PAPER • OPEN ACCESS

Comparison study between nearest neighbor and farthest insert algorithms for solving VRP model using heuristic method approach

To cite this article: Wilson Kosasih *et al* 2020 *IOP Conf. Ser.: Mater. Sci. Eng.* **852** 012090

IOP Conf. Series: Materials Science and Engineering **852** (2020) 012090 doi:10.1088/1757-899X/852/1/012090

Comparison study between nearest neighbor and farthest insert algorithms for solving VRP model using heuristic method approach

Wilson Kosasih[1*], Ahmad[1], Lithrone Laricha Salomon[1], Febricky[1]

[1]Department of Industrial Engineering, Faculty of Engineering Universitas Tarumanagara Jl. Letjend S. Parman No. 1, Jakarta 11440

* wilsonk@ft.untar.ac.id, ahmad@ft.untar.ac.id, lithrones@ft.untar.ac.id, febricky22@yahoo.com

Abstract. In Indonesia, transportation costs from physical distribution still tend to be high because not all business people can optimize their distribution routes. This paper discusses a comparative study between Nearest Neighbor and Farthest Insert algorithms in solving a Vehicle Routing Problem (VRP) model. Aim of this study is to determine the most optimum distribution route so that the distance or time or transportation costs can be minimized. This research was conducted at a bottled water distribution company. In the end, the comparative study was considered effective as a basis for decision making on the distribution route, where there were indications of distance savings or reduced costs, and increased utilization of the higher vehicle fleet.
Keywords: Distribution Routes, VRP, Nearest Neighbor, Farthest Insert.

1. Introduction

In the business world, distribution management has a vital role. One of the most important operational decisions in distribution management is determining the distribution schedules and routes from one location to several destinations. Decision of the distribution schedules and routes to be taken by each vehicle will greatly affect the transportation costs [1],[2]. However, cost is not the only factor that needs to be considered in the shipping process. In the case example, the company may also have a target that each customer at a delivery destination must have obtained a product/item no later than the agreed upon time. In other words, there are time constraints that are often called time windows [3]. In addition, schedules and routes often also have to consider other constraints such as vehicle capacity or transportation fleet.

In general, the problem of scheduling and determining the distribution route can have several goals to be achieved, such as the goal to minimize shipping costs, minimize time, or minimize mileage. In the language of mathematical model, one of these objectives can be an objective function and the other becomes a constraint. For example, the objective function is to minimize shipping costs, but there are time window constraints and maximum mileage constraints per vehicle, in addition to other constraints such as vehicle capacity or other constraints [4],[5]. To solve this problem, the Vehicle Routing Problem (VRP) Model is used as a basis for route decision making for vehicle assignments, distribution ordering, and scheduling. The route does not only involve operational planning issues, but also involves strategic and tactical planning of the distribution system. Interaction between strategies will build an optimal distribution system. Toth and Vigo [6] state that several characteristics in VRP that need to be considered, including; customers, depots, drivers, and vehicle routes. In addition, the VRP model also ensures that the total demand on a route does not exceed the capacity of the operating vehicle. Solving with the Heuristic approach to help determine the shortest route (minimum distance), and then followed up by sorting the shipping route so as to minimize costs incurred. Therefore, this study discusses a comparison between Nearest Neighbor and Farthest Insert algorithms to complete the VRP Model so that the most optimal distribution route is obtained.

2. Literature Review

2.1 Vehicle Routing Problem

Vehicle Routing Problem (VRP) was first introduced by Dantzig and Ramser in 1959, and has since been widely studied. According to Fisher, VRP is defined as a way of searching for the efficient use of a number of vehicles that must travel to visit a number of places to deliver and pick up people or goods. Each consumer must be served by one vehicle. The vehicle-customer pair is determined by considering the capacity of vehicle in a single transport, to minimize the costs required. Usually the determination of the minimum cost is closely related to the minimum distance [7].

VRP is actually a development or expansion of the Traveling Salesman Problem (TSP). TSP can be explained as a problem where a salesman must depart from a depot to visit *n nodes* (cities) then return to the original depot by selecting the shortest feasible tour. The purpose of this TSP is to find a minimum cost per tour from all cities so that you can get a route with a minimum pass or minimize costs. In other words design a shortest travel route where each node must be visited by the salesman [8].

Problems in VRP can be divided into two, namely static and dynamic problems. In the case of static, customer demands are known in advance. Whereas in dynamic problems, some or all customer demands will be known when the transport vehicle has started operating, that is, when the route has been arranged or there is a change in transport.

The main purpose of VRP is to deliver goods to customers at minimum cost through vehicle routes start from the depot and return to the depot [9]. In more detail, the purpose of VRP are i) minimizing transportation costs, ii) minimizing the number of vehicles to serve customers, iii) balancing routes and vehicle loads, and iv) minimizing penalties, which are related to service to customers [6].

VRP can be solved by two methods, namely; 1) Optimal (Exact) Method, this approach uses the methods of linear programming, integer programming and mixed programming which are based on calculations with mathematical programming. Using this approach an optimal solution will be obtained. However, this approach can only produce good solutions if the problems faced are small-scale. As for problems involving large amounts of input data, this method of solving becomes inefficient because it requires a long computational time; 2) Heuristic Method, this approach uses algorithms that specifically and interactively will produce solutions that will be close to optimal. The heuristic approach can be applied more to real problems that involve large amounts of data input and generate fast calculations due to search constraints by reducing the number of alternatives available. One of the heuristic methods that can be used to solve transportation problems in determining distribution routes and schedules is the savings matrix method.

2.2 Nearest Neighbor vs. *Farthest Insert*

Both of these algorithms are heuristic approaches in solving VRP. The Nearest Neighbor method was first introduced in 1983. This method is a VRP solving technique that is very effective, runs fast, and usually produces a decent enough quality, which starts from the starting point and then looks for the closest point [9]. Nearest Neighbor is an algorithm that is easy to implement and easy to execute, but does not guarantee an optimal solution.

Nearest Neighbor algorithm procedures include; i) starts with a starting point (depot); ii) find the nearest point from the starting point, then connect that point; iii) repeat procedure (ii) until all points have been visited; iv) connecting the first point with the last to complete the tour and the procedure is completed [10], [11].

As for Farthest Insertion algorithm [12], input the customers who provide the most distant trips. For each customer not included in one route, evaluate the increase in mileage that has the biggest change in increment by using the following formula:

(1)

Where, ΔF = increase in mileage; = the distance between customer i and customer k; = the distance between customer k and customer j; = the distance between customer i and customer j.

3. Method

This research was conducted on a distributor of one of the bottled drinking water products. First of all, the process of depicting an initial model in product distribution is carried out using the VRP model approach. The model is described as a depot that serves multiple points - as an agent. The study was conducted by collecting data from the company, such as; agent location, demand, transportation facility, and distance inter-agents as well as current distribution routes. It was found that each agent has a different number of demands. The distance inter-agents is determined using google maps so that it is more real condition. Furthermore, the data is processed using the heuristic method approach, which is the saving matrix method. According to Pujawan [1], saving matrix is essentially a method to minimize distance or time or cost by considering existing constraints. The steps of the method are as follows; 1) Identifying distance matrix, in this step it is necessary to know the distance between the company's warehouse to each destination (customer) and the distance inter-destinations; 2) Identifying a savings matrix, at the beginning of this step it is assumed that each destination will be visited by one truck exclusively. Savings matrix calculations using mathematical equations are stated as follows:

$$\mathbf{S(a,b) = J(p,a) + J(p,b) - J(a,b)} \quad (2)$$

Where, S(a,b) = saving distance; J(p,a) = the distance between factory and agent a; J(p,b) = the distance between factory and agent b; J(a,b) = the distance between agent a and agent b.

3) Allocating destinations in vehicle travel routes, at this stage, the destination is divided into a vehicle travel route by considering the customer and the vehicle capacity used. A route is said to be feasible if the total number of demands from all customers does not exceed the capacity of the vehicle and the number of demands from one customer can be accommodated as a whole by one vehicle; 4) Sorts destinations in a defined route. This stage is the final stage of the saving matrix method. The purpose of this stage is to order visits from vehicles to each destination that has been grouped in a travel route so that a minimum distance can be obtained.

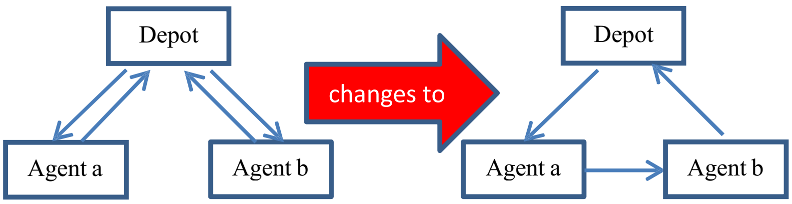

Figure 1. Optimization of Distribution Routes

After getting the optimal number of routes based on the saving matrix method, then proceed with the distribution route sorting with nearest neighbor and farthest insert methods. Then, both of them are compared to get the most optimal distribution route.

Table 1. List of Locations and Demands of Each Agent

No.	Code of Agent	Region	Demand (gallon)	No.	Code of Agent	Region	Demand (gallon)
1	A1	Tanjung Uncang	85	18	A18	Kampung Pelita	310
2	A2	Buliang	30	19	A19	Baloi Indah	40
3	A3	Kibing	120	20	A20	Patam Lestari	60
4	A4	Bukit Tempayan	100	21	A21	Tiban Indah	80
5	A5	Muka Kuning	75	22	A22	Tiban Baru	110
6	A6	Sambau	50	23	A23	Tiban Lama	60
7	A7	Mangsang	225	24	A24	Tanjung Riau	70
8	A8	Batu Besar	260	25	A25	Taman Baloi	60
9	A9	Kabil	75	26	A26	Teluk Tering	145
10	A10	Ngenang	40	27	A27	Sei Panas	140

11	A11	Tembesi	80	28	A28	Sukajadi	85
12	A12	Sungai Binti	35	29	A29	Sengkuang	90
13	A13	Sagulung Kota	90	30	A30	Sei Jodoh	105
14	A14	Sungai Langkai	145	31	A31	Batu Merah	35
15	A15	Baloi Permai	235	32	A32	Kampung Seraya	80
16	A16	Belian	190	33	A33	Bengkong Sadai	125
17	A17	Lubuk Baja Kota	170	34	A34	Tanjung Buntung	180

Table 2. Transportation Facility

No.	Type of Vehicle	Holding Capacity (max)	Average Speed	Amount
1.	Hino Dutro 130 LD	314 gallon	50 km/h	6 units
2.	Isuzu Elf NHR 55	314 gallon	50 km/h	7 units

Table 3. Distance Matrix

	GU	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11	A12	A13	A14	A15	A16	A17
A1	22																	
A2	15	7.5																
A3	17	10	2.6															
A4	17	6.1	1.7	4.2														
A5	7.7	26	20	22	22													
A6	21	40	33	35	35	21												
A7	14	23	17	18	19	18	32											
A8	16	35	28	30	30	16	9.3	26										
A9	15	34	27	29	29	15	21	25	13									
A10	17	36	29	31	31	17	23	27	15	5.6								
A11	15	14	7.8	9.1	9.7	19	33	16	24	26	29							
A12	20	4.1	6.3	8.8	4.9	24	38	21	29	31	34	13						
A13	17	5.5	4.4	6.9	3.7	21	35	17	26	28	31	9.8	4.2					
A14	15	7.8	2.8	5.3	3.5	19	33	16	24	26	29	8.1	6.6	4.3				
A15	2.6	21	15	16	17	8.5	23	13	13	16	19	15	20	18	16			
A16	5.7	26	20	21	22	7.1	15	18	6.2	11	14	20	25	23	21	9.3		
A17	7.4	23	19	22	18	14	28	18	19	21	24	21	22	20	21	10	15	
A18	4.9	24	19	20	19	12	26	16	17	20	23	19	23	21	20	6.4	10	1.7
A19	8.7	20	16	19	15	14	28	18	19	21	24	21	19	17	18	10	15	4
A20	12	15	11	14	11	18	32	22	23	25	28	19	14	12	13	14	19	11
A21	12	18	13	16	13	18	32	22	23	25	28	24	16	14	15	14	19	11
A22	12	13	9.1	12	8.3	18	32	22	23	25	28	17	12	10	11	13	19	11
A23	7.2	19	15	18	14	13	27	17	17	20	23	19	18	16	17	7.9	14	5.9
A24	22	6.4	5.7	8.2	4.9	27	42	22	32	35	38	14	6.5	4.7	7.4	21	29	21
A25	2.5	21	15	16	17	8.4	22	13	13	16	19	15	20	17	16	2.4	8	5.6
A26	2.8	23	17	18	21	10	23	15	14	16	19	17	22	19	18	4.3	7.9	7.1
A27	4.1	25	19	21	20	13	27	17	18	20	23	19	23	21	20	6	10	3.1
A28	4.3	20	14	16	16	8	22	12	13	15	18	14	19	17	15	4	9.1	6.5
A29	9.6	27	24	26	24	17	32	22	23	26	27	23	26	24	24	13	18	5.5
A30	7.9	24	20	23	19	15	29	19	20	22	25	21	23	21	22	9.4	16	2.3
A31	12	30	26	27	25	20	34	24	24	27	30	26	29	27	27	15	21	8.3
A32	6.9	25	21	22	20	14	28	19	19	22	25	21	24	22	22	8.4	12	1.9
A33	5.2	25	20	21	20	14	28	18	19	21	24	20	24	22	21	6.7	11	4.5
A34	9	28	22	24	23	16	30	20	21	23	26	23	26	25	23	12	17	5.2

Continued Table 3. Distance Matrix

	A18	A19	A20	A21	A22	A23	A24	A25	A26	A27	A28	A29	A30	A31	A32	A33	A34
A1																	
A2																	
A3																	
A4																	
A5																	
A6																	
A7																	
A8																	
A9																	
A10																	
A11																	
A12																	
A13																	
A14																	
A15																	
A16																	
A17																	
A18																	
A19	6																
A20	12	9															
A21	12	8.9	2.5														
A22	12	8.9	3.9	4.7													
A23	6.3	3.7	6.3	6.3	7.9												
A24	21	19	13	14	10	15											
A25	6	4	11	11	13	8.2	19										
A26	6.9	5.6	13	13	14	9.9	21	4.2									
A27	2.9	4.3	12	11	13	8.6	19	6	4.3								
A28	6.9	4.8	12	12	14	9	20	4	7.6	6.9							
A29	4.8	7.8	17	17	18	13	24	11	11	7.2	12						
A30	3.1	6.2	11	11	12	8	19	8	7.7	4.8	8.8	5.9					
A31	7.7	11	16	16	17	13	25	13	12	8.5	13	6.4	6.4				
A32	2.2	5.5	12	12	14	9.1	20	7.3	6.7	3.9	8.1	4.8	1.1	6.1			
A33	4.3	5	13	13	15	10	20	6.7	5.4	1.5	7.5	7.2	5.1	8.5	4.8		
A34	4.5	7.3	15	15	16	12	22	9.1	8.8	4.4	10	6.3	5.7	7.5	5.1	3	

4. Results and Discussion

Using the equation in Equation 2, we can calculate the saving distance matrix between factory and agent visited, for example as follows:

Savings matrix calculation between agents A1 and A2

S(a1,a2) = J(p,a1) + J(p,a2) – J(a1,a2)
= 22 + 15 – 7.5
= 29.5

Savings matrix calculation between agents A1 and A3

S(a1,a3) = J(p,a1) + J(p,a3) – J(a1,a3)
= 22 + 17 – 10
= 29

And, etc., for the results can be seen in Table 4.

Table 4. Saving Matrix

	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11	A12	A13	A14	A15	A16	A17
A1																	
A2	29.5																
A3	29	29.4															
A4	32.9	30.3	29.8														
A5	3.7	2.7	2.7	2.7													
A6	3	3	3	3	7.7												
A7	13	12	13	12	3.7	3											
A8	3	3	3	3	7.7	27.7	4										
A9	3	3	3	3	7.7	15	4	18									
A10	3	3	3	3	7.7	15	4	18	26.4								
A11	23	22.2	22.9	22.3	3.7	3	13	7	4	3							
A12	37.9	28.7	28.2	32.1	3.7	3	13	7	4	3	22						
A13	33.5	27.6	27.1	30.3	3.7	3	14	7	4	3	22.2	32.8					
A14	29.2	27.2	26.7	28.5	3.7	3	13	7	4	3	21.9	28.4	27.7				
A15	3.6	2.6	3.6	2.6	1.8	0.6	3.6	5.6	1.6	0.6	2.6	2.6	1.6	1.6			
A16	1.7	0.7	1.7	0.7	6.3	11.7	1.7	15.5	9.7	8.7	0.7	0.7	-0.3	-0.3	-1		
A17	6.4	3.4	2.4	6.4	1.1	0.4	3.4	4.4	1.4	0.4	1.4	5.4	4.4	1.4	0	-1.9	
A18	2.9	0.9	1.9	2.9	0.6	-0.1	2.9	3.9	-0.1	-1.1	0.9	1.9	0.9	-0.1	1.1	0.6	10.6
A19	10.7	7.7	6.7	10.7	2.4	1.7	4.7	5.7	2.7	1.7	2.7	9.7	8.7	5.7	1.3	-0.6	12.1
A20	19	16	15	18	1.7	1	4	5	2	1	8	18	17	14	0.6	-1.3	8.4
A21	16	14	13	16	1.7	1	4	5	2	1	3	16	15	12	0.6	-1.3	8.4
A22	21	17.9	17	20.7	1.7	1	4	5	2	1	10	20	19	16	1.6	-1.3	8.4
A23	10.2	7.2	6.2	10.2	1.9	1.2	4.2	6.2	2.2	1.2	3.2	9.2	8.2	5.2	1.9	-1.1	8.7
A24	37.6	31.3	30.8	34.1	2.7	1	14	6	2	1	23	35.5	34.3	29.6	3.6	-1.3	8.4
A25	3.5	2.5	3.5	2.5	1.8	1.5	3.5	5.5	1.5	0.5	2.5	2.5	2.5	1.5	2.7	0.2	4.3
A26	1.8	0.8	1.8	-1.2	0.5	0.8	1.8	4.8	1.8	0.8	0.8	0.8	0.8	-0.2	1.1	0.6	3.1
A27	1.1	0.1	0.1	1.1	-1.2	-1.9	1.1	2.1	-0.9	-1.9	0.1	1.1	0.1	-0.9	0.7	-0.2	8.4
A28	6.3	5.3	5.3	5.3	4	3.3	6.3	7.3	4.3	3.3	5.3	5.3	4.3	4.3	2.9	0.9	5.2
A29	4.6	0.6	0.6	2.6	0.3	-1.4	1.6	2.6	-1.4	-0.4	1.6	3.6	2.6	0.6	-0.8	-2.7	11.5
A30	5.9	2.9	1.9	5.9	0.6	-0.1	2.9	3.9	0.9	-0.1	1.9	4.9	3.9	0.9	1.1	-2.4	13
A31	4	1	2	4	-0.3	-1	2	4	0	-1	1	3	2	0	-0.4	-3.3	11.1
A32	3.9	0.9	1.9	3.9	0.6	-0.1	1.9	3.9	-0.1	-1.1	0.9	2.9	1.9	-0.1	1.1	0.6	12.4
A33	2.2	0.2	1.2	2.2	-1.1	-1.8	1.2	2.2	-0.8	-1.8	0.2	1.2	0.2	-0.8	1.1	-0.1	8.1
A34	3	2	2	3	0.7	0	3	4	1	0	1	3	1	1	-0.4	-2.3	11.2
Demand	85	30	120	100	75	50	225	260	75	40	80	35	90	145	235	190	170

Continued Tabel 4. Saving Matrix

	A18	A19	A20	A21	A22	A23	A24	A25	A26	A27	A28	A29	A30	A31	A32	A33	A34
A1																	
A2																	
A3																	
A4																	
A5																	
A6																	
A7																	
A8																	
A9																	
A10																	
A11																	
A12																	
A13																	
A14																	
A15																	
A16																	
A17																	
A18																	
A19	7.6																
A20	4.9	11.7															
A21	4.9	11.8	21.5														
A22	4.9	11.8	20.1	19.3													
A23	5.8	12.2	12.9	12.9	11.3												
A24	5.9	11.7	21	20	24	14.2											
A25	1.4	7.2	3.5	3.5	1.5	1.5	5.5										
A26	0.8	5.9	1.8	1.8	0.8	0.1	3.8	1.1									
A27	6.1	8.5	4.1	5.1	3.1	2.7	7.1	0.6	2.6								
A28	2.3	8.2	4.3	4.3	2.3	2.5	6.3	2.8	-0.5	1.5							
A29	9.7	10.5	4.6	4.6	3.6	3.8	7.6	1.1	1.4	6.5	1.9						
A30	9.7	10.4	8.9	8.9	7.9	7.1	10.9	2.4	3	7.2	3.4	11.6					
A31	9.2	9.7	8	8	7	6.2	9	1.5	2.8	7.6	3.3	15.2	13.5				
A32	9.6	10.1	6.9	6.9	4.9	5	8.9	2.1	3	7.1	3.1	11.7	13.7	12.8			
A33	5.8	8.9	4.2	4.2	2.2	2.4	7.2	1	2.6	7.8	2	7.6	8	8.7	7.3		
A34	9.4	10.4	6	6	5	4.2	9	2.4	3	8.7	3.3	12.3	11.2	13.5	10.8	11.2	
Demand	310	40	60	80	110	60	70	60	145	140	85	90	105	35	80	125	180

Then, Table 4 shows that the largest savings value is 37.9 which is the value of the merger between agent A1 and agent A12. The number of requests is 85 gallons and 35 gallons respectively, so that the merging of routes can be done because it is smaller than the capacity of the trucks used. The route for agent A1 is followed by agent A12 being the first route with a total capacity of 120 gallons. The next merger is the second largest savings, amounting to 37.6 which is the saving distance between agents A1 and A24. A1 agents have already joined the first route with a total capacity of 120 gallons. The number of A24 agent requests is 70 gallons so that the merging is feasible because the number of requests for the three agents is smaller than the truck's capacity. Therefore, agent A24 joins the first route with a total capacity of the first route of 190 gallons. The next merger is the third largest savings, amounting to 35.5 which is the saving distance between agent A12 and agent A24. The merger of agents A12 and A24 has been done on the first route so that no merging is done. The next combination with a savings value of 34.3 is the saving distance between agent A13 and agent A24. Agent A24 has joined the first route with a total demand capacity of 190 gallons. The number of requests for A13 agents is 90 gallons so that the merging is still feasible because the demand capacity is smaller than the truck capacity. Then agent A13 joins the first route with a total demand capacity of 280 gallons. Meanwhile, the next merger with a savings value of 34.1 is the saving distance between Agent A4 and Agent A24. Agent A24 has joined the first route with a total demand capacity of 280 gallons. The number of requests for A4 agents is 100 gallons so that the merging is not feasible because it exceeds the capacity of the truck, and so on. Merging routes is done so that no more agents can be added or combined because all agents have been allocated on their respective routes. From the example described earlier, the first route is obtained, namely agents A1, A24, A12, A13 and A2.

Table 5. Distance Between Agents and Factory for the First Route

Code	GU	A1	A2	A12	A13	A24
GU	0	22.0	15.0	20.0	17.0	22.0
A1	22.0	0	7.5	4.1	5.5	6.4
A2	15.0	7.5	0	6.3	4.4	5.7
A12	20.0	4.1	6.3	0	4.2	6.5
A13	17.0	5.5	4.4	4.2	0	4.7
A24	22.0	6.4	5.7	6.5	4.7	0

The next step is to determine the order in which agents must be visited on each of these routes. Table 5 shows that among the five agents, the closest distance to the factory is the A2 agent with a distance of 15 km. Therefore, the agent visited first is agent A2. Then, proceed with the selection of the most optimum distance from agent A2 of 4.4 km, namely agent A13. Next, an optimum distance from agent A13 of 4.2 km was made, agent A12. The optimum distance from Agent A12 is 4.1 km, which is agent A1. Then the last agent, is agent A24. So, the first route sequence formed based on the Nearest Neighbor algorithm is from Factory - Agent A2 - Agent A13 - Agent A12 - Agent A1 - Agent A24 - Factory. Different for the Farthest Insertion algorithm, there are 2 agents that have the farthest distance, namely agents A1 and A24, so the two alternatives must be calculated by entering the agent that has the next largest mileage, such as the following:

Distance G-A1-A24-A12-G = 22+6.4+6.5+20= 54.9 km

Distance G-A24-A1-A12-G = 22+6.4+4.1+20= 52.5 km

From the two alternatives above, the greatest mileage is 54.9. Then the agent visited first was agent A1 then agent A24 and then agent A12. In the same way allocated agents will then be visited.

Distance G-A1-A24-A12-A13-G = 22+6.4+6.5+4.2+17= 56.1 km

Distance G-A1-A24-A12-A2-G = 22+6.4+6.5+6.3+15= 56.2 km

Because the farthest distance is the second alternative with a distance of 56.2 km, then the one visited after agent A1, agent A24, agent A12 is agent A2. Then, the first route produced based on the Farthest Insertion method is Factory-A1-A24-A12-A2-A13-Factory with a total distance of 62.6 km. Likewise, in the same way the ordering of the second to thirteenth routes, where the results of the comparison of 13 optimal routes based on the two algorithms can be seen in Table 6.

Because the results of sorting the route using Nearest Neighbor method in this case obtained a shorter total distance so that the next calculation phase will refer to these results. As mentioned previously there are 34 agents with different routes, which management allocates to 18 optimal routes with a total distance of 651.2 km. Then, obtained distance savings for this new route to the company's initial route is 40.12%. Surely the results of this optimization will have a direct impact on costs, especially fuel costs. Likewise, the average utilization of the transportation mode used will increase from 66.88% to 92.60%.

Table 6. Comparison Results Between Nearest Neighbor and Farthest Insert Algorithms

Route	*Nearest Neighbor*		*Farthest Insertion*	
	Route Order	**Total Distance (km)**	**Route Order**	**Total Distance (km)**
Route 1	G-A2-A13-A12-A1-A24-G	56.1	G-A1-A24-A12-A2-A13-G	62.6
Route 2	G-A8-A6-G	46.3	G-A6-A8-G	46.3
Route 3	G-A16-A9-A10-G	39.3	G-A10-A9-A16-G	39.3
Route 4	G-A11-A3-A4-G	45.3	G-A3-A4-A11-G	52.8
Route 5	G-A23-A20-A21-A22-G	32.7	G-A20-A21-A22-A23-G	34.3
Route 6	G-A29-A31-A34-G	32.5	G-A31-A34-A29-G	35.4
Route 7	G-A33-A32-A30-G	19.0	G-A30-A33-A32-G	24.7
Route 8	G- A28-A19-A17-G	20.5	G-A19-A17-A28-G	23.5
Route 9	G-A7-A5-G	39.7	G-A7-A5-G	39.7
Route 10	G-A25-A15-G	7.5	G-A15-A25-G	7.5
Route 11	G-A26-A27-G	11.2	G-A27-A26-G	11.2
Route 12	G-A18-G	9.8	G-A18-G	9.8
Route 13	G-A14-G	30.0	G-A14-G	30.0
	Σ	**389.9**	Σ	**417.1**

5. Conclusion

This research proves that the comparative study of these two algorithms is considered effective for completing the VRP model in order to obtain a decision of the proposed distribution route that has more optimal mileage or transportation costs. Determining the distance inter-nodes (agents) using google maps is considered to provide data that is close to real. Next research is expected to develop an application software to make it easier to apply the two algorithms to various VRPs to be completed.

6. Aknowledgements

On this occasion the authors would like to thank all those who have helped this research so that it could be completed.

7. References

[1] Pujawan, I Nyoman. 2005. Supply Chain Management. Surabaya: Guna Widya.
[2] Kosasih, W., I.S. Kumala, & Y. Salim. 2017. Evaluasi Sistem Distribusi Industri Kecil Menengah Menggunakan Metode Forecasting dan Distribution Requirement Planning (Studi Kasus: CV. Mandala Citra Lestari, Tangerang). Jurnal Ilmiah Teknik Industri 5(3): pp. 139-147. DOI: http://dx.doi.org/10.24912/jitiuntar.v5i3.2101.
[3] Dethloff, J.. 2001. Vehicle Routing and Reverse Logistic: The Vehicle Routing Problem with Simultaneous Delivery and Pick-up. OR Spektrum (23), pp. 79-96.
[4] Murata, T., & R. Itai. 2005. Multi-Objective Vehicle Routing Problems Using Two-Fold EMO Algorithms to Enhance Solution Similarity on Non-Dominated Solutions. Proceedings of 3rd International Conference on Evolutionary Multi-Criterion Optimization, pp. 885-896.
[5] Watanabe, S. & K. Sakakibara. 2007. A Multiobjectivization Approach for Vehicle Routing Problem. Proceedings of 4th International Conference on Evolutionary Multicriterion Optimization, pp. 660-672.
[6] Toth, P. & D. Vigo. 2002. The Vehicle Routing Problema. SIAM, Philadelphia, pp. 3-27. http://dx.doi.org/10.1137/1.9780898718515.
[7] Hendrawan, Bambang Eko. 2007. Implementasi Algoritma Paralel Genetic Algorithm untuk Penyelesaian Heterogeneous Fleet Vehicle Routing Problem. Surabaya: Institut Teknologi Sepuluh Nopember. https://www.researchgate.net/publication/228355238.
[8] Sutapa, I Nyoman & I Gede Agus Widyadana. 2003. Studi Tentang Travelling Salesman dan Vehicle Routing Problem dengan Time Windows. Jurnal Teknik Industri 5(2), pp. 81-89.
[9] Prana, Raden Prana. 2007. Aplikasi Kombinatorial pada Vehicle Routing Problem. Bandung: Jurusan Teknik Informatika, Institut Teknologi Bandung.
[10] Amri, Mahardika, Arif Rahman, & Rahmi Yuniarti. Penyelesaian Vehicle Routing Problem dengan Menggunakan Metode Nearest Neighbor (Studi Kasus: MTP Nganjuk Distributor PT. Coca Cola). Jurnal Rekayasa dan Manajemen Sistem Industri 2(1) (2014): pp. 36-45.
[11] Prasetyo, Waluyo, & Muchammad Tamyiz. 2017. Vehicle Routing Problem dengan Aplikasi Metode Nearest Neighbor. Journal of Research and Technology 3(2): pp. 88-99.
[12] Islam, M., S. Ghosh, & M. Rahman. 2015. Solving Capacitated Vehicle Routing Problem by Using Heuristic Approaches: A Case Study. Journal of Modern Science and Technology 3(1), pp. 135-146.