

# SOLUTION TO TRAVELLING SALESMAN PROBLEM (TSP) FOR LOGISTICS DISTRIBUTION IN PT JALUR NUGRAHA EKAKURIR (JNE) REGIONAL DEPOK USING THE APPLICATION OF LINEAR PROGRAMMING AND SOLVER PROGRAM

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## 1. Research purpose

One of the problems happening in logistic companies, especially PT JNE, is that the vehicles that deliver packages to several addresses and return back to the starting depot take such a long distance and time because they do not know and choose the shortest path. This can waste such amount of money, customer satisfaction, and competitiveness of the company.

The problem above can be formulated as a Travelling Salesman Problem, which can be solved quite easily because it is can be just simply formulated in linear programming and can be solved using executor engines which use algorithms or heuristics. One example is Premium Solver Platform in MS Excel, which is simple and easy to use, so it can be applicable in R&D office environment, without requiring one to learn difficult programming concepts.

With my background knowledge in mathematics and MS Excel, I want to solve this problem so JNE can perform better in the future and become able to compete with its other rivals.

## 2. Research method

In this research, I used linear programming which is formulated in MS Excel and then executed it using Gurobi Solver Engine in Premium Solver Platform.

Firstly, data of the 55 addresses were obtained. Then, the coordinates of those addresses were searched in Google Maps and a distance matrix between those 55 coordinates were created using Google Maps API. Next, the linear programming formulation was made in MS Excel. Finally, it was executed in Premium Solver Platform using LP Gurobi Solver Engine.

This engine, which uses branch-and-bound heuristic, is reliable and optimal for medium-sized TSP problem (50 to 100 nodes), solves it in short time and finds a good optimum solution. In addition, it is simple easy to use by R&D office workers, and they don't have to learn complex programming concepts.

## 3. Theoretical model

There are 2 vehicles used here (Vehicle 1: East and Vehicle 2: West corridors), each uses motorcycle).

This model is known as multiple TSP. Here, two salesmen must leave the main depot to other different addresses and must return from another different addresses. Otherwise, there should be only one path—in total—taken between cities. The objective function can be formulated as:

$$\text{Minimize } Z = \sum_{i=1}^{55} \sum_{j=1}^{55} x_{ij} d_{ij}$$

with  $x_{ij}$  as the decision variable and  $d_{ij}$  as the distance between node  $i$  and  $j$ .

## 4. Experiment result and discussion

	Vehicle 1	Vehicle 2	Total
<b>No. of nodes Previous</b>	17	39	56
<b>Total distance Previous</b>	67.2 km	129.5 km	196.7 km
<b>No. of nodes After</b>	<b>19</b>	<b>37</b>	<b>56</b>
<b>Total distance After</b>	<b>55.0 km</b>	<b>103.7 km</b>	<b>158.7 km</b>
<b>Saving</b>	<b>18.15%</b>	<b>19.92%</b>	<b>19.32%</b>

The result of the experiment is shown below:

*Table 1: Comparison before and after solving*

As the total distance is reduced, the total time taken and cost used by each vehicle can be reduced. Using the normal-condition assumption of average motor vehicle speed in Depok of 21.4 km, and that JNE's motorcycles consume 25 km each liter, with the fuel cost is Rp8,450, the average time and fuel cost

	Vehicle 1	Vehicle 2	Total
<b>Previous time</b>	3.14	6.05	9.19
<b>Result time</b>	2.57	4.85	7.42
<b>Saving</b>	<b>18.15%</b>	<b>19.92%</b>	<b>19.32%</b>

savings are shown below.

	Vehicle 1	Vehicle 2	Total
<b>Previous cost</b>	22,713.60	43,771	66,484.60
<b>Result cost</b>	18,590	35,050.60	53,640.60
<b>Saving</b>	<b>18.15%</b>	<b>19.92%</b>	<b>19.32%</b>

*Table 2: Time savings*

*Table 3: Fuel cost savings*

The solving time using Gurobi Solver Engine, which uses branch-and-bound algorithm, is 6.01 seconds—a short time to solve a medium-sized multiple TSP—and can find a good optimum value.

## **5. Conclusion**

In this research, it can be concluded that the Travelling Salesman Problem, especially for the case study of logistics distribution in PT JNE regional Depok, can be solved using the application of linear programming and Solver program efficiently and produce optimal result and savings in such a short solving time.