Research Article

Comparison Of Optimal Distribution Route For Personal Protection Equipment By Saving Matrix And Tabu Search Methods Using Nearest Neighbor Approach At Covid-19 Referral Hospitals In West Java

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Abstract: At the beginning of COVID-19 pandemic in 2020, the disease was spread across the universe. This virus has level of blistering transmission because it can be transmitted through the air. To contain the outbreak, the people need to be self-isolated to minimize interaction with other people. In this case, the health workers are on the front line to combat this COVID-19 pandemic. It is because they must be dealing with the affected patients directly by taking care of them during their self-isolation period. The health workers must wear personal protective equipment (PPE) to avoid the virus transmission. In this turmoil, the availability of *personal* protective equipment or *PPE* is quite worrying. Therefore, the Indonesian government and every government around the world are arm in arm organize a worldwide aid in the form of PPE distribution through referral hospitals, with the objective of making the health workers safer. This research is aimed at conducting a simulation of distribution to obtain PPE route distribution in a more effective and efficient ways to get an optimal route. In this case, this research had been conducted by comparing two methods: *saving matrix* and *tabu search* for Hazmat suit distribution. Apart from getting an optimal route, the cost and time could be pushed more effectively to clock the fastest time in distribution with the fewest cost of distribution. The simulation of distribution point used was Distribution Center of West Java as an origin point, specifically at the COVID-19 referral hospitals in West Java, which was listed on the PIKOBAR site as the beneficiary of the PPE and the data of health workers in West Java mentioned in Central Agency on Statistics or locally known as *BPS* as the determinant of the requested PPE numbers. The result of this research showed that Tabu Search method was more optimal compared to Saving Matrix method based on similar approach, Nearest Neighbor, in determining the route that resulted in four distribution routes. This study showed that Saving Matrix research method concluded a mileage of 2.404 km in 80 hours at the cost of Rp. 10.505.968, while Tabu Search concluded a mileage of 2.351 km in 78 hours at the cost of Rp. 10.437.492.

Keywords: Saving matrix method, tabu search method, nearest neighbor, COVID-19, PPE

INTRODUCTION

Pandemic in the Kamus Besar Bahasa Indonesia (KBBI) is an epidemic that has spread simultaneously everywhere, covering a wide geographical area. The COVID-19 pandemic means an outbreak caused by the coronavirus, which has spread across a wide geographic area covering the entire world. The International Committee on Taxonomy of Viruses organization calls the virus that causes Coronavirus Disease-19 (Covid-19), namely "Severe Acute Respiratory Syndrome Coronavirus-2 (SARS-CoV-2 virus)" (Lai et al., 2020). World Health Organization has set a global pandemic status for Covid-19 because it has spread from day to day to all corners of the world (WHO, 2020). A quick response to tackling the spread of Covid-19 is needed because it has hurt the economy and other sectors of life in the community affected by the Covid-19 case (Budastra, 2020).

Personal protective equipment (PPE) is a tool used to protect oneself or the body against the dangers of work accidents (Suma'mur, 2009). Personal protective equipment (PPE) is a crucial weapon for medical personnel to work. The scarcity of PPE is still happening. The Executive Board of the Indonesian Doctors Association (IDI) explained that PPE is only for single-use; this has led to PPE limitations, although the number of cases and patients has increased (Sulistyawati, 2020). In handling the coronavirus, medical personnel must increase vigilance and use personal protective equipment to avoid transmission from positive patients. The increase in the number of positive patients, increasing every day, makes global PPE reserves limited (WHO, 2020). As a result of the scarcity of PPE, the hospital lacks PPE so that the government can send regular assistance to each hospital. The distribution centre, as a government agency, strives to assist referral hospitals for Covid-19 patients. Assistance in the form of PPE hazmat suits is sent once a month by considering the number of health workers in each hospital area. The number of

health workers available is considered a request for PPE that must be filling every month. Reporting from the news of liputan6.com as of Wednesday, January 6 2021, DKI Jakarta, Central Java and West Java are the provinces with the highest number of active cases. Although rare, personal protective equipment must still be in place so that health workers can treat patients safely. In manufacturing companies, almost 25% of the company product costs are for distribution activities. Therefore, evaluating improvements with the distribution method is always carried out continuously (Render, 2004). The cost of this distribution activity includes the distribution of PPE. One of the most critical operational decisions in distribution management is the schedule and route of delivery from one location to several destination locations. The decision on the delivery schedule and the route to be taken by each vehicle will significantly affect shipping costs (Pujawan & Mahendrawathi, 2010).

A saving matrix is a technique used to schedule a limited number of vehicles from a facility, and the number of vehicles in this fleet is limited. They have different maximum capacities (Bowersox, 2002). From this explanation, this method helps in distributing goods with a limited number of fleets based on this explanation.

Saving Matrix minimises distance, time, or cost by considering existing constraints (Pujawan & Mahendrawathi, 2010). Using the savings matrix method to determine the PPE distribution route, the distance travelled can use the shortest distance so that distribution speeds can be achieved and reduce PPE shortages due to timely distribution. Besides, the resulting time will be shorter, and the costs incurred will be less. By determining the optimal path to distribute PPE in West Java using the Saving Matrix method, the paths obtained will be shorter, the time needed is shorter. The transportation costs resulting will be less.

The Tabu Search algorithm is a metaheuristic method used to find the optimal solution in the Vehicle Routing Problem (VRP). The Tabu Search algorithms basic concept is to determine the stage in producing the most optimal aspiration criteria without being trapped in the initial solution found during the problem determination stage (Wassan, 2017). The Tabu Search Algorithm application can also complete reconfiguration in the distribution system (Augugliaro, 1999). The Tabu Search Algorithm results depend on the solution of neighbors or neighbors, the number of iterations that make the step taboo, and the best combination of intensification and diversification of mechanisms in the long and short term (Young-Jae Jeon, 2004).

LITERATURE REVIEW

1. Distribution

Distribution is an interdependent organisational tool in providing a single product for use or consumption by consumers or users (Daryanto, 2011). Distribution is a process of storing finished goods from producers to consumers or users when needed, so distribution is moving products or goods from one place to another using transportation, namely transportation (Willem, 2013).

2. *Saving Matrix Method*

The Saving Matrix method is a method used to determine the distance, route, time, or cost in carrying out the distribution of products from the company to the customer. This method aims to distribute goods according to customer orders effectively and efficiently so that companies can save costs, energy, and distribution time (Istantiningrum, 2010). The steps for the saving matrix method are as follows:

a. Determining the Distance Matrix

Determination of the distance matrix based on the distance data between origin and destination, a destination to the next destination, as well as the last destination returning to the origin, which is the calculation uses the following formula:

$$j(1,2) = \sqrt{(x_1 - x_2) + (y_1 - y_2)}^2$$

Explanation:
j = distance between Facilities 1 and 2
x = coordinate of point x
y = coordinate of point y

However, if the distance between the two coordinates is known, the calculation using the formula is not used and uses the existing distance.

b. Determine the Saving Matrix

The saving matrix determination by combining the distribution for locations will be passed by one truck exclusively. This there will be saved if there is a combination of routes that are considered one way with other routes. In calculating the saving matrix, you can use the following formula:

$$S(x,y) = j(x,y) + j(x,y) - j(x,y)$$

Explanation:
S = distance saving (combining x and y routes)

c. Allocation of Vehicles and Routes
Allocation of locations to routes or vehicles where a new delivery route is determined based on the combined route.
d. Ordering of Destination Locations in a Route
In ordering locations to determine a distribution route, there are several methods, namely:
1) Nearest Insert method
Determine visits by prioritizing locations that, when included in an existing route, resulting in the minimum distance.
2) Nearest Neighbor Method
This method determines the visit by using the closest to the last destination. This methods advantage is that it has a shorter iteration and gives optimal results for solving optimization problems. So that distribution using this method can be used as an initial route in making improvements to other methods (Adam et al., 2020).
e. Scheduling
Scheduling has done so that the distribution of goods is carried out sequentially according to the schedule made. The schedule is in the form of time records which are written into one calendar by the workers.
3. Tabu Search Algorithm
Tabu Search Algorithm is a heuristic method that guides each stage to produce the most optimum results to prevent a repetition of a solution in an iteration (Glover, 1986). There is no repetition on the path taken, and it is necessary to make a tabu list containing the known attributes of the solution.
Below is an algorithm from the tabu search:

a. Determine the initial solution
b. Determine alternative solutions by swapping each node on one path
c. Evaluating alternative solutions with the tabu list
d. Choosing the optimal alternative solution, which is the solution with the minimum value
e. Updating the tabu list with new results

METHODS

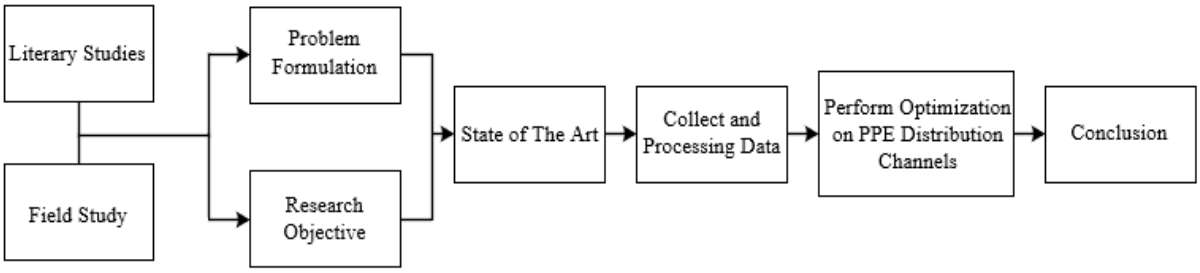

Figure 1. Research Methodology

The stages carried out in this research are:

1. Literary Studies
   Literature studies collect references from papers, books and other research related to research material.
2. Field Study
   Field Study is collecting data through observations at sources related to research materials used as primary and secondary data needed to conduct research.
3. Problem Formulation
   Compare distribution routes using the efficient matrix method and Tabu Search to optimize vehicle capacity, minimize distance and distribution time to get the lowest cost.
4. Research Objectives

Making considerations based on a comparison of two optimal route search methods related to the vehicle maximum capacity and the closest distance using the nearest neighbor algorithm in a distribution route to get the lowest cost.

5. Previous Research Review and Establishment of the State of Art Research
   By referring to several previous studies, it can facilitate future research by paying attention to existing equations.
6. Collect and Processing Data
   The data used in this study uses secondary data taken from the PIKOBAR website (https://pikobar.jabarprov.go.id/) and the number of health workers from BPS (https://jabar.bps.go.id/). The number of health workers in West Java assumes the number of PPE requests origin used is the West Java Distribution Center distributed to the Referral Hospital in West Java.
7. Perform Optimization on PPE Distribution Channels
   The optimization of the PPE distribution line compares two methods, namely the Saving Matrix and Tabu Search, with known distances and needs.
8. Conclusion
   The conclusion is a way to answer research objectives based on the results of the research that has done. The author's suggestions become input for further research and find out the shortcomings of the research.

RESULTS AND DISCUSSIONS

Data collection in this study was carried out by looking for data on requests for personal protective equipment from the COVID-19 referral hospital in West Java which was seen from the data on the number of health workers in West Java based on the Badan Pusat Statistik (BPS). One PPE box contains 50 hazmat suits. Distribution is carried out using a Colt Diesel fleet, and the goods transported are packaged using boxes with the respective specifications as shown in Figure 2 as follows:

Car Body Size		Weight		Fleet Size	
Length	560cm	Empty Weight	2,5 ton	Length	670cm
Width	200cm	Maximum Weight	8 ton	Width	200cm
Height	220cm			Height	220cm
Volume	24 CBM				

Figure 2. Fleet and Box Specifications

The fleet above can contain 432 boxes with one master box dimension, namely the length x width x height, which is 520mm x 440 mm x 130 mm in one shipment. The origin used is the West Java Distribution Center Office. The distance used is the shortest distance on Google Maps, there is also the number of hazmat suit requests, COVID-19 referral hospitals data, and the hospital distance used can be seen in Table 1:

Table 1. List of PPE Requests from Referral Hospitals

No.	Area	Hospital	Demand	Demand Box
1	Bekasi	RSUD dr. Chasbullah Abdulmajid	3850	77
2	Depok	RSUD Kota Depok	2405	48
3	Bogor	RSUD Kota Bogor	3672	73
4	Sukabumi	RSUD Sekarwangi Kab. Sukabumi	3945	79
5	Cianjur	RSUD Sayang Kab. Cianjur	2253	45
6	Karawang	RSUD Karawang	1227	25
7	Purwakarta	RSUD Bayu Asih Purwakarta	4313	86
8	Cimahi	RS Tk. II Dustira	3448	69
9	Bandung	RSU Hasan Sadikin	10004	200
10	Sumedang	RSUD Sumedang	3742	75
11	Majalengka	RSUD Cideres Majalengka	4532	91
12	Subang	RSUD Subang	3162	63
13	Banjar	RSUD Kota Banjar	2223	44
14	Garut	RSUD dr. Slamet Kab. Garut	1724	34

15	Indramayu	RSUD Indramayu	346	7
16	Cirebon	RSU Gunung Jati	3021	60
17	Kuningan	RSUD 45 Kab. Kuningan	3763	75
18	Ciamis	RSUD Ciamis	3005	60
19	Tasikmalaya	RSUD Dr. Soekardjo Tasikmalaya	5160	103

The following is the matrix distance between locations as nodes in distribution routing. The destination node is the referral hospital, and the origin is the Distribution Center office in West Java. Table 2 shows the distance matrix from origin to destination.

Table 2. Distance Matrix

	Depot	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Depot	0	140	182	192	124	124	109	70	25	11	38	77	132	138	200	229	223	248	114	103
1		0	50	59	95	108	42	71	119	125	185	173	113	283	204	174	210	235	260	250
2			0	63	104	118	31	67	115	121	167	155	102	266	186	163	193	217	242	233
3				0	86	99	83	111	160	165	212	200	146	310	231	214	237	262	287	276
4					0	72	89	118	167	172	215	203	150	314	234	217	241	265	290	279
5						0	100	129	178	183	171	217	164	328	190	231	255	279	304	293
6							0	128	177	109	229	217	163	327	248	260	254	279	304	293
7								0	91	97	143	228	174	242	162	242	265	290	218	207
8									0	112	158	251	198	257	177	265	289	313	233	222
9										0	107	204	151	206	126	218	242	266	182	171
10											0	129	76	240	160	143	167	191	216	205
11												0	58	202	123	124	149	173	179	168
12													0	159	79	185	208	233	135	124
13														0	77	133	206	231	133	122
14															0	192	216	240	143	131
15																0	214	239	142	130
16																	0	235	138	127
17																		0	119	108
18																			0	110
19																				0

After obtaining the distance matrix value of each node and origin, it is necessary to calculate the value of saving obtained if the distribution of several nodes is combined. The calculation of the value of saving uses a formula such as a Table 3:

Table 3. Distance Saving Formulas

Condition	Distance	
Before Saving	Oi + Oj	2 x (O-i) + 2 x (O-j)
After Saving	Oij	(O-i) + (i-j) + (O-j)
Distance Saving	Sij	(O-i) + (O-j) – (i-j)

Table 4. Saving Matrix Distance

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
1	0	272	273	169	156	207	139	46	26	-7	44	159	-5	136	195	153	153	-6	-7
2		0	311	202	188	260	185	92	72	53	104	212	54	196	248	212	213	54	52
3			0	230	217	218	151	57	38	18	69	178	20	161	207	178	178	19	19
4				0	176	144	76	-18	-37	-53	-2	106	-52	90	136	106	107	-52	-52
5					0	133	65	-29	-48	-9	-16	92	-66	134	122	92	93	-66	-66
6						0	51	-43	11	-82	-31	78	-80	61	78	78	78	-81	-81
7							0	4	-16	-35	-81	28	-34	108	57	28	28	-34	-34
8								0	-76	-95	-149	-41	-94	48	-11	-41	-40	-94	-94
9									0	-58	-116	-8	-57	85	22	-8	-7	-57	-57
10										0	-14	94	-64	78	124	94	95	-64	-64
11											0	151	13	154	182	151	152	12	12
12												0	111	253	176	147	147	111	111
13													0	261	234	155	155	119	119
14														0	237	207	208	171	172
15															0	238	238	201	202
16																0	236	199	199
17																	0	243	243
18																		0	107
19																			0

An example of a calculation to determine a saving value if you combine nodes 1 and 2 based on the values above:

$Saving_{12}$ = $(O\text{-}_1)$ + $(O\text{-}_2)$ – (1-2)
= 140 + 182 – 50
= 272

The initial route is determined based on the most significant saving value, then analyzes the number of goods transported by the fleet. The first node selected is 2 to 3 (Table 5), which has a saving value of 311km with a total capacity of 198 boxes. Then the iteration is continued by looking for the most considerable saving value. Still, with the demand that does not exceed the transport capacity, iteration continues until the fleet capacity is met. The next route starts again by finding the most considerable saving value without considering the path that has been taken previously. Here is an example of the iteration performed:

Table 5. Iteration 1 Route 1

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
1	0	272	273	169	156	207	139	46	26	-7	44	159	-5	136	195	153	153	-6	-7
2		0	311	202	188	260	185	92	72	53	104	212	54	196	248	212	213	54	52
3			0	230	217	218	151	57	38	18	69	178	20	161	207	178	178	19	19
4				0	176	144	76	-18	-37	-53	-2	106	-52	90	136	106	107	-52	-52
5					0	133	65	-29	-48	-9	-16	92	-66	134	122	92	93	-66	-66
6						0	51	-43	11	-82	-31	78	-80	61	78	78	78	-81	-81
7							0	4	-16	-35	-81	28	-34	108	57	28	28	-34	-34
8								0	-76	-95	-149	-41	-94	48	-11	-41	-40	-94	-94
9									0	-58	-116	-8	-57	85	22	-8	-7	-57	-57
10										0	-14	94	-64	78	124	94	95	-64	-64
11											0	151	13	154	182	151	152	12	12
12												0	111	253	176	147	147	111	111
13													0	261	234	155	155	119	119
14														0	237	207	208	171	172
15															0	238	238	201	202
16																0	236	199	199
17																	0	243	243
18																		0	107
19																			0

The following is a summary of the selected nodes and the demands of each node:

Table 6. Selected Nodes

Rute	Node	Demand	Total Demand
Rute 1	2	48	431
	3	73	
	1	77	
	13	44	
	14	34	
	6	25	
	12	63	
	15	7	
	18	60	
Rute 2	17	75	431
	19	103	
	16	60	
	4	79	
	5	45	
	8	69	
Rute 3	7	86	377
	11	91	
	9	200	
Rute 4	10	75	75

The route determination is carried out using the nearest neighbor approach, namely by looking at the node with the closest distance to the last node (Pujawan & Mahendrawathi, 2010). The time needed to distribute PPE is calculated by multiplying the total distance with the average speed, where the average speed of the car is 30km/hour. The following is a comparison of the distribution time before and after the repair:

Table 7. Distance and Time Before Repair

No	Area	Distance (Km)	Time (hour)	No	Area	Distance (Km)	Time (hour)
1	Bekasi	280	9,3	11	Majalengka	154	5,1
2	Depok	364	12,1	12	Subang	264	8,8
3	Bogor	384	12,8	13	Banjar	276	9,2
4	Sukabumi	248	8,3	14	Garut	400	13,3
5	Cianjur	248	8,3	15	Indramayu	458	15,3
6	Karawang	218	7,3	16	Cirebon	446	14,9
7	Purwakarta	140	4,7	17	Kuningan	496	16,5
8	Cimahi	50	1,7	18	Ciamis	228	7,6
9	Bandung	22	0,7	19	Tasikmalaya	206	6,9
10	Sumedang	76	2,5	Total		4958	165,27

Table 8. Distance and Time After Repair

Rute	Rute Saving Matrix	Jarak Tempuh (km)	Jumlah Box	Waktu Tempuh (jam)	Biaya
1	O-6-2-1-3-12-14-13-15-18-O	913	431	30	Rp 10,505,968
2	O-8-4-5-16-19-17-O	1002	431	33	
3	O-9-7-11-O	413	377	14	
4	O-10-O	76	75	3	
Jumlah		2404	1314	80	

Things that can consider in choosing a distribution channel are the costs incurred if the track is used. In distributing the PPE needs to be needed by the Referral Hospitals, the Distribution Center operates a fleet of Colt Diesel cars with a capacity of 432 PPE boxes that use pertalite as fuel. Table 9 is data on fixed and variable costs in the PPE distribution process.

Table 9. Fixed and Variable Costs

Fixed Cost		**Note**
Driver and kernet salaries (month)	Rp 3.700.000,00	Wages for chauffeur and kernet respectively. Wages are based on the Bandung City Regional Minimum Wage in 2021
Variable Cost		**Note**
Maintenance Cost	Rp 117,00	Maarif, M. A. 2020. Manajemen Perawatan Truk Jenis Mitsubishi Dengan Pendekatan Metode Realibility Centered Maintenance (RCM) Study Kasus di CV.Barokah Djaya A. JISO: Journal of Industrial and Systems Optimization, 3(1), 41-46.
Fuel price/liter	Rp 9.400,00	Price adjustment by Pertamina on January 1, 2021
Fuel Price/km	Rp 1.175,00	Damayanti, T. R., et al. 2020. Route Optimization Using Saving Matrix Method-A Case Study at Public Logistics Company in Indonesia. In International Conference on Industrial Engineering and Operations Management (pp.1583-1591)

Furthermore, determining the distribution route using the Tabu Search method using the same data as the previous calculation, choosing the distribution route using the Nearest Neighbor method, which is limited by a car capacity of 432 PPE boxes. Table 10 is the result of determining the distance using the Nearest Neighbor algorithm.

Table 10. Distance Determination Uses the Nearest Neighbor Algorithm

Nearest Neighbor					
No	Path	Distance		Transported	
1	O-9-7-2-6-O	315	km	359	boxes
2	O-8-1-3-4-5-12-O	657	km	406	boxes
3	O-10-11-14-13-19-17-O	845	km	422	boxes
4	O-18-16-15-O	695	km	127	boxes

Based on Table 10, it can be seen if the algorithm produces four distribution routes. Each node on each route is then exchanged to find an alternative solution that is likely to have a more optimum value. Example of calculating the number of routes per iteration on route 2:

$C_{(i,j)} = \frac{i!}{j!(i-j)!}$; i: number of nodes, j: number of nodes swicthed

$C_{(6,2)} = \frac{6!}{2!(6-2)!}$

$=15$

So that for route two, 15 alternative solutions can be used and used as distribution routes. Exchange nodes on line 2 can be seen in Table 11.

Table 11. Determination of Alternative Route

Number of Route	Route 2, first iteration		
	Move	Path	Distance (km)
0	1-1	O-8-1-3-4-5-12-O	657
1	1-2	O-1-8-3-4-5-12-O	859
2	1-3	O-3-1-8-4-5-12-O	905
3	1-4	O-4-1-3-8-5-12-O	912
4	1-5	O-5-1-3-4-8-12-O	874
5	1-6	O-12-1-3-4-5-8-O	665
6	2-3	O-8-3-1-4-5-12-O	707
7	2-4	O-8-4-3-1-5-12-O	741
8	2-5	O-8-5-3-4-1-12-O	728
9	2-6	O-8-12-3-4-5-1-O	775
10	3-4	O-8-1-4-3-5-12-O	583
11	3-5	O-8-1-5-4-3-12-O	688
12	3-6	O-8-1-12-4-5-3-O	770
13	4-5	O-8-1-3-5-4-12-O	656
14	4-6	O-8-1-3-12-5-4-O	709
15	5-6	O-8-1-3-4-12-5-O	709

Based on Table 11, it is known that the most optimal route is obtained by changing nodes 3 and 4 so that the shortest distance is 583km. The same is done for the other three routes in order to get the shortest distance from each route. Table 12 is the most optimal route after switching nodes.

Table 12. Distance Determination of Tabu Search Method

Tabu Search					
No	Path	Distance		Transported	
1	O-9-6-2-7-O	288	km	359	boxes
2	O-8-1-4-3-5-12-O	583	km	406	boxes
3	O-10-11-14-13-17-19-O	787	km	422	boxes
4	O-18-15-16-O	693	km	127	boxes

The results of determining the distance using the Tabu Search on the 4th route have two optimum results where the first line distance in the first iteration gets the optimum path results, namely 0-18-15-16-0 with a distance of 693km. In the second iteration, you get a line, namely 0-18-15-16-0, with the same distance. If such iteration results are obtained, then it is permissible to choose one of the routes between the two because it does not affect the calculations to be carried out. Table 13 is a comparison of the routes and distances obtained by the Saving Method and Tabu Search method.

Table 13. Comparison of Calculating Result

Route	Saving Matrix Route	Distance (km)	Transported (boxes)	Time (hour)	Cost
1	O-6-2-1-3-12-14-13-15-18-O	913	431	30	Rp10.505.968
2	O-8-4-5-16-19-17-O	1002	431	33	
3	O-9-7-11-O	413	377	14	
4	O-10-O	76	75	3	
Total		2404	1314	80	
Route	Tabu Search Route	Distance (km)	Transported (boxes)	Time (hour)	Cost
1	O-9-6-2-7-O	288	359	10	Rp10.437.492
2	O-8-1-4-3-5-12-O	583	406	19	
3	O-10-11-14-13-17-19-O	787	422	26	
4	O-16-15-18-O	693	127	23	
Total		2351	1314	78	

It can be seen if the route and distance generated by the Tabu Search method are smaller than the Saving Matrix method, where this will affect the costs incurred for the distribution of the Personal Protective Equipment. The Saving Matrix method results in a travel distance of 2404km while the Tabu Search method is only 2351km and the costs that need to be incurred by each method, namely Rp 10,505,968 and Rp 10,437,492. It can also be seen that the route produced by Tabu Search is much more even, there is no imbalance from one route to another. This is because there is an evaluation of the optimum solution in the Tabu Search method, so even though the Nearest Neighbor approach is optimal, Tabu Search is looking for another more optimal path. In contrast, in the Saving method, the calculation results are the most optimal path.

CONCLUSION

The results show that the Personal Protective Equipment distribution system at the Referral COVID-19 Hospital in West Java using the Tabu Search method is better than the Saving Matrix, which is seen from a distance traveled, time and costs that need to be spent by each method. The Saving Matrix method minimizes distance, time, and costs to produce efficient distribution routes (Pattiasina, 2018). With this method, it is hoped that it can help companies in their distribution network. The Saving Matrix method requires a distance between the origin and the purpose of distributing goods sourced from the company. At the same time, the Tabu Search Method is an optimization method whose search process moves from one solution to the next by choosing the best solution using the Nearest Neighbor approach then, it is recommended to evaluate with Tabu list (Glover, 1986).

The results showed that the distribution distance has a difference of 53km. This is because the Saving Matrix method does not include further evaluation and optimization as in the Tabu Search method. The distribution time is also a difference of 2 hours. These two factors affect the cost of distribution, where the cost of distribution differs from Rp 68,476,-. Comparison data for distribution route using the Saving Matrix and Tabu Search methods can be seen in Table 14:

Table 14. Comparison of the Saving Matrix and Tabu Search Methods

Method	Total Route	Distance (km)	Time (hour)	Cost
Saving Matrix	4	2404	80	Rp10.505.968
Tabu Search	4	2351	78	Rp10.437.492

Based on Table 14, it can be seen that the two methods have the same number of routes but have different distances and costs. These results were obtained based on the provisions of using 2 Colt Diesel cars with a maximum carrying capacity of 432 boxes and an average speed of 30km/hour.

The calculation of the distribution route for Personal Protective Equipment (PPE) using the Saving Matrix and Tabu Search methods aims to compare the two better methods to solve this case and optimize the existing distribution lines with the final result efficiency at a distance, time and cost that needs to be removed. Based on the research results, it is hoped that the distribution of PPE will be more maximal and minimize the scarcity that exists so that it is one way to reduce the number of the spread of Covid-19.

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