	0	
C10	46	37	-6	-5	-5	132	61	21	5	0

- Allocate outlets into routes based on location

Table 3 Defined Route Group

ROUTE	OUTLET	DEMAND
1	C57-C58-C52-C49-C21-C15-C1-C6	415
2	C4-C3-C5-C8-C9-C16-C24-C26	417
3	C33-C35-C37-C38-C39-C40-C45	420
4	C53-C54-C55-C22-C23-C25-C51	420
5	C18-C19-C20-C31-C32-C36-C28-C17-C34-C44	413
6	C29-C30-C41-C42-C43-C46-C47-C48-C50	398
7	C59-C60-C61-C62-C27	361
8	C1-C2-C7-C11-C12-C13-C14-C56	372

4.2 Nearest Neighbor

- Determine the center point to be the zero point in the delivery route.
- Determine the outlet with the closest distance from the warehouse which becomes the first destination point and merge the route.
- The last point visited becomes the starting point and find the closest point from the last point visited.
- Perform repetition by considering the maximum capacity of the vehicle.
- This point is called a delivery route, the capacity of the vehicle is a constraint in delivery.
- Do the same process, by doing the first step until the last step.

Table 4 Visit Order with Nearest Neighbor Method

ROUTE	ORDER OF VISIT
1	G-C52-C49-C21-C15-C6-C58-C57-C10-G
2	G-C24-C26-C16-C8-C9-C3-C4-C5-G
3	G-C38-C33-C39-C45-C40-C37-C35-G
4	G-C25-C51-C54-C53-C55-C22-C23-G
5	G-C17-C28-C36-C34-C44-C31-C32-C18-C19-C20-G
6	G-C50-C43-C42-C41-C48-C46-C29-C30-C47-G
7	G-C27-C62-C61-C62-C59-G
8	G-C56-C13-C14-C11-C7-C12-C2-C1-G

The table above shows the sequence of visits starting from the warehouse as the zero point of delivery then continuing with the first outlet, second and so on until returning to the warehouse.

4.3 Efficiency

$$Distance\ Efficiency = \frac{2.540\,km - 1.410\,km}{2.540\,km} x\ 100\%$$

$$= 44{,}49\ \%$$

$$Time\ Efficiency = \frac{3.904\,minutes - 2.592\,minutes}{3.904\,minutes} x\ 100\%$$

$$= 33{,}61\%$$

$$Cost\ Efficiency = \frac{IDR\ 1.727.200 - IDR\ 958.800}{IDR\ 1.727.200} x\ 100\%$$

$$= 44{,}49\%$$

5. Discussion

In this study, several savings results were obtained ranging from mileage to costs incurred in the process of shipping Illona tissue products based on previously obtained data. First, there is a reduction in shipping routes from 11 routes to 8 routes due to the process of merging several outlet routes based on the saving matrix. Second, the distance traveled on the route which was originally 2,540 km was reduced to 1,410 km, thus showing a mileage efficiency of 44.49%. Furthermore, for travel time from the initial route of 3,904 minutes to 2,592 minutes, which means there is an efficiency of 33.61%. Finally, the costs incurred on the initial distribution route amounted to IDR 1,727,200, after the savings were reduced to IDR 958,800, resulting in an efficiency of 44.49%.

The results of these calculations are the application of the saving matrix method which identifies savings from combining routes so as to create new, more efficient routes and the use of the nearest neighbor method which serves to identify the order of outlet visits from each route starting from the warehouse to return to the warehouse.

These results are in line with several previous studies that researchers have used as references, such as Pratama (2020), Trisna et al (2019), Andalia et al. (2021), Permatasari & Lukmandono (2024), Aksari et al. (2023), and Lestari et al. (2022)

6. Conclusion

The findings are as follows;

- Saving 11 routes to 8 routes with a combination of new route groups and the order of visits starting from point zero (warehouse) proceeding to the nearest point from the last visited point.
- The mileage efficiency of 44.49% is a saving from 2,540 km to 1,410 km.
- Travel time efficiency of 33.61% is a savings from 3,904 minutes to 2,592 minutes.
- Cost efficiency of 44.49% is a savings from IDR 1,727,200 to IDR 958,800.

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