# Application Deep Ant Colony Optimization Algorithm Determine Track Shortest Distribution Vaccination In Deli Serdang Regency

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**ABSTRACT**

*Covid-19 is an infectious disease caused by the Severe Acute Respiratory Syndrome Coronavirus-2 (SARS-Cov-2) virus, where clinical manifestations that appear in this infection include: symptoms of acute respiratory distress such as fever, cough and shortness of breath. Because one of the several areas recorded as a red zone and the most confirmed cases of Covid-19 with 2nd place in North Sumatra is Deli Serdang Regency with 15,750 confirmed cases of Covid 19 and 410 deaths. Then in the distribution of the Covid 19 Vaccine the Central Government and Regional Governments are responsible for the distribution of the Covid 19 Vaccine. These problems require optimizing the shortest route in vaccine distribution aimed at optimizing fuel, maintaining quality vaccines and vaccine effectiveness during the vaccine distribution journey to the destination. In this study used the shortest route scheduling with Ant Colony Optimization that exists results from calculation with Ant Colony Optimization yields route shortest For distribute vaccine to Public health center that is with totals for each _ journey with distance travel 127.4 Km / day And consumption material burn of 63.7 L.*

**Keywords:** ***Covid 19, Distribution Vaccines, Ant Colony Optimization, Routes shortest***

## INTRODUCTION

*Respiratory Syndrome Coronavirus 2 (SARSCOV2).* So, this disease is called Coronavirus Disease-2019 (COVID-19) (World Health Organization/WHO, 2020) (Nasution and Hidayah 2021) . Covid-19 is an infectious disease caused by the Severe Acute Respiratory Syndrome Coronavirus-2 (SARS-Cov-2) virus, which is a new type of coronavirus and has never been identified in humans before (Ministry of Health of the Republic of Indonesia, 2020) (Ririansyah, Efendy, and Yuniati 2022) . Then Covid-19 is a disease that can cause severe symptoms such as Middle East Respiratory Syndrome (MERS) and Severe Acute Respiratory Syndrome (SARS). Where the clinical manifestations that appear in this infection include: symptoms of acute respiratory disorders such as fever, cough and shortness of breath. The incubation period for Covid-19 infection is on average 5-6 days and the longest incubation period is 14 days (Alvian Pristy Windiramadhan, Phenomenology et al. 2022) .

The Covid 19 pandemic occurred in various regions of Indonesia with different intensities. Some areas, especially in North Sumatra Province. Therefore North Sumatra has recorded a red zone for the Covid 19 case in 31 December 2021 Positive Confirmation Cases 106,119 and 2,893 death cases. Because one of the several areas recorded as a red zone and the most confirmed cases of Covid-19 with 2nd place in North Sumatra is Deli Serdang Regency with 15,750 confirmed cases of Covid-19 and 410 deaths (Central Bureau of Statistics for North Sumatra Province).

Vaccines based on Permenkes No. 84 of 2020 are defined as biological products that contain antigens in the form of microorganisms that are dead or which have been weakened, whole or in part, or microorganism toxins that have been processed into toxoids or recombinant proteins, which are added to other substances and when given to someone will cause specific immunity to actively fight a particular disease. Vaccination is the provision of vaccines that are specifically given in order to actively induce or increase a person's immunity to a disease, so that if one day they are exposed to the disease they will not get sick or only experience a mild illness and not become a source of transmission. Then, based on the data, 8,639,038 doses and 5,659,799 people had been vaccinated with doses 1 and 2 in North Sumatra Province as of December 31, 2021. Vaccination data in Sumatra Province specifically for Deli Serdang district doses 1 and 2 were 928,490 and 614,130 (North Sumatra Provincial Health Office).

Then in the distribution of the Covid 19 Vaccine the Central Government and Regional Governments are responsible for the distribution of the Covid 19 Vaccine. Therefore several things that must be considered in preparing a vaccine distribution plan are the availability of vehicles, the availability and capacity of cooling facilities/equipment according to the characteristics of the vaccine, the distribution schedule, maximum and minimum stock levels of vaccines, as well as vaccine interval times according to the type of vaccine. Because In the distribution of vaccines, the problems that often occur are the waste of fuel expended due to the lack of choosing the shortest route, limited supporting equipment and logistics, namely a cold *chain where vaccines must always be in certain cold temperature* conditions in their storage containers to maintain quality and vaccine effectiveness .

So from these problems it is necessary to optimize the shortest route in vaccine distribution aimed at optimizing fuel, maintaining quality vaccines and vaccine effectiveness during the vaccine distribution journey to the destination.

In this research, the *Ant Colony Optimization (ACO) method was used. ACO* is an algorithm that adopts the behavior of ant colonies. Ants can find the shortest route in search of food sources. This is based on footprints on the trajectory that has been traversed. The more ants that follow a certain route, the easier this path will be recognized by other ants (Kaunang and Hartomo 2022)

Table 1. Displays the shortest route search results from the starting point of departure to the final point of vaccine distribution.

| **Vaccine Distribution** | | | |
|---|---|---|---|
| **Travel Code** | **Public health center** | **Mileage** | **Fuel Consumption** |
| AB | Deli Serdang Health Office – Sibolangit Health Center | 62.4 km | 31.2 L |
| BC | Sibolangit Health Center – Namorambe Health Center | 24.1 km | 12.05 L |
| CD | Namorambe Health Center – Pancur Health Center Rock | 12.2 km | 6.1 L |
| DE | Blue Health Center – Delitua Health Center | 15.9 km | 7.95 L |
| EF | Delitua Health Center – Patumbak Health Center | 4.6 km | 2.3 L |

| | | | |
|---|---|---|---|
| FA | Patumbak Health Center – Deli Serdang Health Office | 27.7 km | 13.85 L |
| Total | | 146.8 km | 73 ,4 5 L |

## METHOD

In this study using mileage data for the distribution of the Covid 19 vaccine in Deli Serdang Regency which will be described as finding the shortest route. In this study, from previous data with the shortest distance that has been traveled to find the shortest route with the result that the overall trip has reached 146.8 KM/day, consuming 69.4 Liter/day of fuel consumption, then to determine the shortest distance the research uses Hereustic methods commonly used in optimization problems in research use Ant Colony Optimization.

### Distribution Vaccine

The distribution of the COVID 19 vaccine needed in the implementation of the COVID-19 vaccination must be carried out and managed in accordance with a good drug distribution method. vaccine distribution aims to increase the community's immunity while reducing the number of infected people (Puteri, Yuliarti, and Maharani 2022) . The Central Government is responsible for the distribution of the COVID 19 Vaccine distribution, supporting equipment and logistics needed in the implementation of the COVID 19 Vaccination to provincial areas, Provincial Regional Governments are responsible for distribution to districts/cities in their territory and District/city Regional Governments are responsible for distribution to Community Health Centers and other Health Service Facilities in their area. In the event of a vacancy or shortage of availability of the COVID 19 vaccine in one area, the Central Government can relocate the COVID 19 vaccine from another area.

### Track route shortest

The shortest path is the problem of finding a path between two vertices (or points) in a graph, so that the total weight / distance traveled is the minimum. An example is finding the fastest way from one location to another on a map (Study et al. 2021) . This path search usually uses the ant algorithm. Determination of the shortest path is important and needed in connection with the optimization of the time used and some savings in other fields. With the shortest path that is passed, it makes work more effective, faster and of course there can be cost savings. The shortest path can be interpreted as the minimum value of a path. The problem faced in determining the shortest path is the number of routes that may be chosen from the place of departure to the destination. One way to solve this problem can use the heuristic method.

### Transportation

Transportation is the transfer of people or goods using vehicles driven by humans or machines (Kurniawan et al. 2022) . Transportation has three main things to consider, namely capacity, quality of vehicles and the routes that are traversed. The following can be described, namely:

1. Capacity

   This capacity referred to in this study is the carrying capacity of the vehicles used to send goods such as long 4 meters, small box cars 1,65 meter and large box cars and 1.9 meters. This small box can transport as many as 70-100 packages weighing 7-18 kg each per package. The big box car has box dimensions with a length of 5.6 meters, a width of 2 meters

and a height of 2.2 meters. This box has a transport capacity of 100-400 packages with a maximum carrying capacity of 2,000 kg.

2. Vehicle Quality
   The quality of vehicles is seen from the percentage of transportation facilities and infrastructure that are still in good or proper condition. Vehicle health greatly determines the smooth process of goods delivery. In guaranteeing the roadworthiness of a vehicle, it has set a limit on the age of use of the vehicle, namely for large box cars and small box cars, a maximum of 5 years. To ensure the vehicle is roadworthy, before the vehicle is used, the mechanic team routinely checks the condition of the vehicle.
3. Route to be followed
   In Law no. 38 of 2004, based on their function, roads are grouped into four groups, namely arterial roads, collector roads, local roads and environmental roads.

***Ant Colony Optimization (ACO)***

The ant algorithm was introduced by Moyson and Manderick and extensively developed by Marco Dorigo. The ant algorithm is a bioinspired metaheuristic, having a special group that tries to emulate the behavior characteristics of social insects, namely ant colonies. The behavior of each actor in imitating the behavior of living ants and how they interact with each other in order to efficiently find food sources and bring them to their colony (Dorigo and Socha 2007) . Ant Colony Optimization (ACO) is a probabilistic technique for solving calculation problems by finding the best path through a graph, this algorithm is inspired by the behavior of ants and their colonies in search of food.

**Google Maps**

Application study this use Google Maps is a facility provided by Google for free. The Google Maps facility will display a world map that can be used to view an area (Network, Putra, and Afri 2020) . In this study this application is used to find the direction of the road for vaccine distribution and determine the distance to vaccine distribution.

## RESULT AND DISCUSSION

In study this, Discussion For distance travel using google maps. Objective For display distance data travel delivery distribution vaccine Covid 19 to Health center in particular For Deli Serdang Regency. Picture route distribution vaccine Covid 19 to Public health center use Google Maps as following:

Figure 1. Google Maps Distribution Vaccine Deli Serdang Regency

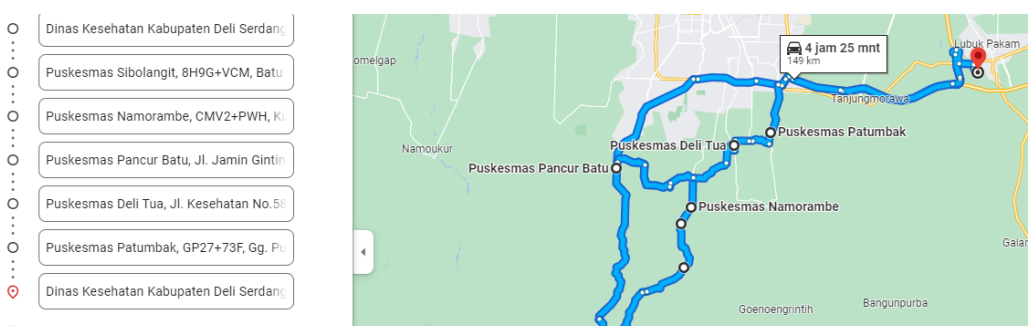

Table 2. Distance Between Point

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| A | 0 | 62,4 | 39,2 | 40,6 | 31,6 | 26,9 |
| B | 62,4 | 0 | 24,1 | 21,7 | 32,7 | 36,7 |
| C | 39,2 | 24,1 | 0 | 12,2 | 8,7 | 12,6 |
| D | 40,6 | 21,7 | 12,2 | 0 | 15,9 | 20.5 |
| E | 31,6 | 32,7 | 8,7 | 15,9 | 0 | 4,6 |
| F | 26,9 | 36,7 | 12,6 | 20.5 | 4,6 | 0 |

The table describes the distance the vaccine distribution will be taken by the Health Service - Health Center Or A - B reaching a distance of 62.4 Km, then continuing the journey from health center B to health center C reaching the distance traveled 24.1 Km, then returning from the health center C to puskesmas D by reaching a travel distance of 12.2 Km, and then from the point of departure starting from returning to puskesmas D to puskesmas E with the travel distance reaching 15.9 Km, then from puskesmas E to puskesmas F the distance traveled is 4, 6 Km.

Table 3. Displays data that has been counted Long Track Every Ant With Hamilton Circuit

| Ants Ke | Track Ant | | | | | | | Line Length/KM |
|---|---|---|---|---|---|---|---|---|
| 1 | A | B | C | D | E | F | A | 145.8 |
| 2 | A | B | C | D | F | E | A | 136.65 |
| 3 | A | B | C | E | D | F | A | 158.5 |
| 4 | A | B | C | E | F | D | A | 158.9 |
| 5 | A | B | C | F | D | E | A | 158.8 |
| 6 | A | B | C | F | E | D | A | 160.2 |
| 7 | A | B | D | C | E | F | A | 136.5 |
| 8 | A | B | D | C | F | E | A | 144.8 |
| 9 | A | B | D | E | C | F | A | 148,2 |
| 10 | A | B | D | E | F | C | A | 156.4 |
| 11 | A | B | D | F | C | E | A | 157,2 |
| 12 | A | B | D | F | E | C | A | 157,1 |

Table 3. Displays data that has been counted Long Track Every Ant With Hamilton Circuit (Continued)

| Ants Ke | Track Ant | | | | | | | Line Length/KM |
|---|---|---|---|---|---|---|---|---|
| 13 | A | C | E | B | D | F | A | 149.7 |
| 14 | A | C | E | B | F | D | A | 164.7 |
| 15 | A | C | E | D | B | F | A | 149,1 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 16 | A | C | E | D | F | B | A | 183.4 |
| 17 | A | C | E | F | B | D | A | 150.8 |
| 18 | A | C | E | F | D | B | A | 157,1 |
| 19 | A | C | F | B | D | E | A | 157,4 |
| 20 | A | C | F | B | E | D | A | 177.7 |
| 21 | A | C | F | D | B | E | A | 158 |
| 22 | A | C | F | D | E | B | A | 183.3 |
| 23 | A | C | F | E | B | D | A | 151.4 |
| 24 | A | C | F | E | D | B | A | 156.4 |
| 25 | A | D | B | C | E | F | A | 126.6 |
| 26 | A | D | B | C | F | E | A | 134.9 |
| 27 | A | D | B | E | C | F | A | 143,2 |
| 28 | A | D | B | E | F | C | A | 143,2 |
| 29 | A | D | B | F | C | E | A | 151.6 |
| 30 | A | D | B | F | E | C | A | 151.5 |
| 31 | A | D | C | B | E | F | A | 141.1 |
| 32 | A | D | C | B | F | E | A | 149.5 |
| 33 | A | D | C | E | B | F | A | 157.8 |
| 34 | A | D | C | F | B | E | A | 166,1 |
| 35 | A | D | E | B | C | F | A | 153 |
| 36 | A | D | E | B | F | C | A | 177,4 |
| 37 | A | E | C | D | B | F | A | 137.5 |
| 39 | A | E | F | B | D | C | A | 145.7 |
| 40 | A | E | F | B | C | D | A | 149.5 |
| 41 | A | E | F | D | B | C | A | 141.4 |
| 42 | A | E | F | C | B | D | A | 134.9 |
| 43 | A | E | B | C | D | F | A | 147.7 |
| 44 | A | E | B | C | F | D | A | 161.8 |
| 45 | A | E | B | D | C | F | A | 137,4 |
| 46 | A | E | B | F | D | C | A | 172.6 |
| 47 | A | E | C | B | D | F | A | 133,2 |
| 48 | A | E | C | F | D | B | A | 157,2 |
| 49 | A | F | C | E | B | D | A | 143,2 |
| 50 | A | F | C | D | B | E | A | 137,4 |
| 51 | A | F | E | B | C | D | A | 141.1 |
| 52 | A | F | E | D | B | C | A | 132,4 |
| 53 | A | F | B | D | C | E | A | 137.5 |
| 54 | A | F | C | B | D | E | A | 132.5 |
| 55 | A | F | B | C | D | E | A | 147,1 |
| 56 | A | F | B | D | C | E | A | 137.5 |
| 57 | A | F | C | E | D | B | A | 148,2 |
| 58 | A | F | C | D | B | E | A | 137,4 |
| 59 | A | F | D | B | C | E | A | 133,2 |
| 60 | A | F | D | C | B | E | A | 147.7 |

Table 3 explains the results of the length calculation Track Every Ant With Hamilton Circuit randomly and look for cross route shortest started from point beginning until end with method count results distance Service Health North Sumatra to Public health center with using google maps from counting the Can seen which path shows the smallest distance compared to the distance Another route ie route to 25 with results the distance reached 126.6 in One day with 6 places location distribution different vaccines.

Table 4. Displays Data That Has Been Counted Distance And Pheromone Intensity Data

| Ant Path | Distance | *Pheromones* |
|---|---|---|
| Q/C1 | 145.8 | 0.0068 |
| Q/C2 | 136.65 | 0.0073 |
| Q/C3 | 158.5 | 0.0063 |
| Q/C4 | 158.9 | 0.0063 |
| Q/C5 | 158.8 | 0.0063 |
| Q/C6 | 160.2 | 0.0062 |
| Q/C7 | 136.5 | 0.0073 |
| Q/C8 | 144.8 | 0.0069 |
| Q/C9 | 148,2 | 0.0067 |
| Q/C10 | 156.4 | 0.0063 |
| Q/C11 | 157,2 | 0.0063 |
| Q/C12 | 157,1 | 0.0063 |
| Q/C13 | 149.7 | 0.0066 |
| Q/C14 | 164.7 | 0.0060 |
| Q/C15 | 149,1 | 0.0067 |
| Q/C16 | 183.4 | 0.0054 |
| Q/C17 | 150.8 | 0.0066 |
| Q/C18 | 157,1 | 0.0063 |
| Q/C19 | 157,4 | 0.0063 |
| Q/C20 | 177.7 | 0.0056 |
| Q/C21 | 158 | 0.0063 |
| Q/C22 | 183.3 | 0.0054 |
| Q/C23 | 151.4 | 0.0066 |
| Q/C24 | 156.4 | 0.0063 |
| Q/C25 | 126.6 | 0.0078 |
| Q/C26 | 134.9 | 0.0074 |
| Q/C27 | 143,2 | 0.0069 |
| Q/C28 | 143,2 | 0.0069 |
| Q/C29 | 151.6 | 0.0065 |
| Q/C30 | 151.5 | 0.0066 |
| Q/C31 | 141.1 | 0.0070 |
| Q/C32 | 149.5 | 0.0066 |
| Q/C33 | 157.8 | 0.0063 |
| Q/C34 | 166,1 | 0.0060 |
| Q/C35 | 153 | 0.0065 |
| Q/C36 | 177,4 | 0.0056 |
| Q/C37 | 137.5 | 0.0072 |
| Q/C38 | 151.6 | 0.0065 |

Table 4. Displays Data That Has Been Counted Distance And Intensity Data Pheromones (Continued)

| Ant Path | Distance | *Pheromones* |
|---|---|---|
| Q/C39 | 145.7 | 0.0068 |
| Q/C40 | 149.5 | 0.0066 |
| Q/C41 | 141.4 | 0.0070 |
| Q/C42 | 134.9 | 0.0074 |
| Q/C43 | 147.7 | 0.0067 |
| Q/C44 | 161.8 | 0.0061 |
| Q/C45 | 137,4 | 0.0072 |
| Q/C46 | 172.6 | 0.0057 |
| Q/C47 | 133,2 | 0.0057 |
| Q/C48 | 157,2 | 0.0063 |
| Q/C49 | 143,2 | 0.0069 |
| Q/C50 | 137,4 | 0.0072 |
| Q/C51 | 141.1 | 0.0070 |
| Q/C52 | 132,4 | 0.0078 |
| Q/C53 | 137.5 | 0.0072 |
| Q/C54 | 132.5 | 0.0075 |

| | | |
|---|---|---|
| Q/C55 | 147,1 | 0.0067 |
| Q/C56 | 137.5 | 0.0072 |
| Q/C57 | 148,2 | 0.0067 |
| Q/C58 | 137,4 | 0.0072 |
| Q/C59 | 133,2 | 0.0075 |
| Q/C60 | 147.7 | 0.0067 |

Table 4 explains the search for the highest results from the length of the dipheromone path by calculating the distance traveled divided by 1 and the smallest distance by selecting the highest pheromone result is the C25 ant trip with a distance traveled of 126.6 KM with the result of the *pheromone evaporation rate* with a value of 0.0078.

Table 5. Displays Scheduling Data route shortest With *Ant Colony Optimization*

| **Vaccine Distribution** | | | |
|---|---|---|---|
| **Travel Code** | **Public health center** | **Mileage** | **Fuel Consumption** |
| A - D | Deli Serdang Health Office – Pancur Health Center Rock | 40.6 Km | 20.3 L |
| D - B | Blue Health Center – Sibolangit Health Center | 2 1.7 Km | 10.85 L |
| B - C | Sibolangit Health Center - Namorambe Health Center | 24 , 1 Km | 12.05 L |
| C - E | Namorambe Health Center – Delitua Health Center | 8.7 Km | 4.35 L |
| E - F | Delitua Health Center – Patumbak Health Center | 4.6 Km | 2.3 L |
| F-A | Patumbak Health Center – Deli Serdang Health Office | 27.7 Km | 13.85 |
| Total | | 127.4 Km | 63.7 L |

Table 5 explains the shortest route scheduling with *Ant Colony Optimization* that exists results from calculation with *Ant Colony Optimization* yields route shortest For distribute vaccine to Public health center that is with totals for each _ journey with distance travel 127.4 Km / day And consumption material burn of 63.7 L.

## CONCLUSION

With a travel route length of 126.6, the *pheromone evaporation* rate is 0.0078, which is the highest amount of pheromone evaporation compared to other routes. While the Pheromone on the other way has evaporated a lot so the ants don't choose roads other than the 25th lane. The more ants that follow path 25, the more ants follow it. So , based on the research that has been done, it can be concluded that the results obtained with the distance traveled reach 126.6 km and the amount of fuel expended reaches 63.7 liters/day at a price of up to RP. 598,780 compared to before and after being rescheduled, it can reach 9.75 liters / day at a price of RP. 91,650.

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