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Submission date: 31-Jan-2024 06:45AM (UTC-0600)
Submission ID: 2282846917
File name: yayang_safitri_-_jiko_1.docx (127.4K)
Word count: 2111
Character count: 11497

JIKO (Jurnal Informatika dan Komputer)
Vol. x, No. x, April 2024, pp. x-x
DOI: 10.33387/jiko

Accredited KEMENDIKBUD RISTEK, No.105/E/KPT/2022
p-ISSN: 2614-8897
e-ISSN: 2656-1948

DETERMINATION OF BULOG RICE DISTRIBUTION ROUTES USING SEQUENTIAL INSERTION METHOD AND NEAREST NEIGHBOR METHOD

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(Received: dd mmm yyyy, Revised: dd mmm yyyy, Accepted: dd mmm yyyy)

Abstract (10pt)

Perum Bulog is BUMN engaged in food distribution with its largest commodity being rice. Perum Bulog North Sumatra Regional Office does not have a fixed route arrangement, distribution relies on JPL partners and driver intusition and there are conditions of multiple trips, different demands, and limited vehicle capacity. This study aims to determine the best route that can be applied in the distribution of Bulog rice using the Sequential Insertion and Nearest Neighbor methods and a comparison is made to carry out distribution routes with the shortest distance and fastest time. In the situation of making more than one trip (multiple trips), the results sought are the optimal distance and time for all trips starting from the depot and ending at the depot with the Sequential Insertion and Nearest Neighbour methods.

Keywords: ***Distribution Route, Sequential insertion, Nearest Neighbour***

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1. INTRODUCTION

Every company engaged in the service and goods sector cannot avoid distribution activities. Distribution activities not only concern the interests of the company, but also cover the economic activities of a country. One of the distributions that is very important and must be optimized is the distribution of food, which includes all foodstuffs derived from natural resources and water, both in raw and processed form, which can be consumed by humans as food and drink.

Perum Bulog is one of the State-Owned Enterprises (BUMN) that specializes in food distribution with its largest commodity being rice. erum Bulog SUMUT does not have a fixed route arrangement, the distribution path is still intuitionistic only relying on the driver's experience, and the existence of Multiple Trips is a term that refers to the condition of deliveries made with respect to a predetermined planning plan. Some of the issues that must be addressed during the distribution process include different demands from each customer, delivery time limits, vehicle capacity, average line speed, and specific times. Therefore, if there is no prior determination of the distribution route, the predetermined goals or targets will not be achieved optimally.

This analysis contributes to the calculation and organization of Bulog's rice distribution process by minimizing the paths to be taken using the Vehicle Routing Problem (VRP) method. By performing data processing to design alternative routes, the distribution process can become more efficient.

2. RESEARCH METHOD

Vehicle Ranking Problem (VRP) is a challenge that involves determining the path of transportation trips that transport products from factories to customers. The main objective of VRP is to reduce the overall distance that must be passed by the vehicle, so as to reduce transportation costs and the time required by the vehicle in making the trip.

Capaciated Vehicle Rounting Problem (CVRP), is a model developed from the Vehicle Rounting Problem (VRP) model. CVRP is similar to VRP along with another element, which is that each vehicle has a unique capacity for one type of goods.

the problem is modeled to reduce the overall vehicle miles traveled. The decision variables are defined as:

$$x_{ij}^k = \begin{cases} 1 & \\ 0 & \end{cases} \quad 1$$

If vehicle k travels from point v_i to point v_j. And vehicle k travels from point v_i to point v_j.

$$u_{ij}^k = \begin{cases} 1 & \\ 0 & \end{cases} \quad 2$$

If point v_i is not served by vehicle k. And point v_i is served by vehicle k.

the objective of this problem is to achieve the minimum total vehicle miles traveled. If z is the objective function,

minimizing z,

$$\sum_{k\in k}\sum_{i\in v}\sum_{j\in v} c_i x_{ij}^k \quad 3$$

With constraint,

$$\sum_{k\in K}\sum_{j\in V, i\neq j} x_{ij}^k = 1, \forall i \in V \quad 4$$

2.1 Sequential Insertion Method

The Sequential Insertion method is an approach that seeks to solve problems by inserting clients between established bus arcs to achieve optimal results.

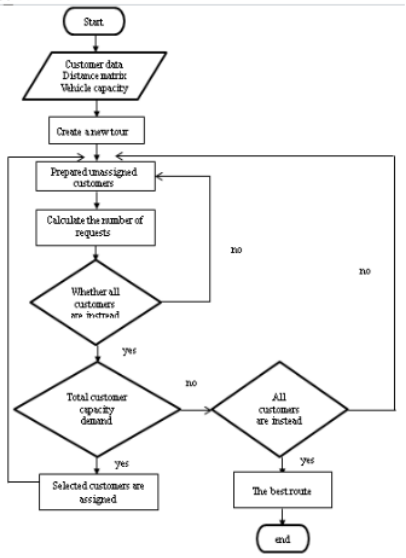

Figure 2. Flowchart Of Neirest Neighbour Method

2.2 Nearest Neighbour Method

The Nearest Neighbor method is applied because delivery routes that can be adjusted to field conditions can be made with this method. In addition, this method is easier to use than other route determination methods and can solve problems quickly.

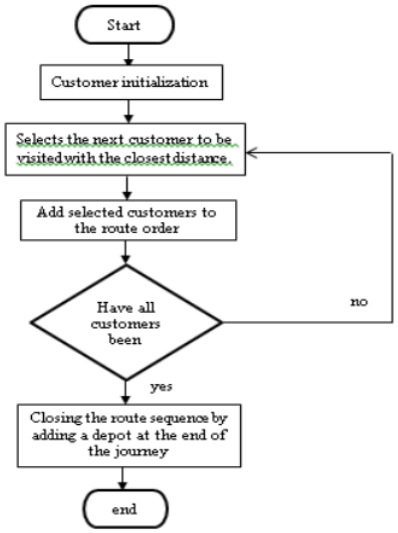

Figure 1. Flowchart Of Neirest Neighbour Method

3. RESULT AND DISCUSSION

3.1 Completion Using Sequential Insertion Method

The sequential insertion method can be used to find bulog rice carrier routes. The main principle of this technique is to insert customers between the insertion arcs that already exist on the previously formed route. The inserted customers are selected based on the closest distance from the depot (Z) and viewed through the distance matrix.

	Z	A	B	C	D	E	F	G	H	I	J	K	L
Z	0	12,2	6,8	4,2	66,8	127,7	83,3	250,9	58,8	85,5	213,2	256,4	255,3
A		0	11,4	8	77,7	135,4	94,4	262	71	96,6	222	270	266,4
B			0	3,5	66,6	128,8	84,4	250,9	59,9	86,6	213,1	257,5	255,3
C				0	68	129,9	86,6	255,3	63,3	88,8	216,5	266,4	255,3
D					0	62,2	42,2	210,9	82,1	43,3	155,4	222	215,3
E						0	62	174,3	126,5	60	100	191	177,6
F							0	172,1	65,5	2,22	129,9	182	177,6
G								0	204,2	169,8	96	23,3	51
H									0	67,8	187,6	266,4	208,9
I										0	127,7	181	175,9
J											0	117,7	100
K												0	20
L													0

Table 1. the distance matrix

For t = t + 1 (Z – G – L – K – Z)

Vehivle capacity (Q) > demand $d_{G,L,K}$

10 tons > 1,5 + 1, 2 + 2, 85

10 tons > 5,55 tons (compliant)

Distance traveled c_{ij} = 250,9 + 51, 0 + 200 + 256,4

= 578,3 km

travel time (WT) = $\frac{578,3}{40} \times 60 = 836$ menit

the sequential insertion method produces two routes. The first route, resulting in a distance of 519, 12 km with a travel time of 779 minutes. While the second route, produces a distance of 578,3 km with a travel time of 836 minutes.

3.2 Completion Using the Nearest Neighbor Method

The basic principle of this method is that transport vehicles serve the customer closest to the last location visited when they create a travel route. It initially finds the closest customer point to the depot (Z), then that customer becomes the starting point for finding the next closest customer from that location.

	Z	A	B	C	D	E	F	G	H	I	J	K	L
Z	0	12,2	0,8	4,2	66,6	127,7	83,3	250,9	58,8	85,5	213,2	256,4	255,3
A	12,2	0	11,4	8	77,7	135,4	94,4	262	71	96,6	222	270	266,4
B	0,8	11,4	0	3,5	66,6	128,8	84,4	250,9	59,9	86,6	213,1	257,5	255,3
C	4,2	8	3,5	0	68	129,9	86,6	255,3	63,3	88,8	216,5	266,4	255,3
D	66,6	77,7	66,6	68	0	62,2	42,2	210,9	82,1	43,3	155,4	222	215,3
E	127,7	135,4	128,8	129,9	62,2	0	62	174,3	126,5	60	109	191	177,6
F	83,3	94,4	84,4	86,6	42,2	62	0	172,1	65,5	2,22	129,9	182	177,6
G	250,9	262	250,9	255,3	210,9	174,3	172,1	0	204,2	169,8	96	23,3	51
H	58,8	71	59,9	63,3	82,1	126,5	65,5	204,2	0	67,8	187,6	266,4	208,9
I	85,5	96,6	86,6	88,8	43,3	60	2,22	169,8	67,8	0	127,7	181	175,9
J	213,2	222	213,1	216,5	155,4	100	129,9	96	187,6	127,7	0	117,7	100
K	256,4	270	257,5	266,4	222	191	182	23,3	266,4	181	117,7	0	20
L	255,3	266,4	255,3	255,3	215,3	177,6	177,6	51	208,9	175,9	100	20	0

Table 2. the distance matrix

- Calculate the travel time of delivery trips between locations (WT) $WT = \frac{20}{40} \times 60 = 30\ minutes$.
- Calculate the unloading time (UT), or unloading time $UTl = 1{,}2\ tons \times 3\ minutes = 3{,}6\ minutes$
- Calculating the total completion time (CT), CT = WT + UT + LT = 30 + 3,6 + 0 = 33,6 minutes ≤ T maks.
- Calculate vehicle capacity or load (Q), Q = Q + d_L = 4,35 + 1,2 = 5,55 ton ≤ Q maks
- All customers have been served, the distribution is complete.
- The Nearest Neighbor method produces two routes. The first route, resulting in a total mileage of 505.82 Km with a total travel time of 534.83 minutes. While the second route, produces a total mileage of 547.5 Km with a total travel time of 441.4 minutes.

3.3 Comparison of Routes Using Sequential Insertion and Nearest Neighbor Methods

Comparison of routes using sequential insertion and nearest neighbor methods under multiple trips conditions with a planning horizon. Thus, the distribution carried out pays attention to the maximum load limit of the transport vehicle. If the planning horizon has expired, but there are still customers who have not been served, the driver can return to the depot and continue by doing the next tour according to the location of the customer who has not been served.

Based on the calculation of sequential insertion and nearest neighbor methods, a route for transporting Bulog Regional Office of North Sumatra rice is obtained. The routes are compared based on distance and travel time.

Method	**Tour**	**route**	**capacity**	**Travel distance**	**Travel time**
Sequential Insertion	1	Z-B-C-A-H-D-F-I-E-J-Z	9,45 ton	519,12 Km	779 minutes
	2	Z-G-L-K-Z	5,55 ton	578,3 Km	868 minutes
	Total		**15 ton**	**1.097,42 Km**	**1647 minutes**
Nearest Neighbour	1	Z-B-C-A-H-F-I-D-E-J-Z	9,45 ton	505,82 Km	534,83 minutes
	2	Z-G-K-L-Z	5,55 ton	547,5 Km	441,4 minutes
	Total		**15 ton**	**1.053,32 Km**	**976,23 minutes**

Table 3. Comparison of Sequential Insertion & Nearest Neighbor Methods

Method	**Advanteges**	**disadvantages**
Sequential Insertion	• In customer selection, a simple way of working is to consider the	• No steps to prepare a more complete planning

	position of the customer closest to the depot to be inserted in the available insertion arc. • The working steps are simpler.	horizon in advance. • No steps to consider loading and unloading counts as well as thorough distribution times.
Nearest Neighbour	• In customer selection, it simply works by finding the closest point from the last unvisited location. • Has a step to set the planning horizon first. • It has a solution step by considering the loading and unloading time as well as the distribution time.	• Work steps have a longer process.

Table 4. advantages and disadvantages method

4. CONCLUSION

In the Sequential Insertion solution, the first route GD. PBD I - GD. PBD II - GD. MABAR - GD. LABUHAN DELI - GD. SUMBER MUFAKAT - GD. PASIR - GBB. NAGA PITA - GBB. LUMBAN PEA - GBB. KISARAN NAGA - GBB. BAKARAN BATU - GD. PBD I and the second route GD. PBD I - GSP. HUTA LOMBANG - GBB. SITATARING - GBB. PALOPAT - GD. PBD I with a total distance of 1,097.42 Km and a total travel time of 1647 minutes. While the Nearest Neighbor solution obtained the first route GD. PBD I - GD. PBD II - GD. MABAR - GD. LABUHAN DELI - GD. SUMBER MUFAKAT- GBB. NAGA PITA - GBB. LUMBAN PEA - GD. PAYA PASIR - GBB. KISARAN NAGA - GBB. BAKARAN BATU - GD PBD I and the second route GD. PBD I - GSP. HUTA LOMBANG - GBB. PALOPAT - GBB. SITATARING - GD. PBD I with a total distance of 1,053.32 km and a total travel time of 976.23 minutes. So it can be concluded that the route formed using Nearest Neighbor in this study is more optimal with a distance difference of 44.1 Km shorter and a time difference of 670.77 minutes shorter than the route formed on Sequential Insertion.

Analysis of the Nearest Neighbour method as the optimal method for determining the route for this problem, the Nearest Neighbour method as a method for solving problems by considering the shortest distance so as to produce a fairly decent quality in determining the resulting distance, which can minimize the distance traveled and the travel time of the vehicle.

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