Distribution Route Optimization of Newspaper Publishing Company with Saving Matrix Method and Milk-Run System

Adindha Karunia Ciptaning Pragowoaji, Iksan Widiantoro Restuaji, and Yusuf Fardhan Nurdianto
Industrial Engineering Department, Faculty of Engineering, Universitas Sebelas Maret
Jl. Ir. Sutami, 36A, Surakarta, Indonesia
adindha.karunia.c.p@student.uns.ac.id, iksanwidiantoro@student.uns.ac.id,
yusuf.fardhan12@student.uns.ac.id

Arinda Soraya Putri
Industrial Engineering Department, Faculty of Engineering,
Universitas Muhammadiyah Surakarta
Jl. Ahmad Yani Tromol Pos 1, Pabelan, Kartasura, Surakarta, Indonesia
asp835@ums.ac.id

Wahyudi Sutopo
University Centre of Excellence for Electrical Energy Storage Technology,
Universitas Sebelas Maret
Jl. Ir. Sutami, 36 A, Surakarta, Indonesia
wahyudisutopo@staff.uns.ac.id

Yuniaristanto
Research Group Industrial Engineering and Techno-Economic, Industrial Engineering Department, Faculty of Engineering, Universitas Sebelas Maret
Jl. Ir. Sutami, 36 A, Surakarta, Indonesia
yuniaristanto@ft.uns.ac.id

Abstract

The rapidly growing communication technology brings not only an opportunity but also a challenge to the printing industry. Consumers are significantly moving from conventional media to digital. Determining the optimal distribution route to ensure a smooth distribution flow is crucial to retaining customers by providing an optimal service. One of the limitations in the distribution process is related to vehicle capacity *(Capacitated Vehicle Routing Problem)*. Previous research has succeeded in determining a combined route between three newspaper industry companies in Surakarta, but each company still needs optimal independent routes. Using the saving matrix method with the milk-run system, this study aims to determine the optimal route for distributing newspapers independently, focusing on one of the newspaper companies by considering three conditions: when demand increases, decreases, and is static. Nearest Insert and Nearest Neighbor methods are used to optimize the distribution route. The results show that each of the three conditions has two optimal routes. When the demand is static, the total monthly cost is IDR 618,750. When the demand increases, the total cost per month will be IDR 562,650, and when the demand decreases, the total cost per month will be IDR 592,350/month.

Keywords
Capacitated Vehicle Routing Problem (CVRP), Supply Chain Management, Distribution, Saving Matrix, Milk-Run

1. Introduction

The presence of communication technology that is snowballing has become a breath of fresh air for the manufacturing industry in improving the quality of the company's internal and external communications. However, for the printing media industry, the presence of communication technology is not only an opportunity but also a challenge to survive in the digital era (Prihanto, 2018).

The rapid development of communication and information technology has given birth to new digital-based media that have changed people's mass media consumption (Aliudin & Arisanty, 2018). Consumers are significantly moving from conventional media to digital. Print media lost their readers drastically, especially from the young group (Aliudin & Arisanty, 2018). Quoted from Prihanto (2018), based on a survey conducted by Nielsen Consumer & Media View on 17 thousand respondents from a total population of 54 million people, it shows that digital media readers in Indonesia are way more in number than print media readers. In 4 years (2013-2017), newspaper buyers continued to decline due to public perception that information should be obtained for free. The rate of personal newspaper purchases, which reached 28% in 2013, decreased to 20% in the third quarter of 2017. There was an 8% decrease in demand during those four years.

One of the newspaper industries affected by changes in people's behavior is newspaper publishing company. The newspaper industry had relatively short cycle times, tight delivery deadlines, and no inventory system (Riskadayanti et al., 2019). Daily newspapers are now generally only published in the morning. Although evening newspapers used to be quite common, they are now hard to find. Now, because it is published in the morning, the price of the newspaper will tend to fall as the day goes on. Therefore, the smooth distribution of newspapers in the morning is crucial. Due to this pressure, most of the production and distribution processes are usually carried out at night and in a short time.

The results of a case study at a newspaper company in Surakarta illustrate several problems, one of which is a slow distribution process due to the wrong route determination (Saputra et al., 2018). This problem is caused by the Vehicle Routing Problem (VRP), which determines the route with the minimum cost from the depot to the customer with different requests (Amri et al., 2014).

In the research, Jodinesa et al. (2019) has succeeded in determining a combined route between three newspaper industry companies in Surakarta, namely PT. Aksara Solopos, Suara Merdeka, and Jawa Pos. That study proposed routes and plans for distributing newspapers where newspaper products from the three companies will be collected at PT. Aksara Solopos was then distributed to all agents in the Surakarta area. This distribution plan is able to save the total distribution cost of up to IDR 5,516,600/year. However, in an effort to implement it, distribution managers from each company need to conduct further discussions regarding mutual agreements. In this case, each company still needs to have a backup plan that can be implemented if the joint distribution plan has not/cannot be implemented. Based on the description of the newspaper distribution problem at the newspaper publishing company, the Saving Matrix approach with the Milk-Run system was chosen to achieve the ideal distribution route in order to decrease expenses that the firm must spend.

Based on the explanation above, the research aims to determine the optimal route for distributing newspapers independently at the newspaper publishing company by considering three conditions: when demand increases, decreases, and is static.

2. Literature Review

In a study conducted by Damayanti, T. R., et al (2020), the problem of distributing rice to depots owned by logistics companies was attempted to be solved using the saving matrix method, which is to determine the distribution route by specifying the distribution route to be passed and the number of vehicles based on the capacity of the vehicle to obtain the shortest route and minimal transportation costs. The results from the data processing and analyzing shows that the routes change from 18 to 9 new routes, and it obtained the distance saving of 752.2 km or 45.91% from the initial distance of 1638.3 km to 886.2 km. Pamosoaji, A. K., et al (2019) in their research, also focus on distribution companies to evaluate distribution channels for vehicles that deliver goods to depots and outlets. The method used in this research is *Modified Clarke-Wright Saving*, some constraints used in this research such as the maximum allowable traveling time, maximum number of delivery shifts, and maximum number of vehicles. The results from this research are obtained if the distribution channel currently used does not have a significant burden or loss. Saputra, I.W, et al. (2018) studied the best distribution route by considering the time windows. This research aims to obtain the optimal

route and minimum cost of distribution. Optimal route can be determined using a Differential Evolution Algorithm to calculate the shortest route for every agency and maximize the usage of the vehicle using coordinates and demands of the agencies. The result shows that there is an optimal route which has a shorter route and shorter travel time than the existing route in the distribution process. Jodinesa et al. (2019) studied the savings in distributing newspapers to customers with joint delivery planning. The calculation of distribution costs using the Vehicle Routing Problem with Time Windows (VRPTW) approach. The output of this paper is that delivery is carried out simultaneously to save shipping costs, but we must consider the advantages and disadvantages. M. Ilham, (2019). Studied the problem of the distribution process of PT. Riau Pos Intermedia is caused by the absence of an optimal route because vehicles visit different regions which can cause considerable distance, travel time and distribution costs. Therefore, this study aims to minimize distance, time and cost. Then the method used to solve the Vehicle Routing Problems (VRP) by using the Clark and Wright Saving method. The result of this paper is a distribution route that is more optimal than the previous route.

3. Methods

This study carried out data processing using the saving matrix method. According to research by Nur Anisa Fitriani et al. (2021), the saving matrix method was discovered by Clarke and Wright in 1964, where this method is used to save distance, time, and costs by considering existing constraints. In the calculation process, this algorithm uses distance as the main parameter and uses the time to get the value of the most considerable savings and then arranges it into the best route. In addition, this method also combines two or more customers/outlets into one route. The advantage that can be obtained by using this method is to schedule a limited number of vehicles taking into account the maximum capacity of the same or different vehicles. According to Saputra & Pujotomo (2018), the creation of a new distribution pattern is based on the following mathematical model:

1. Objective Function
2. Index
3. Decision Variable
4. Variable Description
5. Constraint

The existing constraint functions are as follows:

- Each customer will be visited only once
- Every vehicle route starts from the warehouse and also ends at the warehouse
- Limit in vehicle capacity
- Every customer demand will be fully fulfilled
- The vehicle must arrive at each customer according to the time windows which have been specified

According to Saputra & Pujotomo (2018), The steps that need to be taken to determine the optimal distribution pattern are as follows:

1. Identifying the distance matrix

This stage requires distance data from the warehouse to each agent, which can be obtained from the coordinates of the warehouse and each agent in kilometres (km).

2. Identifying the savings matrix

At this stage, it assumed that the location would be passed by one truck exclusively. The savings will be obtained if there is a merger for delivery to several destinations. The formulation to get the amount of savings is as follows:

$$S\,(x,y) = J\,(G,x) + J\,(G,y) - J\,(x,y)$$

S(x,y) = Distance Saving
J = Distance
G = Warehouse
x = First order outlet
y = Second order outlet

After obtaining the savings matrix, the next step is to rank the distance savings results from the largest to the smallest.

3. Allocating vehicles and routes by location

The new delivery route will be determined in this stage based on the merged route chosen in the previous step.

4. A route's destination locations are ordered in a particular order

The order of the visits is determined in this stage. There are numerous approaches for establishing the order of visits, and this study will use the Nearest Neighbor and Nearest Insert method.

When determining the visit, the Nearest Neighbor approach prioritizes the nearest location to the previously visited location. Meanwhile, the Nearest Insert approach will focus on consumers who provide the shortest trip, using the principle of choosing an agent which when inserted into an existing route, results in a minimum additional distance (Raihan & Iman, 2017).

This study will also use the Milk Run delivery method. According to Fuad Gary (2011), the history of the milk run system dates back to the past, dairy farmers in Europe store milk in cans and put it on the side of the road in front of their homes. Then the milk collector collects it and sends it to the dairy factory. This is then known as the Milk Run, which has developed into a transportation and distribution system widely applied in the industrial world. Milk run is a proven and tested method of optimizing transport systems. The definition of Milk-run is one of the advanced shipping concepts that can improve transportation management. With the Milk Run system, delivery can occur several times for transportation or dropping off goods at different locations on the same and regular schedule (Vicentius Venda, 2019).

The Milk Run delivery method involves picking up from several locations and then delivering it to a single site or a cargo picked up from multiple suppliers and delivered to a single customer. The following are the benefits of employing this method: it may cut expenses by optimizing the delivery route, may shorten delivery time and quantity, and can be readily utilized, adapted, and applied on all delivery systems.

4. Data Collection

The data used is secondary data taken from previous research (Jodinesa et al., 2019)**.** In the study, researchers determined a combined route between three newspaper industry companies in Surakarta, namely PT. Aksara Solopos, Suara Merdeka, and Jawa Pos. However, the independent distribution route of each company, especially PT. Aksara Solopos remains undetermined. The data from this research is used as the reference data for this research and has been adjusted to the increase and decrease in demand so that it becomes the latest data that is more accurate with the current conditions. This research focuses on the newspaper publishing company script with agents spread across the city of Surakarta.

List of the newspaper publishing company agents and the number of requests from each agent can be seen in Table 1. Referring to (Prihanto, 2018), in a period of 4 years from 2018 to 2021, it is assumed that there are two conditions, increasing and decreasing total demand by 8%. The company has two vehicles for newspaper distribution with a capacity of 2000 copies each.

Table 1. List of Agents and Number of Demand

No.	Code	Agent Name	Demand (copies)		
			Static	Decreased	Increased
1	C1	Surya 1	190	169	211
2	C2	ABC	294	273	315
3	C3	Wahyu	350	329	371
4	C4	Mandira/Kencana	280	259	301
5	C5	ABA	122	101	143
6	C6	Sheva	587	565	608
7	C7	Momok 1	115	94	136
8	C8	Asih	115	94	136
9	C9	Margono 2	315	294	336
Total			2368	2178	2557

Table 2. Coordinate Point of Each Agent

Agent	X	Y
C1	-7.545586	110.77916
C2	-7.545586	110.77916
C3	-7.550793	110.81788
C4	-7.553314	110.820476
C5	-7.553469	110.820597
C6	-7.568512	110.823682
C7	-7.567927	110.81713
C8	-7.572134	110.823997
C9	-7.573876	110.818691

Saving Matrix is a method for determining the distance, route, time, or cost of delivering goods from the enterprise to the customer (Damayanti et al., 2020). The objective of this method is to ensure the delivery of goods can be done effectively and efficiently to save cost, energy, and time. There are several steps in using the Saving Matrix method. The first step is determining the distance matrix between the warehouse and agents. The overall results of the distance matrix calculation can be seen in Table 3. In the next step, a saving matrix will be calculated by assuming that one vehicle would pass the location exclusively. The following example shows the calculation of the distance saving from warehouse to agent A2 to Agent A6.

$$S(x,y) = J(G,x) + J(G,y) - J(x,y) = 0{,}3 + 7{,}7 - 6{,}9 = 1{,}1 \text{ km}$$

Table 3. Distance between Warehouse and Agent (km)

Warehouse		C1	C2	C3	C4	C5	C6	C7	C8	C9
C1	0.2	0								
C2	0.3	0.1	0							
C3	5.3	5.1	5.5	0						
C4	5.1	5.7	5.6	0.2	0					
C5	5.1	5.7	5.6	0.2	0.1	0				
C6	7.7	6.9	6.8	2.8	2.8	2.4	0			
C7	6.8	6.5	6.4	2.8	2.8	2.4	0.8	0		
C8	7.7	8.8	8.7	4.7	4.7	4.3	0.5	2.8	0	
C9	7.5	7.7	7.6	3.6	3.6	3.2	1.1	0.9	0.9	0

Table 4. Saving Matrix

	C1	C2	C3	C4	C5	C6	C7	C8	C9	Demand (copies)
C1	0									169
C2	0.4	0								273
C3	0.4	0.5	0							329
C4	-0.4	-0.3	4.7	0						259
C5	-0.4	-0.3	4.7	4.5	0					101
C6	1	1.1	6.1	5.9	5.9	0				565
C7	0.5	0.6	5.6	5.4	5.4	8	0			94
C8	-0.9	-0.8	4.2	4	4	6.6	5.7	0		94
C9	0	0.1	5.1	4.9	4.9	7.5	6.6	7.5	0	294

The operational costs of the company include vehicle operating costs and fuel costs. The company uses third-party services, so they only need to pay a rental fee of IDR 650,000/ month for each vehicle plus the fuel costs. The calculation later assumes that 1 liter of fuel can cover a distance of 10 km, and 1 liter of Solar fuel costs IDR5,500.

5. Results and Discussion

Table 4 presents the significant distance between agents using the saving matrix method. Then, agents that can be combined into one route to obtain the shortest distance, maximize delivery time and consider the vehicle capacity can be seen. The calculation results show that there are two routes to optimize the distribution of newspapers. Each route will use the nearest insert and nearest neighbor method to arrange the distribution order.

5.1 Numerical Results

Here are the results of calculating the optimal route with Microsoft Excel. Table 5 calculates the distance and distribution route using the nearest insert and nearest neighbor approach, with three conditions: static demand, demand increases, and demand decreases. Each of the demand conditions has two distribution routes. Table 6 summarizes vehicle fuel costs using two optimal routes from the nearest insert and nearest neighbor approaches.

Table 5. Recapitulation of Calculation Result

	Route	Method	Distribution Order	Total Distance
Static Demand	Route 1	Nearest Insert	W-C1-C4-C7-C6-W	15.2
		Nearest Neighbor	W-C1-C4-C7-C6-W	24.5
	Route 2	Nearest Insert	W-C2-C5-C3-C9-C8-W	22.3
		Nearest Neighbor	W-C2-C3-C5-C9-C8-W	22.3
Demand Increases	Route 1	Nearest Insert	W-C4-C5-C7-C6-G8-W	16.4
		Nearest Neighbor	W-C4-C5-C7-C6-C8-W	16.6
	Route 2	Nearest Insert	W-C1-C2-C3-C9-W	17.7
		Nearest Neighbor	W-C1-C2-C3-C9-W	17.7
Demand Decreases	Route 1	Nearest Insert	W-C5-C3-C7-C6-W	16.6
		Nearest Neighbor	W-C5-C3-C6-C7-W	16.1
	Route 2	Nearest Insert	W-C1-C2-C4-C9-C8-W	19.8
		Nearest Neighbor	W-C1-C2-C4-C9-C8-W	19.8

Table 6. Recapitulation of Cost Calculation

Recapitulation	Route	Method	Distribution Order	Total Distance (km)	BBM Cost/day (IDR)	BBM Cost/ month (IDR)	Total Cost/ month (IDR)
Static Demand	Route 1	Nearest Insert	W-C1-C4-C7-C6-W	15.2	8.360	250.800	618.750
	Route 2	Nearest Neighbor	W-C2-C3-C5-C9-C8-W	22.3	12.265	367.950	
Demand Increases	Route 1	Nearest Insert	W-C4-C5-C7-C6-G8-W	16.4	9.020	270.600	562.650
	Route 2	Nearest Neighbor	W-C5-C3-C7-C6-W	17.7	9.735	292.050	
Demand Decreases	Route 1	Nearest Neighbor	W-C5-C3-C6-C7-W	16.1	8.855	265.650	592.350
	Route 2	Nearest Insert	W-C1-C2-C4-C9-C8-W	19.8	10.890	326.700	

5.2 Graphical Results

Figure 1 shows that when the sales condition is static, the nearest insert approach shows the most optimal distribution routes. The distance travelled from the warehouse to the agents and back to the warehouse is 15.2 km, with a travel time of 41 minutes. The transportation cost required is IDR 250,800/month.

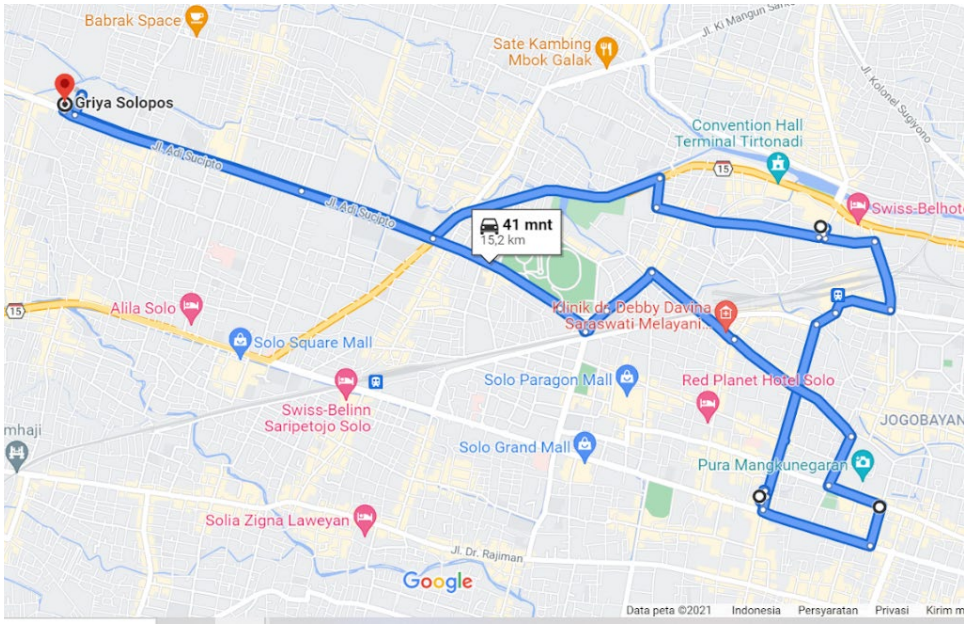

Figure 1. Static Demand - Route 1

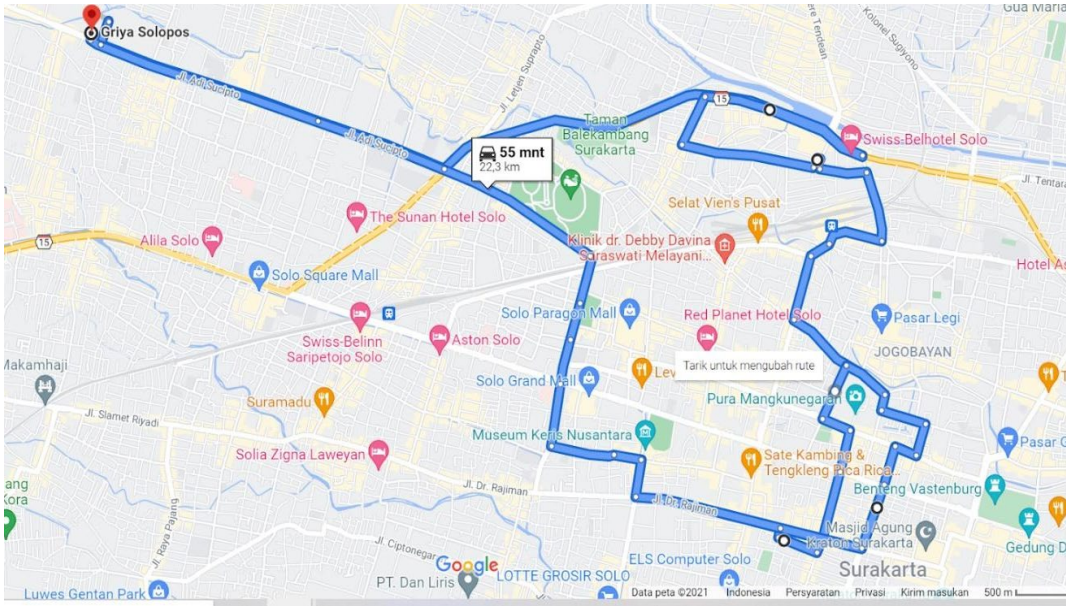

Figure 2. Static Demand - Route 2

Figure 2 shows that when the sales condition is static, the nearest neighbor approach shows the most optimal distribution routes. The distance travelled from the warehouse to the agents and back to the warehouse is 22.3 km, with a travel time of 55 minutes. The transportation cost required is IDR 250,800/month.

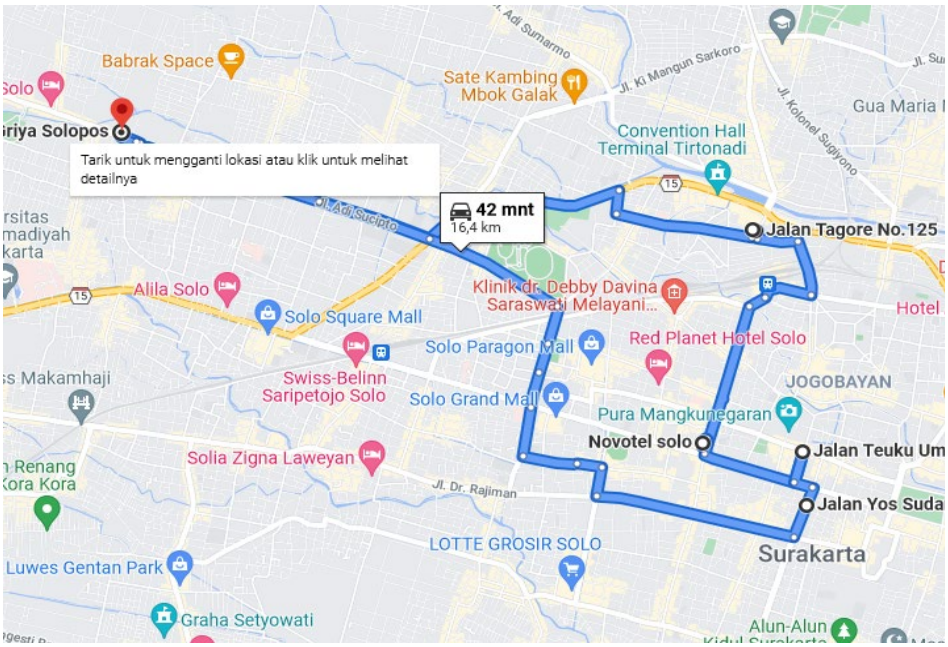

Figure 3. Increased Demand - Route 1

Figure 4 shows that the nearest insert approach shows the optimal distribution route sequence when sales conditions increase. The distance travelled from the warehouse to the agents and back to the warehouse is 16.4 km, and the travel time is 42 minutes. The transportation cost required is IDR 367,950 / month.

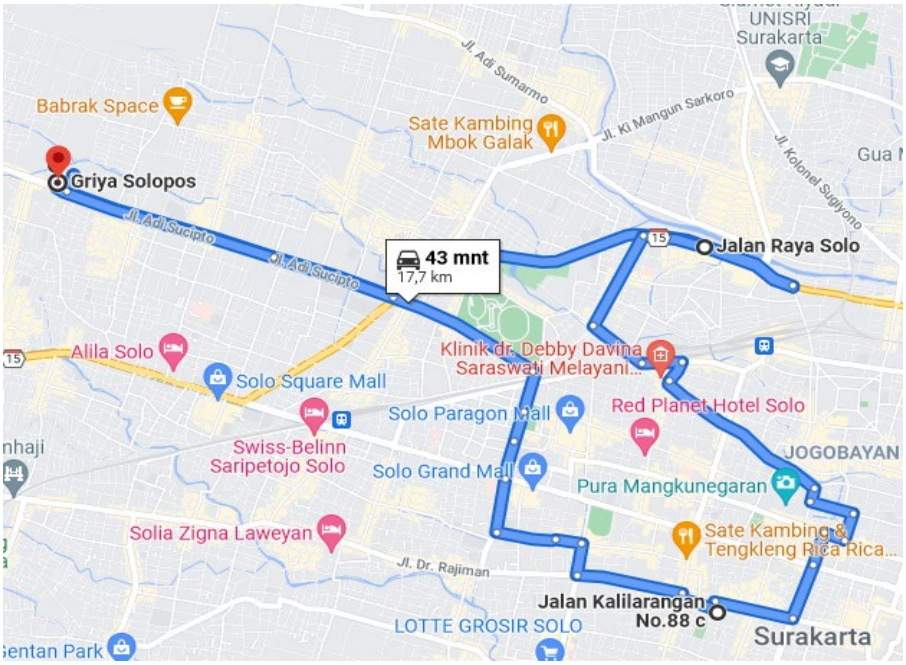

Figure 4. Increased Demand- Route 2

Figure 4 shows that the nearest neighbor approach shows the most optimal distribution routes when sales conditions increase. The distance travelled from the warehouse to the agents and back to the warehouse is 17.7 km, with a travel time of 43 minutes. The transportation cost required is IDR 292,000/month.

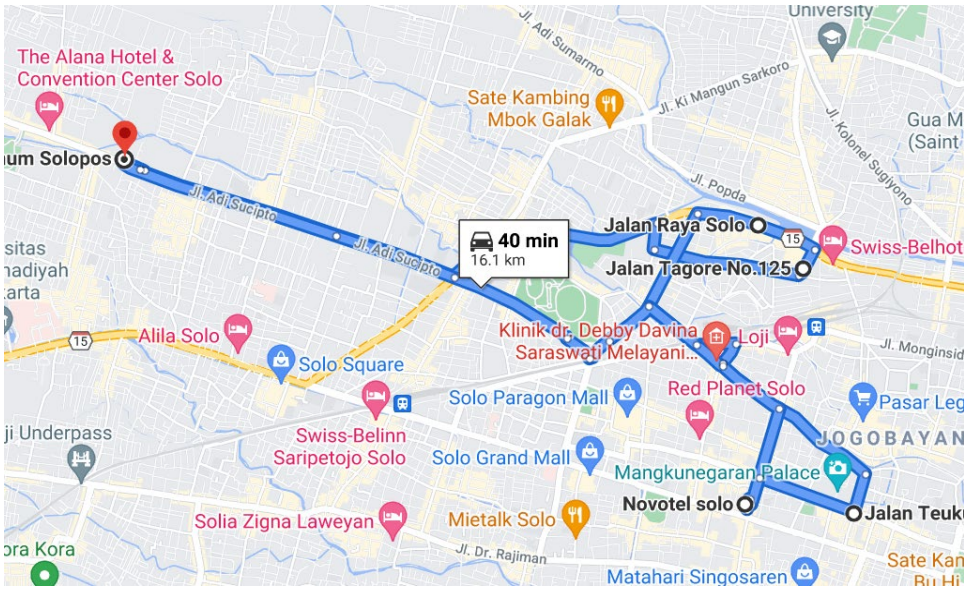

Figure 5. Decreased Demand - Route 1

Figure 5 shows that the nearest neighbor approach offers the optimal distribution route sequence when sales conditions are decreased. The distance travelled from the warehouse to the agents and back to the warehouse is 16.1 km, with a travel time of 40 minutes. The transportation cost required is IDR 265,250/month.

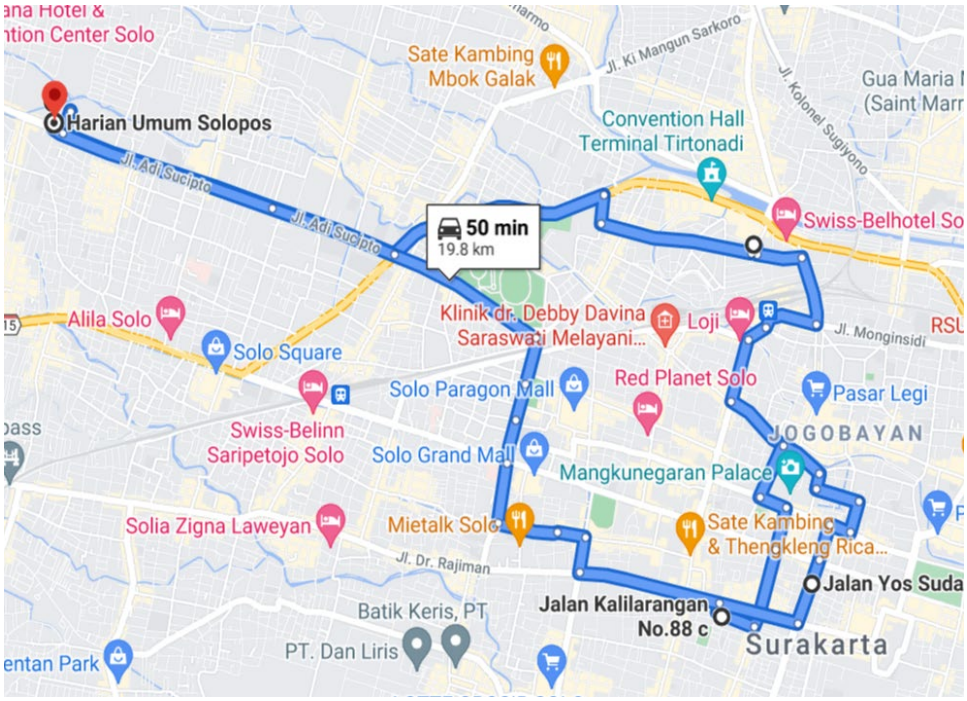

Figure 6. Decreased Demand - Route 2

Figure 6 shows that the nearest insert approach shows the most optimal distribution routes when sales conditions are decreased. The distance travelled from the warehouse to the agents and back to the warehouse is 19.8 km, with a travel time of 50 minutes. The transportation cost required is IDR 326,700/month.

The difference between this research and the reference paper is that the reference paper focuses on the distance travelled and the resulting cost. However, it does not consider the conditions of sales both when they are up and when sales are down. Meanwhile, this research focuses on optimizing the route taken based on the minimum distance travelled using the nearest insert and nearest neighbor methods. So that indirectly can reduce transportation costs. In addition, it also considers when the sales condition is up or down. So the company can minimize losses because the optimal distribution route has been obtained in each situation.

6. Conclusion

Based on the latest conditions, namely the savings in distributing newspapers to customers with joint delivery planning, but not considering static, decrease, and increased demand conditions. While the improvement results from this research are the calculation of the state of demand, such as when the demand state is static, decrease and increase so that in each situation there are two optimal routes, each of which has been carried out data processing with the saving matrix method. The result of data processing using the saving matrix method with the nearest insert and nearest neighbor approaches, two optimal routes with three conditions are obtained to distribute Solopos newspapers.

When the demand is static, the optimal distance on route 1 using the nearest insert approach is 15.2 km, with the distribution route, namely W-C1-C4-C7-C6-W, and the fuel cost is IDR 250,800/month. For route 2, using the nearest neighbor approach, the distance needed to be travelled is 22.3 km. The distribution route is W-C2-C3-C5-C9-C8-W, and the vehicle fuel cost is IDR 367,950/When the demand is static, the total cost per month is IDR 618,750/month.

When demand increases, the total distance of route 1 with the nearest insert approach is 16.4 km. The distribution route will be W-C4-C5-C7-C6-G8-W, and the vehicle fuel cost is IDR 270,600/month. Route 2, using the nearest neighbor, will have a total distance of 17.7 km with the distribution route: W-C5-C3-C7-C6-W. The entire vehicle cost will be IDR 292,050/month. When the demand increases, the monthly cost will be IDR 562,650/month.

When demand decreases, the optimal distance on route 1 using the nearest neighbor approach is 16.1 km, with the distribution route, namely W-C5-C3-C6-C7-W, and the vehicle fuel cost is IDR 265,650/month. Meanwhile, using the nearest insert approach, the total distance of route 2 is 19.8 km with distribution route W-C1-C2-C4-C9-C8-W, and the vehicle fuel cost is IDR 326,700/when the demand decreases, the total cost per month will be IDR 592,350/month.

References

Aliudin, E. R., & Arisanty, M. (2018). Transformasi Digital Majalah Hai dalam Upaya Mempertahankan Eksistensi *Brand*. *5*(2).

Amri, M., Rahman, A., & Yuniarti, R. (2014). Penyelesaian Vehicle Routing Problem dengan Menggunakan Metode *Nearest Neighbor* (Studi Kasus: MTP Nganjuk Distributor PT. Coca Cola).

Damayanti, T. R., Kusumaningrum, A. L., Susanty, Y. D., & Susilawati, S. (2020). *Route Optimization Using Saving Matrix Method-A Case Study at Public Logistics Company in Indonesia*.

Fitriani, N. A., Pratama, R. A., Zahro, S., Utomo, P. H., & Martini, T. S. (2021, February). *Solving Capacitated Vehicle Routing Problem Using Saving Matrix, Sequential Insertion, And Nearest Neighbor of Product 'X' in Grobogan District.* In *AIP Conference Proceedings* (Vol. 2326, No. 1, p. 020007). AIP Publishing LLC.

Jodinesa, M. N. A., Yuniaristanto, Sutopo, W., & Hisjam, M. (2019). Joint delivery planning with time windows: A case study on supply chain in newspaper industry. *IOP Conference Series: Materials Science and Engineering*, *495*(1). https://doi.org/10.1088/1757-899X/495/1/012034

Mácsay, V., & Bányai, T. (2017). Toyota production system in milk run based in-plant supply. Journal of Production Engineering, 20(1), 141-146.

Prihanto, J. J. N. (2018). Transformasi Digital Media Cetak Di Indonesia: Studi Pada Industri Media Cetak Terverifikasi Administratif Dan Faktual Tahun 2017 Oleh Dewan Pers Indonesia (Vol. 10, Issue 1).

Raihan, A. H. (2017). Analisis Metode Heuristik Pengolahan *Data Travelling Salesman Problem* Terhadap Jumlah Titik (Doctoral dissertation, Fakultas Teknik).

Riskadayanti, O., Yuniaristanto, Sutopo, W., & Hisjam, M. (2019). Discrete-Event Simulation of a Production Process for Increasing the Efficiency of a Newspaper Production. *IOP Conference Series: Materials Science and Engineering*, *495*(1). https://doi.org/10.1088/1757-899X/495/1/012026

Saputra, R., & Pujotomo, D. (2019). Penyelesaian Vehicle Routing Problem Dengan Karakteristik Time Windows Dan Multiple Trips Menggunakan Metode Saving Matrix (Studi Kasus: PT. Coca Cola Bottling Indonesia-Wilayah Medan. Industrial Engineering Online Journal, 7(4).

Saputra, I. W., Hisjam, M., & Sutopo, W. (2018). *Optimization of Distribution Channel Vehicle Routing Problem with Time Windows using Differential Evolution Algorithm: A Case Study in Newspaper Industry*.

Biographies

Adindha Karunia Ciptaning Pragowoaji is an undergraduate student of the Industrial Engineering Department of Universitas Sebelas Maret, Surakarta, Indonesia. Her research interests are in the supply chain, logistics, business, techno economy, and distribution.

Iksan Widiantoro Restuaji is an undergraduate student of the Industrial Engineering Department of Universitas Sebelas Maret, Surakarta, Indonesia. His research interests are in the supply chain, logistics, business, techno economy, and distribution.

Yusuf Fardhan Nurdianto is an undergraduate student of the Industrial Engineering Department of Universitas Sebelas Maret, Surakarta, Indonesia. His research interests are in the supply chain, logistics, business, techno economy, and distribution.

Arinda Soraya Putri is a lecturer at Industrial Engineering Department, Universitas Muhammadiyah Surakarta, Surakarta, Indonesia. She obtained her Masters of Industrial Engineering and a Bachelor of Engineering in Industrial Engineering from Universitas Sebelas Maret, Surakarta, Indonesia. She is a member of the research group of Logistics and Industrial Optimization from 2019 until now. Her research interests are Logistics & Supply Chain Management, Distribution Systems, Simulation, Market Testing Analysis, and Feasibility Study.

Wahyudi Sutopo is a professor in industrial engineering and coordinator for the research group of industrial engineering and techno-economy (RG-RITE) of Faculty Engineering, Universitas Sebelas Maret (UNS), Indonesia. He earned his Ph.D. in Industrial Engineering & Management from Institut Teknologi Bandung in 2011. He is also a researcher for the university center of excellence for electrical energy storage technology (UCE-EEST). He has done projects with Indonesia endowment fund for education (LPDP), sustainable higher education research alliances (SHERA), MIT-Indonesia research alliance (MIRA), PT Pertamina (Persero), PT Toyota Motor Manufacturing Indonesia, and various other companies. His research interests include logistics & supply chain management, engineering economy, cost analysis & estimation, and technology commercialization. He is a member of the board of industrial engineering chapter - the institute of Indonesian engineers (BKTI-PII), Indonesian Supply Chain & Logistics Institute (ISLI), Society of Industrial Engineering, and Operations Management (IEOM), and Institute of Industrial & Systems Engineers (IISE).

Yuniaristanto is a lecturer of the Department of Industrial Engineering, Universitas Sebelas Maret (UNS). He obtained his Master of Engineering from Institut Teknologi Bandung and Bachelor of Engineering in Industrial Engineering from Institut Teknologi Sepuluh November. He is part of the Industrial Engineering and Techno - Economy (RITE) Research Group. His research interests are Logistics & Supply Chain Management, and Production/Operations Management.