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Expert System Troubleshooting Shortest Route Finding Using Traveling Salesman Problem (TSP)

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Abstract

The search for the shortest route is a path that is very functional in helping human activities. The Traveling Salesman Problem (TSP) is a method of finding the shortest route that a salesman can take when they want to visit several cities without having to visit the same city more than once. The case of Route Selection plays an important role because it must be on time and choose the alternative with the smallest value to the destination. Problems that occur in the form of lack of information and logic to obtain efficient information. The aim of this research is to minimize the distance. The search for a solution to the problem is to combine each distance taken to get to a place so that the Salesman can choose the Smallest alternative. The alternative mileage that has the smallest value is STRU, USTR, and URTS with an alternative value of 18.

Keywords: *Searching, Traveling Salesman Problem (TSP), Alternative Shortest Route, Path, Artificial Intelligence*

1. Introduction

The Traveling Salesman Problem (TSP) is a classic problem of finding the shortest route that a salesman can take when he wants to visit several cities without having to visit the same city more than once. The exact solution to this TSP problem requires calculating all possible routes that can be obtained, then choosing the shortest one. Literature review. There are many algorithms for searching the shortest route. The selection of the most optimum algorithm is always a problem in finding the shortest route, where each algorithm has its own advantages and disadvantages. In the scope of finding the shortest route, it cannot be said directly which algorithm is the most optimum for the whole case, because it is not necessarily an algorithm that has a high optimization for one case has a high optimization for another case [2]. The traveling salesman problem is a topic that attracts the attention of many mathematicians because it is easy to define but difficult to solve. The number of flow combinations along with the number of cities visited in the TSP makes this problem not easy. In Figure 1 there are seven cities that will be passed by the salesman and one point is defined as the starting route and the final route of the trip. To find the shortest route, you must first know the distance from each point. However, if the distance of each point is not known, the coordinates of each point can be used [3].

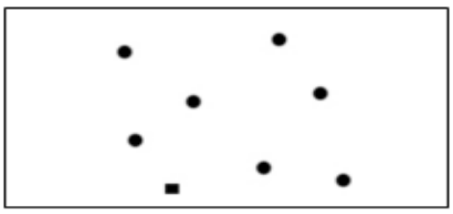

Figure 1. City points that are passed

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A graph is a set of objects called vertices (vertices or nodes) that are connected by edges or arcs (Schreiber 2007). Usually a graph is described as a collection of points (representing vertices) connected by lines (representing edges) or arrow lines (representing arcs). An edge can connect a vertex with the same vertex. This side is called a loop. With writable notation, G = {V,E} Examples of some of the graphs below[4].

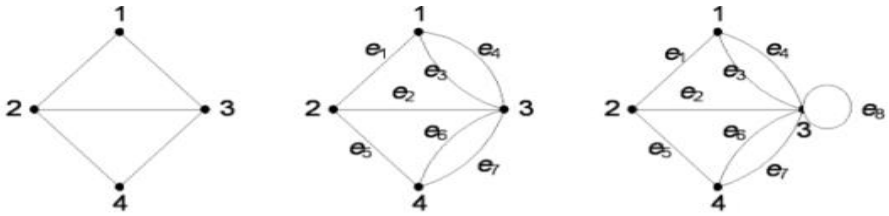


Figure 2. Simple, multiple and pseudo graphs (left-right).

The way the Generate and Test Algorithm works is as follows[5]:

a) Generate a possible solution;
b) Test each node which is a solution by comparing the node with the end node of a selected path with a set of expected goals;
c) If a solution has been found, then exit the system. If you haven't found a solution, then go back to step

So far, the TSP method has been widely applied in several studies with various algorithms to optimize the resources used in the product distribution process. Such as the research conducted by Farida in 2005 which applied a multi-objective genetic algorithm to solve the travel salesman problem. From Farida's research, it shows that the results of the calculation of the genetic algorithm provide optimum results, but for the value of n cities, the larger the algorithm's processing time, the longer [6].

In this TSP problem, if each vertex has an edge to another vertex, then the graph that represents it is a weighted complete graph. In any complete graph with vertices[7].The Generate and Test algorithm combines the DFS algorithm with backtracking, which is moving backwards to the initial state[8]. beginning. The test value isanswer "yes" or "no", [9]. Below is an example Generate and test cases in Salesman Program cases. explanation of the combination of 4 cities with each combination including[10]:

a) Swap City 1,2 (swap the order of the position of the 1st city with the 2nd city).
b) Swap City (swap the order of the position of the 2nd city with the 3rd city).
c) Swap Cities (change the order of the position of the 3rd city with the 4th city).
d) Swap City (swap the order of the 4th city position with the 1st city
e) Swap City 2,4 (swap the order of position of the 2nd city with the 4th city).
f) Swap City1,3 (swap the order of the position of the 1st city with the 3rd city).

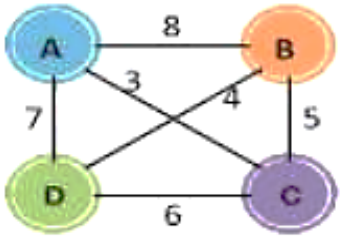


Figure 3. Path Length

Case settlement stage

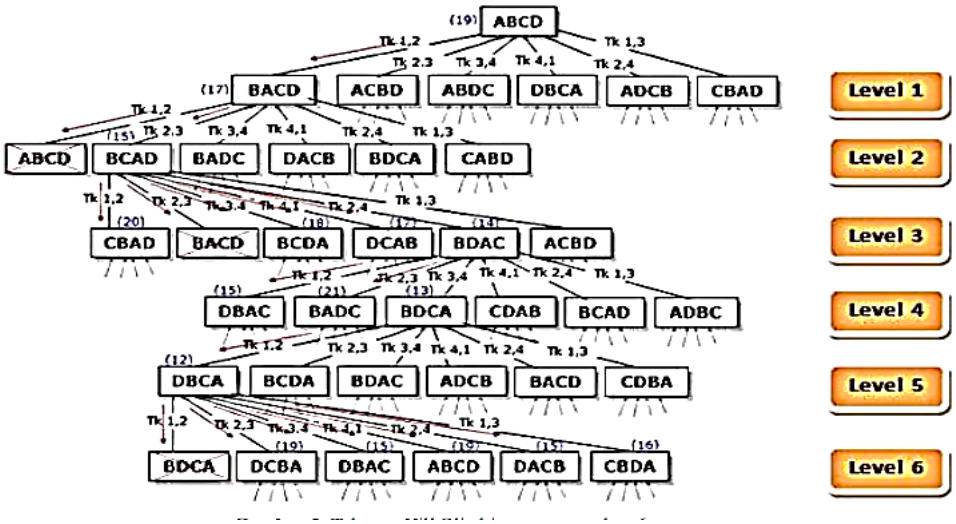


Figure 4. Completion Process 6 Paths

2. Research Methodology

To solve the case of the travel salesman problem, a research methodology is needed. The steps in this research include:

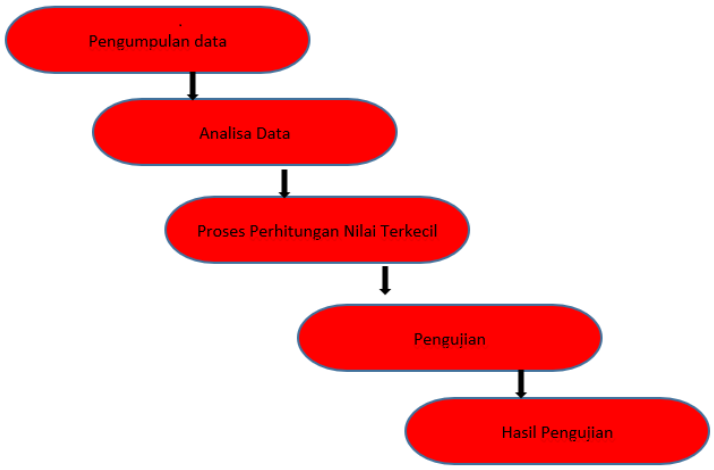


Figure 5. Research Methodology

The methodological processes in this research include:

a) Collecting Data
The first step that must be done in this research is to collect all data related to the distance route that will be taken by the food salesman.

b) Data Analysis
After the data and information are obtained, the authors select and prepare the data to be processed using indicators from alternatives that will be used in the study.

c) The Least Value
Calculation Process After collecting all the route data, all calculations are carried out by selecting the smallest value of each route that will be passed by the food salesman.

d) Testing
The tests carried out are in the form of calculating the value of each route
e) Test Results
The results of the research are the final part of all research that has been carried out by documenting the research as a whole.

3. Results and Discussion

TSP analysis and design produces the shortest route by performing several stages of analysis. The case that will be discussed is a route that can be passed by the sales of the drink which must pass through every right housing once. There are 4 Housing, with a distance of each city Value of each Track

1.RS = 7
2.RT = 5
3.RU = 9
4.SU = 9
5.TU = 8
6.TS = 4

The goal is to find the shortest distance for a Beverage salesperson to visit all housings once. The solution using generate-test is to generate possible solutions according to the problems faced by the salesperson. Alphabet combinations as possible solutions are n! = 4! = 24. The goal is to find a solution for the shortest route. The route is said to be valid if the path traversed is not 0. If the route is valid, then the distance is calculated and then compared to get a very optimal distance.

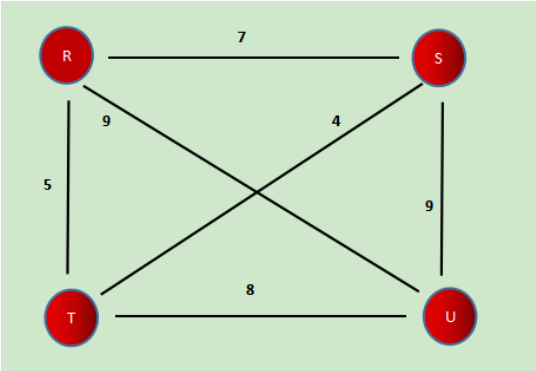


Figure 6. Beverage Sales Travel Route

The table below is a value process that has been processed to find out the shortest route so that the Beverage salesman finds the shortest alternative to visit the route to be addressed.

Table 1. Distance Search Flow Table

Search Order	Route Line	Proces	Preferred route	Route Length
1	RSUT	7+9+8=24	24	24
2	RTUS	5+8+9=22	22	22
3	RUST	9+4+9=22	22	22
4	RTSU	5+9+8=22	22	22
5	RSTU	9+4+8=21	22	22
6	RUTS	9+8+4=21	21	21
7	SRTU	7+5+8=20	20	20
8	SUTR	9+8+5=22	20	20
9	STUR	4+8+9=21	20	20
10	SRUT	7+9+8=24	20	20
11	SURT	9+9+5=23	20	23

Search Order	Route Line	Proces	Preferred route	Route Length
12	STRU	4+5+9=18	18	18
13	TRSU	5+7+9=21	18	21
14	TRUS	5+9+9=23	18	23
15	TUSR	8+9+7=24	18	24
16	TURS	8+9+9=26	18	26
17	TSRU	4+7+9=20	18	20
18	TSUR	4+9+9=22	18	22
19	UTRS	8+5+7=20	18	20
20	UTSR	8+4+7=19	18	19
21	USTR	9+4+5=18	18	18
22	USRT	9+7+5=21	18	21
23	URST	9+7+4=20	18	20
24	URTS	9+5+4=18	18	18

After all routes are calculated the distance of each city, then the next step is to make a simulation of each value of the shortest route, this makes it easier for the beverage salesman to take the route to be passed. The distance simulation process can be seen in the image below:

1) From Table 1 in order of 12, it is found that the shortest route based on distance is S-T-R-U with a total distance of 18 km. Alternative route 1 is S-T-R-U is 4+5+9= 18.

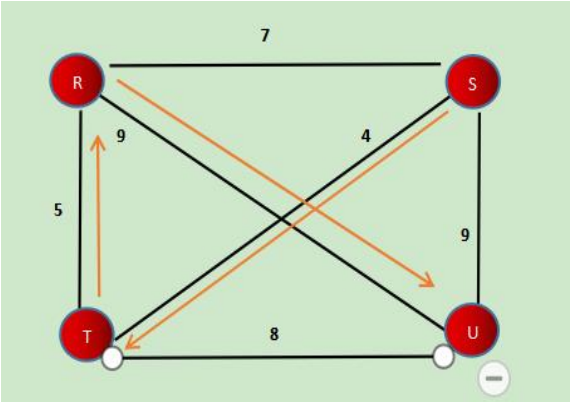


Figure 7. Beverage Travel Route 1

2) From Table 1 in order of 21, it is found that the shortest route based on distance is U-S-T-R with a total distance of 18 km. Alternative route 1 is U-S-T-R is 9+4+5= 18

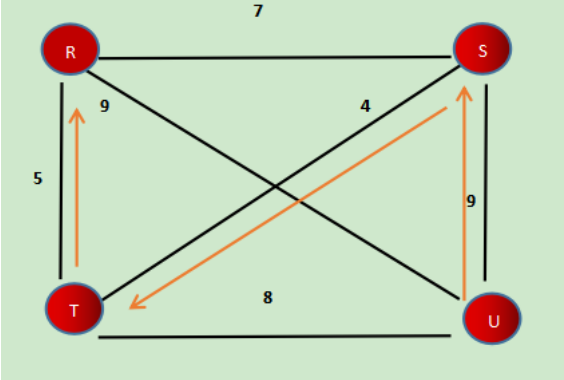


Figure 8. Beverage Travel Route 2

3) From Table 1 in order of 24, it is found that the shortest route based on distance is U-R-T-S with a total distance of 18 km. Alternative route 1 is U-R-T-S is 9+5+4= 18

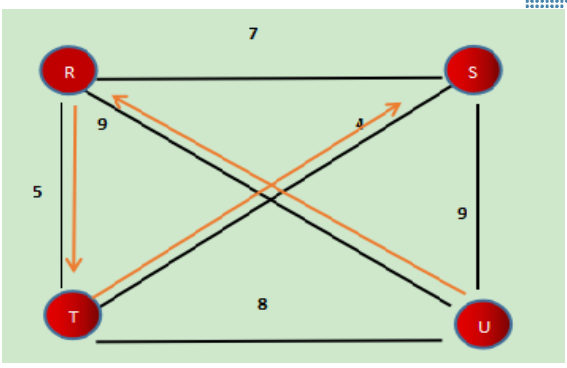
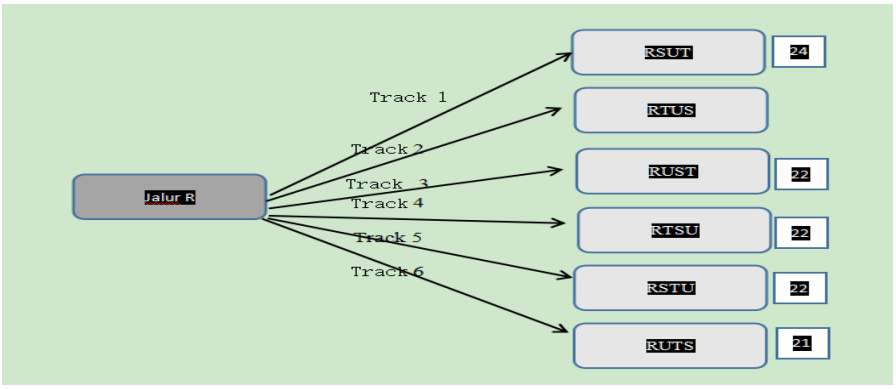
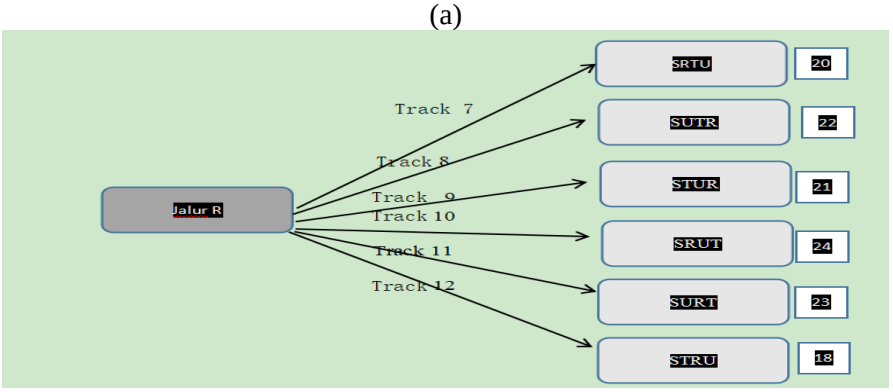


Figure 9. Beverage Travel Route 2

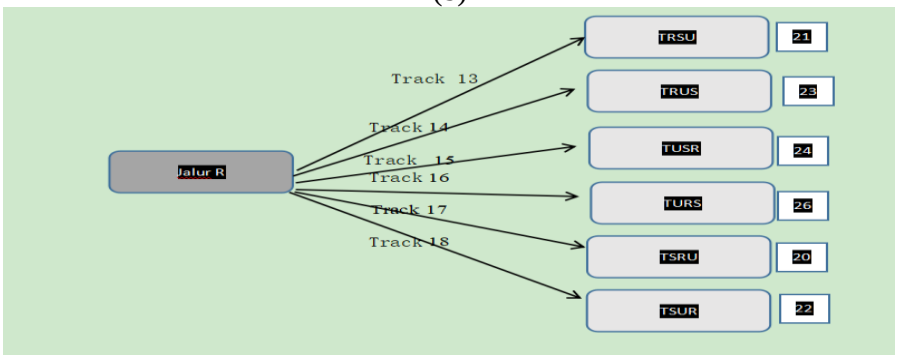
4) Combination Flow formed



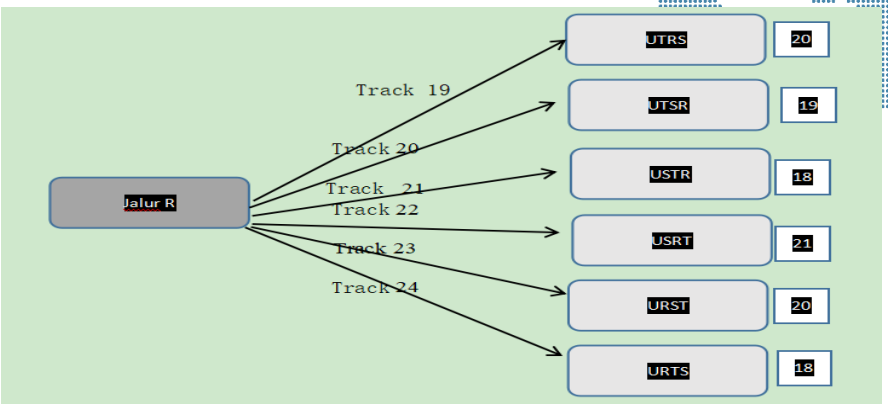
(a)



(b)



(c)



(d)

Figure 9. Combination Flow formed (a-d)

The results of the calculation of the Shortest Route from the Beverage Salesman Case can be seen in the table below:

Table 2. Shortest Route Results

No	Route	Route Value	Route Length
1	STRU	4+5+9	18
2	USTR	9+4+5	18
3	URTS	9+5+4	18

From the table above, the first solution generated is RSTU = 24, the second solution is RTUS = 22. It turns out that the second solution produces a shorter distance so that the path RTUS=22 is chosen. Do it for the next step. In the table, the shortest solution is again the same as STRU, namely USTR or URTS. The weakness of this generate & test technique requires that all possibilities be generated, so that if one housing is added for this TSP problem, namely 5 housing, it will require 120 combinations of paths, unless certain conditions are given, for example, initial housing for sales has been determined.

4. Conclusion

Based on the discussion of research and analysis that has been carried out, it can be concluded several things, to determine the shortest route using the Traveling Salesman Problem (TSP) method. Based on manual calculations with test results as many as 24 distance search paths. The shortest solution obtained by STRU is USTR or URTS with each route value totaling 18. So that the Food salesman can take the alternative shortest path to get to the destination location so as to minimize the distance to be reached. Travelling Salesman Problem (TSP) is implemented to determine the Shortest Route for Food Salesmen so that it can be used as an alternative in helping travel to the destination city.

As the end of this research, the author conveys suggestions that may be useful for anyone who is interested in using this system. In the study of Determining the Shortest Route using the Traveling Salesman Problem (TSP) method is very limited, so that in the future it can be developed, to be even better. It is hoped that by developing this decision support system, the number of paths that are more efficient and using the application system used will be more so that the results obtained are even better from the researchers. For further research, other Traveling Salesman Problem (TSP) methods such as Best First Search and Dept. First Search methods can be used.

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