TSP METHOD USING NEAREST NEIGHBOR ALGORITHM AT PT. J&T EXPRESS IN BANDUNG

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ABSTRACT
Effectiveness and efficiency are very important for an expedition company in optimizing the delivery of goods by a courier. The Traveling salesman problem (TSP) method using the Nearest Neighbor Algorithm can optimize the delivery of goods to all consumer location points with only one visit in one trip. The purpose of this study is to find the shortest route using the TSP method based on the travel distance data from drop point PT. J&T Express Sarijadi Bandung to all consumer points and back to this drop point. This data is processed using Matlab and Excel Solver software based on the Nearest Neighbor Algorithm. The results of this study show that the TSP method produces the shortest route, which is 1,944 meters. The delivery route generated by this method provides travel distance efficiency of 50.09% from the route without the TSP method, which is 3,960 meters. Thus, it is expected that there will also be optimization of time and transportation costs in this delivery.

Keywords: J&T Express, Nearest Neighbor algorithm, shortest route, Traveling Salesman Problem (TSP)

INTRODUCTION
One of the crucial problems faced by companies in the field of shipping goods is the effectiveness of shipping time and costs. The company will optimize operational costs and service optimization so that the level of customer satisfaction and trust increases. Thus companies engaged in freight forwarding services will provide excellent and best service for their customers (Hasanah 2020). To increase consumer satisfaction and confidence, the problem faced is the determination of the best strategy in finding the right expedition route so that the effectiveness of delivery runs in accordance with the company's target. Traveling salesman problem (TSP) occurs when a courier plans to distribute goods to several destinations with the provision that all places must be visited exactly once and the courier returns to the starting point (Cheikhrouhou and Khoufi 2021). TSP is an optimization method related to solving problems used in various fields, one of which is the field of transportation (Irfan 2018).

It is clear that TSP aims to find the shortest route of a person's series of journeys from one point in a subcluster to another into a whole chain in a cluster (Baniasadi et al. 2020). The clusters in this study show the area where the research was carried out, namely the Sarijadi area, while the subclusters are the destination points for shipping. The problem in this study was solved using the TSP method with the Nearest Neighbor algorithm. This algorithm is used to make it easier to find the shortest distance by paying attention to the closest place from the point visited. This method is very effective and easy in its application (Taunk et al. 2019). This is because the Nearest Neighbor algorithm is included in a simpler algorithm compared to others so that the process can be faster and more effective (Agus, Hatta, and Mahyudin 2017). In its implementation, the Nearest Neighbor algorithm is used to mark and measure the shortest distance from a place closest to that place (Sianturi and Sitorus 2019). Data processing in this study with the help of Matlab and Excel Solver software.
Traveling salesman problem (TSP) is a method used to achieve optimal values that are quite classic and non-deterministic polynomial-time complete (NPC), where there is no most optimal solution other than trying all possible solutions. To determine the optimal (shortest) route, the delivery of goods is carried out with several possible travel paths until returning to the point of origin without a single place passed twice (Sumiati 2016). Optimization can also use Prim algorithm to determine the shortest or fastest path in logistics distribution (Lusiani, Sartika, Habinuddin, et al. 2021) and use Dijkstra algorithm to determine the fastest path in logistics distribution by Bulog in the West Java region (Lusiani, Sartika, Binarto, et al. 2021).

The emergence of TSP based on existing data was first studied in depth by Harvard and Karl Menger in Vein, and this method was socialized through scientific publications at Princeton by Marrlin Flood and Hassler Whitney (Sartika n.d.). The Traveling salesman problem model used is as follows (Santosa and Willy 2011).

\[
Z = \sum_{i,j=0}^{n} A_{ij} X_{ij},
\]

with \( \sum_{i=0}^{n} X_{ij} = 1, \ i = 0, ..., n \) and \( \sum_{i=0}^{n} X_{ij} = 1, \ j = 0, ..., n \);

where \( n \) = the number of destination points/locations to be visited,
\( A \) = sequential pair between arc/edge \( (i, j) \),
\( C_{ij} \) = distance from city \( i \) to city \( j \).

The Nearest Neighbor algorithm is a simple algorithm used to determine the closest distance between points so as to solve TSP problems. The first step is to determine the center of activity and then look for another point closer to the center point. To connect the second point to the other point, the same principle as the original provision is used (Gunawan, Febriyanti, and Primadasa n.d.). The practical steps to use the Nearest Neighbor algorithm are: a) determine the distance/cost data to be used; b) label each specified data/point with a name that can represent the existing data; c) calculate the distance between predetermined points (Sologia, Aurachman, and Kusuma 2020). The distance between point \( A(x_1, y_1) \) and point \( B(x_i, y_j) \) uses the Euclidian distance with the following formula:

\[
dist(x,y) = \sqrt{(x_i - x_1)^2 + (y_j - y_1)^2}
\]

METHOD

The object of this study is 17 consumers with 12 different locations in the Sarijadi area, in addition to the initial location of the route, namely the drop point of PT. J&T Express Sarijadi. So, the points that are the object of research are 13 points as presented in the following table. The data was obtained from PT. J&T Express which is located at jl. Sarijadi Raya No.90, Sukarasa, Sukasari District, Bandung City. The data collection method is carried out in several stages, first collecting data on the address of the recipient of the package, second checking the transportation route that connects one place to another through direct monitoring, interviews, and based on maps on google maps. The data processing method uses the TSP Method with the Nearest Neighbor algorithm, assisted by excel solver software and the Matlab application.

RESULT AND DISCUSSIONS

Table 1 Address Data and Distance of Goods Delivery from Drop Point PT. J&T Sarijadi
Each coordinate point is labeled in the order in Table 1. The position of the drop point coordinates as the starting point of the route and 12 other consumers are presented visually in the figure below.

![Figure 1 Coordinate points of the recipient of the shipment of goods from PT. J&T](image)

Based on the distance from google maps data, a manual measurement of a courier’s journey from the drop point of PT. J&T went to 12 different locations in Sarijadi. This distance measurement is adjusted to the courier transportation tool, namely motorbikes and the route used follows the rules of road use in the Sarijadi area. Some road sections are applied to a one-way system, so that two adjacent places are found but the route is farther away. This measurement is also adjusted to the number of alternative routes that can be taken, and of course the shortest route is chosen. The distance data is presented in the following table.

<table>
<thead>
<tr>
<th>Titik ke.</th>
<th>Alamat Penerima</th>
<th>Jarak dari titik 1 (meter)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>J&amp;T Express, Jl. Sarijadi Raya No.95, Sukarasa, Ke, Sukasari, Kota Bandung, Jawa Barat 40213</td>
<td>0</td>
</tr>
<tr>
<td>2</td>
<td>Kantor Pusat Laziswaf Al Hifah, Jalan Gegerkalong Hillir No. 155a, Sarijadi, Sukasari</td>
<td>400</td>
</tr>
<tr>
<td>3</td>
<td>Kost Grahaj Jln. Gegerkalong Hillir No.171 Kelurahan Sarijadi Kecamatan Sukasari</td>
<td>500</td>
</tr>
<tr>
<td>4</td>
<td>Jln. Gegerkalong Hillir No.30 Kelurahan Sarijadi Kecamatan Sukasari</td>
<td>850</td>
</tr>
<tr>
<td>5</td>
<td>Jl. Sarijadi Raya No.95</td>
<td>260</td>
</tr>
<tr>
<td>6</td>
<td>Jl. Sarijadi Raya No.97</td>
<td>270</td>
</tr>
<tr>
<td>7</td>
<td>Jl. Sarijadi Raya No.105</td>
<td>300</td>
</tr>
<tr>
<td>8</td>
<td>PT. Amber Hasya, Jl. Sarijadi Raya No.111</td>
<td>350</td>
</tr>
<tr>
<td>9</td>
<td>Jl. Sarijadi Baru III No. 3 Sukasari</td>
<td>50</td>
</tr>
<tr>
<td>10</td>
<td>Jl. Sarijadi baru III no 21</td>
<td>170</td>
</tr>
<tr>
<td>11</td>
<td>Jl. Sarijadi baru III no 29</td>
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</tr>
<tr>
<td>12</td>
<td>yomart cijerokaso</td>
<td>190</td>
</tr>
<tr>
<td>13</td>
<td>sarikaso</td>
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</table>

**Table 2 Data matrix of distances between points**

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<th>3</th>
<th>4</th>
<th>5</th>
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Route Determination without TSP

Table 2 is a table of mileage between points of delivery of goods. Number 1 shows the location of the drop point as the starting point of the delivery route and the other 12 points are the location of consumers. Routes for shipping goods without the TSP Method, namely: 1 → 2 → 3 → 4 → 5 → 6 → 7 → 8 → 9 → 10 → 11 → 12 → 13 → 1. The graph is seen in the following figure.

![Shipping Route without TSP Method](image)

On this route, arrows indicate the direction of travel of the courier when going on an expedition. Point 2 is the first destination point and so on until point 13 which is the last destination, then return to point 1. The calculation of distance is done by adding up all the mileage from the beginning to the end of the trip. The total travel distance in the graph in Figure 2 is 3,960 meters.

RESULT

Route Determination using TSP

The optimal mileage or shortest route with the TSP method using the Nearest Neighbor algorithm can be obtained with the help of excel solver program software and the Matlab application.

The steps in the excel solver program software are: 1) create a matrix of distribution of distance data between places; 2) create columns of origin, destination point and distance using the index tool; 3) sum up all distances; 4) click Data then click Solver and then input data into Table Solter; 5) click ok then the program will run to find the best route. The view of the data processing process can be seen in the following figure.
Based on Figure 3, in the selection of tools select a solving method, when clicked on the method, three choices will appear, namely nonlinear GRG, Simplex LP, and evolutionary. The next step is to choose the evolutionary method because this method is used to find the optimal solution globally, so this method will select all available paths. This method is in line with the conclusion of a study that revealed that the evolutionary method is a method of the right conjunction in solving TSP problems (Suwarman 2021). After the program processes it, the total minimum distance will appear which is the total optimum distance of 1,944 meters. Figure 3 shows the route:

\[ 1 \rightarrow 12 \rightarrow 11 \rightarrow 10 \rightarrow 9 \rightarrow 5 \rightarrow 6 \rightarrow 7 \rightarrow 8 \rightarrow 2 \rightarrow 3 \rightarrow 13 \rightarrow 4 \rightarrow 1 \]

On this route, the arrow shows the direction of travel of the courier when shipping goods with point 1 being the starting point of delivery, then point 12 is the alternative point of the first destination of delivery of goods and so on until point 4 which is the last destination, and back again to point 1.

Furthermore, data processing will be carried out using the Matlab application. The first step is to determine the coordinates of each starting point of point 1 as the starting point and 12 delivery destinations on google maps. Determination of destination 2, 3, and so on based on the route of delivery of goods by the courier that has been carried out. The next step is to input the coordinate points of 13 places into the matlab software and generate a matrix of distances between places as shown in the following figure.
From Figure 5 obtained the route:

1 → 12 → 11 → 10 → 9 → 5 → 6 → 7 → 8 → 2 → 3 → 13 → 4 → 1

with a total distance of 1,944 meters. The graphs generated from data processing using both software are:
Based on the output of data processing, the best distance and route calculations are obtained, if the courier uses alternative delivery lines using the TSP algorithm, it will benefit in saving a distance of 2,016 meters or about 50.09% of the total distance of 3,960 meters that couriers usually do.

CONCLUSION

Delivery of goods by a courier PT. J&T to 12 separate locations can be done using alternative routes generated using the Traveling salesman problem (TSP) method with the Nearest Neighbor algorithm. The route that should be taken within a distance of 3,960 meters, using the Nearest Neighbor algorithm can save a distance of about 50.09% from the distance traveled the first time the delivery is as far as 3,960 meters. The distance of 1,944 meters is the optimal distance generated using the Nearest Neighbor algorithm with the help of the Matlab application and Excel Solver software. With alternative paths that can be used are:

1 → 12 → 11 → 10 → 9 → 5 → 6 → 7 → 8 → 2 → 3 → 13 → 4 → 1.

In a study that has just been conducted using the Dijkstra algorithm for the same data, a closed route was obtained in the form of a cycle (1,9,10,11,12,13,4,3,2,8,7,6,5,1) with a weight of 1890 meters (Lusiani, Purwaningsih, and Sartika 2023). Several previous studies have concluded that the use of this algorithm can display a more optimal distance so that this step can reduce the level of risk of negative impacts caused by a trip compared to using normal routes (Abu Alfeilat et al. 2019). In conclusions other studies revealed that this algorithm can produce very accurate and effective precision (Sadowski, Spachos, and Plataniotis 2020). In other studies concluded that this algorithm can make a good contribution in streamlining travel time (Wisudawati, Valentine, and Patradhiani 2022). Similarly, this algorithm is highly recommended for use in various disciplines in the hope of obtaining optimal values (Shahabi et al. 2020).

Each algorithm has advantages and disadvantages, this applies in determining the shortest route in an expedition. The data processing uses the Nearest Neighbor algorithm with the help of the Matlab application and Excel Solver Software to produce an optimal
distance of 1. 944 meters is thus 50.09% shorter than the normal distance done by a PT courier. J&T express in carrying out freight forwarding expeditions in the Sarijadi area.

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DAFTAR PUSTAKA


Gunawan, Muhkhhammat Sahrul, Dian Erliana Febriyanti, and Rangga Primadasa. “Journal Of Industrial Engineering And Technology (Jointech) UNIVERSITAS MURIA KUDUS.”


