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APPLICATION OF ANT COLONY OPTIMIZATION ALGORITHM ON DETERMINATION OF TRANSPORTATION FROM BELAWAN TO TUNTUNGAN CAMPUS

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ABSTRACT

Transportation is an alternative used by everyone to get to a destination. In research, several alternative means of transportation can be used by students who live far from their campus. Students can determine the closest route to get to their campus. The campus we take is UINSU Campus IV. This research aims to overcome the transportation problems of students who live in the Belawan area and its surroundings. The research also used the ant colony optimization (ACO) algorithm method, with this method to make it easier to get the shortest route with a short time and the lowest cost or still standard with the distance. The ant colony optimization method is an algorithm inspired by the natural life of ants regarding ant habits in finding food. This research aims to get the shortest route and the optimal means of transportation used. In this study, it was found that the optimal means of transportation as well as distance, time, and cost were motorcycle transportation with a distance of 64.5km and the time required was 1 hour 4 minutes and the cost to be incurred was Rp. 40,000.00. This research uses Google Maps data to determine the distance of a location. Although the results are not optimal, it can be used as a solution for students in calculating the distance, time and cost to be used.

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1. INTRODUCTION

Transportation is a major necessity in daily life, especially for students who have to travel regularly from their residence to the campus location. Students of the State Islamic University of North Sumatra (UINSU) Campus IV Tuntungan face special challenges related to transportation, given the location of the campus which is relatively far from the city center. Most students come from the Belawan area, which is a significant distance from Campus IV Tuntungan. With this condition, transportation efficiency becomes one of the important factors to support the smooth running of their lecture activities. To get the shortest route, we use the Heuristic method to determine the closest distance, fastest time and lowest cost. There are several Heuristic methods that can

determine the shortest route among others; Ant colony optimization algorithm method, Dijkstra algorithm method, Floyd-Warshall algorithm method, Bellman-Ford algorithm method. From several methods we chose one of them, namely the ant colony optmization method.

In Heuristics and Algorithm methods there are several methods that discuss the closest or fastest route, namely: A. Ant colony optimization method (Risqiyanti, Yasin, & Santoso2019) Ant colony optimization is an algorithm inspired by the natural life of ants regarding ant habits in finding food. Naturally, ant colonies are able to find the shortest route on the way from the nest to food sources. The ant colony is able to find the shortest route between the nest and the food source based on the footprints on the path that has been traveled. The more ants that pass through a path, the clearer the will be. This causes paths that are by a small number of ants, to decrease in density over time, or even not be passed at all. And vice versa, the path traveled by a large number of ants, the longer it will increase the density of ants passing through , or even all ants will pass through the path. Given the principle of algorithm based on the behavior of ant colonies in finding the shortest travel distance, ant colony is very appropriate for solving optimization problems, one of which is to determine the shortest path. B. Dijkstra's Algorithm (Bunaen, Pratiwi, & Riti, 2022) Dijkstra's algorithm is one of the most popular algorithms from graph theory for determining shortest paths. Dijkstra's algorithm finds the shortest path by comparing the smallest weight from the starting node to the last node or destination, to find the most effective and efficient path to take. C. Floyd-Warshall Algorithm (2021; Buako, Yahya, & Achmad, 2021) The Floyd-Warshall algorithm is a method that solves problems by viewing the solution to be obtained so that it is an interrelated decision and will choose one shortest path from several alternative paths that have been generated from the calculation process. D. Bellman-Ford Algorithm (Bawole & Chernovita, 2019) The Bellman-Ford algorithm is a development of Dijkstra's algorithm, the Bellman-Ford algorithm will be correct if and only if the graph does not have a cycle with a negative weight reached from the source.

Of the several methods described, we will use one of the methods, namely ant colony optimization. Research on ant algorithms has contributed enormous knowledge to the field of bioinformatics, which is an observation of how an event that exists in nature can be used to solve problems that exist in the industrial world (Fallo, 2018) This research was conducted to determine a new, better route using the ant colony optimization algorithm to make it more efficient. The wider the existing distribution network, of course, will cause new problems, especially the problem of transporting and allocating these products. To anticipate the problem, an optimal distribution route assignment must be planned both in terms of vehicle usage, the availability of cars used in fulfilling all shipments and in the end.

It also requires a distribution that is truly optimal to be applied at this time and in the future (Syukriah, Akmal, & Ramadhani, 2022).

In relation to transportation, the Vehicle Routing Problem (VRP) is a problem in determining a number of routes for a set of identical vehicles that must serve a number of customers from a central depot (Septiashri, Purwanto, & Satyaananda, 2022). The transportation system is a basic element of infrastructure that affects urban development patterns. Transportation and land use development play an important role in government policies and programs. Transportation covers a wide range of fields, because almost all aspects of human life cannot be separated from transportation (transportation) (Frmandani & Trilaksana, 2021). The policy of using transportation as a means of transportation is also applied at MI Salafiyah Kasim educational institution. The type of transportation used is a school bus whose job is to pick up students from home and take them to school until they return home (Assayyis, Cholissodin, & Tibyani, 2020). Choosing the best route is very important so that the delivery runs smoothly and there is no delay in getting to the destination. The results of interviews with the company show that there has been no serious handling by the company for the selection of the best route which is set directly by the company, so in the process of delivering products to customers, the route selection is left directly to the driver or it can be said that it is still in a trial and error system (Eraniola & Suhendar, 2021).

The ant colony optimization method according to Journalists such as; ACO is a heuristic algorithm that has been proven to be applied to a number of Travelling Salesman Problem (TSP) problems and is able to find the shortest path well. Proven by previous studies. The research conducted, namely determining the shortest evaluation path in the plastic industry using ACO. In this study used an initial pheromone of 0.0098. The results of determining the parameters to be used, including the number of iterations of 500, number of ants of 100, Alpha value of 1 and Beta of 5 and evaporation rate of 5.

0.5. From the optimization results, the lowest cost is cost 2 so that the evacuation route for the Circullar Loom room is obtained to Corridor 3 and then exits through exit 4 so that it goes to Gathering Point 1. The higher the cost generated, it will result in the route being passed far away, thus increasing the evacuation time. (Ant colony optimization is a method of solving optimization problems in the form of a collection of several algorithms that use probabilistic techniques and colony communication principles in finding food (Gunawan, Maryati, & Wibowo, 2022). The ant colony algorithm has been used in research to find the location of the nearest place of worship in the city of Bandung. In this study, a system was built that provides information and directions to places of worship in the city of Bandung. The application built is proven to

be able to help users, especially tourists, in finding the nearest place of worship so that it can streamline the time of tourists who want to worship while traveling around the city of Bandung.

Based on the success of previous research, to find the path with the smallest distance value, the distribution problem at the Sasana Bonafide store will be solved with the ant colony optimization (ACO) algorithm. ACO is an algorithm based on the behavior of ant colonies that are looking for food by leaving traces (pheromones), so in the ant colony optimization (ACO) algorithm, pheromones are used as one of the parameters in determining the shortest travel distance to the destination. (Sianturi, Rahayudi, & Widodo, 2021).

2. RESEARCH METHODE

(Risqiyanti, Yasin, & Santoso, 2019) ant colony optimization method is an algorithm inspired by the natural life of ants regarding ant habits in finding food. Naturally, ant colonies are able to find the shortest route on the way from the nest to food sources. The ant colony is able to find the shortest route between the nest and the food source based on the footprints on the path that has been traveled. The more ants that pass through a path, the clearer the footprints will be. This causes paths that are traversed by a small number of ants to have less and less density of ants passing through them, or even to skipped altogether. And vice versa, the path traveled by a large number of ants, the longer it will increase the density of ants passing through it, or even all ants will pass through the path. Given the principle of algorithm based on the behavior of ant colonies in finding the shortest travel distance, ant colony is very appropriate for solving optimization problems, one of which is determining the shortest path.

In this method there are 4 designs, namely:

1. Collection of data on the means of transportation used
2. Calculating the closest distance
3. Calculating the cheapest cost
4. Calculating the fastest time

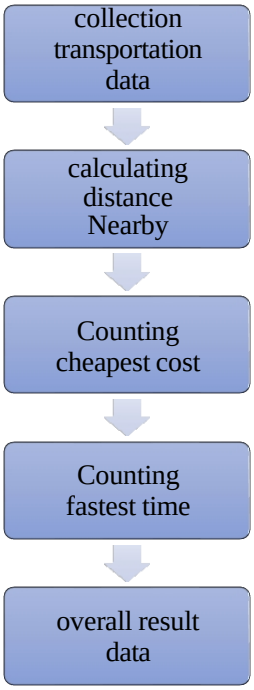

Figure 1.1 Flowchart of Research Method

Figure 1.1 shows the flow of the research process carried out using the ant colony optimization (ACO) method to determine the best transportation route.

3. RESULT AND ANALYSIS

Transportation Equipment Data Collection

The data will be used in conducting research to find optimization that can calculate the overall needs of the data, namely the closest distance, fastest time and lowest cost. There is a route that is passed by the means of transportation, namely:

1. Bus Route from Belawan to Merdeka Square

Figure 1.2 Bus Route from Belawan to Merdeka Square

Figure 1.2 shows the route taken by the bus from Belawan to Merdeka Square. This path consists of stops such as Belawan Market, TNI AL Monument Stop, to Merdeka Field Stop.

2. Bus Route from Merdeka Square to Tuntungan

Figure 1.3 Bus Route from Merdeka Square to Tuntungan

Figure 1.3 shows the routes of the bus line from Merdeka Square to Tuntungan including stops such as Grand Inna Medan Stop, Bank Mestika Stop, and UINSU Campus IV Stop.

3. Car Route

Figure 1.4 Car Route

Figure 1.4 shows the path of car travel starting from Belawan through several roads such as Belmera Toll Road, Jl. Setia Budi, to Jl. Lapangan Golf towards Tuntungan.

4. Motorcycle Route

Figure 1.5 Motorcycle Route

Figure 1.5 shows the motorcycle lane, which passes through main roads such as Jl. Yos Sudarso, Jl. Pertempuran, Jl. Kapten Sumarsono, Jl. Ringroad, to Jl. Pancur Batu.

Calculating Transportation Distance

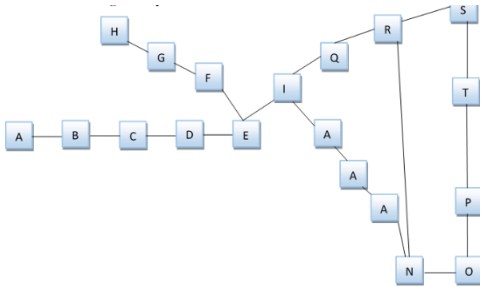

Figure 1.6 Motorcycle Route Graph

Figure 1.6 shows the symbols of roads traveled by motorcycles. Each point in the graph represents a particular road, with the distance between points indicated, such as A (Belawan) to P (Golf Course).

Table 1.1 Motorcycle Vehicle Route

No.	Road Symbol	Street Name	Distance
1	A	Belawan	A-B= 2.6 km
2	B	Port	B-C= 18.4 km
3	C	Jl. Yos Sudarso	C-D= 9.1 km
4	D	Battle Street	D-E= 3.6 km
5	E	Jl. Kapten Sumarsono	E-F= 1.8 km
6	F	Jl. Kapten Muslim Ujung	F-G= 600 m
7	G	Jl. Kapten Muslim	G-H= 3.4 km
8	H	Jl. Sunggal	H-R= 21, 5 km
9	I	Dormitory Road	I-J= 3.6 km
10	J	Jl. Gatot Subroto KM. 6,5	J-K= 6.6 km
11	K	Kp. Lalang Street	K-L= 5.5 km
12	L	Jl. Pinang Baris	L-M= 7.1 km
13	M	Jasmine Tax	M-N= 11, 2 km
14	N	Jl. Gelugur Rimbun	N-O= 14.7 km
15	O	Tanjung Anom Street	O-P= 6.5 km
16	P	Jl. Lap. Golf	P-Q= 11.4 km
17	Q	Ringroad Road	Q-R= 5.8 km
18	R	Jl. Setia Budi	R-S= 12.1 km R-N= 15.4 km
19	S	Jl. Jamin Ginting	S-T= 2.2 km
20	T	Jl. Pancur Batu	T- P = 3.4 km

This table details the distance between points on the motorcycle route. Belawan to Harbor: 2.6 km, Jl. Pertempuran to Jl. Kapten Sumarsono: 3.6 km. The total distance for the optimal motorcycle route is 64.5 km.

Point

Belawan to Port = 2.6 km Port to Jl. Yos Sudarso = 18.4 km
Yos Sudarsoke jl. Battle = 9.1 km
Jl. Pertempuran to Jl. Kapten Sumarsono = 3.6 km
Jl. Kapten Sumarsono to Jl. Kapten Muslim Ujung = 1.8 km Jl. Kapten Muslim Ujung to Jl. Kapten Muslim=600 m
Jl. Kapten Muslim to Jl. Sunggal = 3.4 km
Jl. Kapten Sumarsono to Jl. Asrama = 3.7 km Jl. Sunggal to Jl. Setia Budi = 21.5 km
Jl. Setia Budi to Jamin Ginting = 12.1 km Jl. Jamin Ginting to Pancur Batu = 2.2 km Pancur Batuke Jl. Golf Course = 3.4 km
Jl. Asrama to Jl. Gatot Subroto km.6.5= 3.6 km Jl. Gatot Subrotoke Jl. Kp. Lalang = 6.6 km
Jl. Kp. Lalang to Jl. Pinang Baris = 5.5 km Jl. Pinang Baris to Pajak Melati = 7.1 km
Pajak Melati to Jl. GlugurRimbun= 11.2 km
Jl. GlugurRimbun to Jl. Tanjung Anom = 14.7 km Jl. Tanjung Anom to Jl. Golf Course = 6.5 km Jl. Asmara to Jl. Ringroad = 3.6 km
Jl. Ringroad to Jl. Setia Budi= 5.8 km
Jl. Setia Budi to Jl. GlugurRimbun= 15.4 km

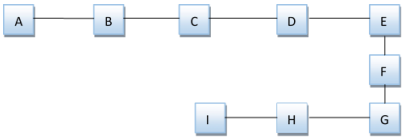

Figure 1.7 Car Route Graph

Figure 1.7 shows the symbols and distances between points for car routes, such as A (Belawan) to I (Golf Course).

Table 1.2 Car vehicle routes

No.	Road Symbol	Street Name	Distance
1	A	Belawan	A-B= 270 m
2	B	Port	B-C= 21 km
3	C	Belmera Toll Road	C-D= 20.5 km
4	D	Medan-Binjai Toll Road	D-E= 13.3 km
5	E	Dormitory Road	E-F= 3.9 km
6	F	Ringroad Road	F-G= 2.6 km
7	G	Jl. Setia Budi	G-H= 5.2 km
8	H	Jl. Jamin Ginting	H-I= 12.5 km
9	I	Golf course road	

Table 1.2 shows the distances between points on the car route, such as: Belawan to Port: 270 m, Belmera Toll Road to Medan-Binjai Toll Road: 20.5 km. The total distance for the car route is 79.37 km.

Table 1.3 Bus Routes from Belawan to Merdeka Square

No.	Bus stop name	Symbol	Distance
1	Belawan Market	A	A-B= 1 km
2	Navy monument bus stop	B	B-C= 350 m
3	Railway station stop	C	C-D= 1 km
4	Hero intersection bus stop	D	D-E= 550 m
5	Prima Husada Hospital Bus Stop	E	E-F= 1.3 km
6	Wismasi Canang bus stop	F	F-G= 3 km
7	PLN belawan bus stop	G	G-H= 1.4 km
8	Pertamina bus stop	H	H-I= 1.1 km
9	Simpang Syahbudin Yatim Bus Stop	I	I-J= 1 km
10	Medan Labuhan Hospital Bus Stop	J	J-K= 1.7 km
11	Impress Market Stop	K	K-L= 1.9 km
12	Titi bambu bus stop	L	L-M= 2.4 km
13	Martubung Junction Bus Stop	M	M-N= 1.6 km

14	Titi board market stop	N	N-O= 1.6 km
15	Kota Bangun bus stop	O	O-P= 1.4 km
16	Kim Junction Bus Stop	P	P-Q= 1.1 km
17	Mabar intersection bus stop	Q	Q-R= 1.7 km
18	White wood intersection bus stop	R	R-S= 3.6 km
19	Glorious Tanjung Junction Bus Stop	S	S-T= 1.4 km
20	Swallow Factory Stop	T	T-U= 1.4 km
21	Palapa Brayan Market Stop	U	U-V= 1.1 km
22	Simpang Brayan Bus Stop	V	V-W= 2.9 km
23	Forward Together Bus Stop	W	W-X= 650 m
24	Methodist Stop 8	X	X-Y= 1.4 km
25	Glugur Bus Stop	Y	Y-Z= 1.3 km
26	Putri Hijau bus stop	Z	Z-1= 2.2 km
27	Post Office Stop	1	1-2= 850 m
28	Merdeka Square Bus Stop	2	Total= 34.15 km

Table 1.3 shows that this route passes 28 stops, with a total distance of 34.15 km.

Table 1.4 Bus Routes from Merdeka Square to Tuntungan Table

No.	Bus Stop Name	Distance
1	Grand Inna Medan Bus Stop	1-2= 850 m
2	Old Fish Tax Stop	2-3= 300 m
3	Bank Mestika Bus Stop	3-4= 650 m
4	Simpang Waspada Bus Stop	4-5= 750 m
5	Ahmad Yani Park Bus Stop	5-6= 900 m
6	Medan Eye Center Bus Stop	6-7= 500 m
7	Mayor's KFC Stop	7-8= 600 m
8	Hermes Polonia bus stop	8-9= 750 m
9	Wahid Hasyim Intersection Bus Stop	9-10= 750 m
10	Dr. Mansyur Bus Stop	10-11= 1.5 km
11	Jamin Ginting Elementary School Bus Stop	11-12= 1.1 km
12	Pajus bus stop	12-13= 1.3 km
13	Harmonica Junction Bus Stop	13-14= 2.1 km
14	Citra Garden 1 Bus Stop	14-15= 1.8 km
15	Simpang Beringin Bus Stop	16-17= 1.6 km
16	Simpang Pos Bus Stop	17-18= 1.1 km
17	Water Gate Intersection Bus Stop	18-19= 650 m
18	Dharma Bakti bus stop	19-20= 500 m
19	Aviation Junction Stop	20-21= 1.3 km
20	Simalingkar Junction Bus Stop	21-22= 850 m
21	PKN Medan Training Stop	22-23= 550 m
22	GBI Jamin Ginting bus stop	23-24= 7.9 km
23	Bukit Permai Hospital Bus Stop	24-25= 750 m
24	Adam Malik Junction Bus Stop	25-26= 650 m

1.4 shows the routes passing 24 stops, with a total distance of 27 km.

Calculating the Fastest Time

At this stage, the time that can be traveled from the route distance of the transportation tool.

Table 1.5 Time taken results

Name of Transportation Equipment	Time Traveled
Trans Metro Deli Belawan-Lapangan Merdeka Bus	1 hour 22 minutes
Trans Metro Deli Bus Lapangan Merdeka-Tuntungan	1 hour 7 minutes
Car	51 minutes
Motorcycle	1 hour 4 minutes

Table 1.5 shows the time required for each transportation: Bus: 2 hours 29 minutes (total of two routes), car: 51 minutes, motorcycle: 1 hour 4 minutes.

Calculating the Costs Incurred

At this stage fuel costs/fares incurred for transportation

Table 1.6 Cost Results/Rates incurred

Name of Transportation Equipment	Costs/Fees Incurred
Bus from Belawan to Merdeka Square	Rp. 4,000.00
Bus from Merdeka Square to Tuntungan	Rp. 4,000.00
Car	Rp. 70,000.00
Motorcycle	Rp. 40,000.00

Table 1.6 shows the transportation costs: Bus: IDR 8,000 (two routes in total), motorcycle: IDR 40,000, car: IDR 70,000.

So on the route of each means of transportation we can choose the shortest route we will take. There are several transportation routes that can be used;

Motorcycle Route

a) Route A-B-C-D-E-F-G-H-R-S-T-P =
2.6km + 18.4km + 9.1km + 3.6km + 1.8km + 600m + 3.4km +21.5km + 12.1km + 2.2km + 3.4km = 78.7 km

b) Route A-B-C-D-E-I-Q-R-S-T-P =
2.6km+ 18.4km+ 9.1km+ 3.6km+ 3.7km+ 3.6km+ 5.8km+ 12.1km+ 2.2km+ 3.4km= 64.5 km

c) Rute A-B-C-D-E-I-J-K-L-M-N-O-P =
2.6km + 18.4km + 9.1km + 3.6km + 3.7km + 3.6km + 6.6km + 5.5km + 7.1km +14.7km + 6.5km= 81.4 km

Car Route

A-B-C-D-E-F-G-H-I

270m + 21km + 20.5km + 13.3km + 3.9km + 2.6km + 5.2km + 12.5km = 79.37km

Bus Route

Belawan to Merdeka Square

1km + 350m + 1km + 550m + 1.3km + 3km + 1.4km + 1.1km+ 1km + 1.7km + 1.9km + 2.4km + 1.6km+ 1.6km+ 1.4km+ 1.1km+ 2.9km+ 650m+ 1.4km +1.3km +2.2km+ 850m= 34.15km

Merdeka -Tuntungan Field

850m + 300m + 650m + 750m + 900m + 500m + 600m + 750m + 750m + 1.5km +1.1km +
1.3km + 2.1km + 1.8km + 1.6km + 1.1km +650m+ 500m + 1.3km + 850m +550m + 7.+ 750m + 650m = 27 km

Total Bus Routes

34.15km + 27km = 61.15 km

No	Name of Transportation Equipment	Time	Cost	Distance
1	Bus	2 Hours 29 Minutes	Rp. 8,000.00	61.15 km
2	Motorcycle	1 Hour 4 Minutes	Rp. 40,000	64.5 km
3	Car	51 Minutes	Rp. 70,000.00	79.37 km

From the routes above, the most optimal route to use is the motorcycle transportation route. This means of transportation also has a fast time to travel and a fairly standard cost for a student. The route traveled is A-B-C-D-E-I-Q-R-S-T-P is Belawan - Port - Jl. Yos Sudarso - Jl..Battle - Jl. Kapten Sumarsono - Jl. Dormitory - Jl. Ringroad - Jl. Setia Budi - Jl. Jamin Ginting - Jl. Pancur Batu - Jl. Golf Course for the distance traveled is 64.5 k the time required is 1 hour 4 minutes and the costs incurred are around Rp. 40,000.00 for round trip when going to campus.

4. CONCLUSION

This research was conducted to overcome the problems of distance, time, cost for students who live around Belawan. ant colony optimization is an algorithm inspired by the natural life of ants regarding the habits of ants in finding food. This research aims to get the shortest route and the optimal means of transportation used. In this study, it was found that the optimal means of transportation as well as distance, time, and cost were motorcycle transportation with a distance of 64.5km with the time required of 1 hour 4 minutes and the cost to be incurred was Rp. 40,000.00, the path taken, namely A-B-C-D-E-I-Q-R-S-T-P is Belawan - Port - Jl. Yos Sudarso - Jl... Battle - Jl. Kapten Sumarsono - Jl. Asrama - Jl. Ringroad - Jl. Setia Budi - Jl. Jamin Ginting- Jl. Pancur Batu - Jl. Golf Course.

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