The Object Tracking System At The Service Delivery Center Of The Traveling Salesperson Problem Method

Richki Hardi 1,2, Nanna Suryana 2, Naim Che Pee 2, Agung Sakti Pribadi 1, Jack Febrian Rusdi 2, Apri Junaidi 2

1 Universitas Mulia, Indonesia
2 Universiti Teknikal Malaysia Melaka, Malaysia

Corresponding author: richki@universitasmulia.ac.id

Abstract. Search object delivery is essential to investigate, especially for package delivery. The technology is beneficial to check whether the goods sent have arrived or not. Otherwise, it will be known where in real-time. This study aims to provide information to the shipping service, to choose the right and optimal shipping routes using the problem of the Travel Salesperson's problem, because of that way. This method is rather difficult when viewed from a computational point of view, but TSP is made easy by trying all possible routes to get a solution or approaching the optimal path. The problem is how to determine the route according to the package that can get to the destination city in the shortest time possible by using that route, package which can reach a town or delivery center to each subsequent branch that matches the package to the postal receiving town with a minimum time limit. In other words, the shortest path and the path that the packet must pass from the sending post to the recipient must be determined.

1. Introduction

The development of science and technology is increasingly rapid. It can be seen and felt directly or indirectly. These developments are having an impact on all aspects of human life. Today's globalization has resulted in changes that have an effect on all aspects of life and have taken place on an ongoing basis, including in the environment of national standard shipping companies. Today's globalization has resulted in changes that affect all aspects of life and sustainably occur in the context of national standard shipping companies. One type of development of science and technology is the development of the world of computing, one of which is the progress of information systems. There are almost no space and time limit about the information system; information from distant places physically can be quickly and easily known by us. Through Information Systems based on information technology, work becomes easy, effective, and efficient. Pos Indonesia, as a mediator company in the field of shipping and delivery, has severe challenges in dealing with the impact of changes that exist today, between another is the pattern of shifting community demand where service units are still not
maximized. Yet, on the other hand, the needs of consumers are increasing, besides problems related to service facilities, delivery of goods, tariffs checking, condition of products, customer satisfaction, work safety, etc. also need serious attention and handling.

The package delivery process is currently running at the post office, especially in the Aceh area using public transportation routes, with a minimal fleet that requires a long time. If the sub-district post office (KPC) wants to send a package to another city, then the package must be processed first by the examining post office (KPRK) and then sent to the destination city, even though the distance between the sub-district post office is closer to the destination city. The problem is how to determine the right route so that the package can get to the destination city in the shortest time possible by using that route, packages that reach a city or post office can be directed to the post office. The next one is right so that the package goes to the recipient city or post office with a minimum time delay. In other words, it must determine the shortest and the closest path the package will travel from the sending post office to the post office receiver. In the process of delivering packages from one city to another, of course, there needs to be consideration of the efficiency of time and cost by the Company so that accuracy is required in determining the shortest route between cities. The results of determining the shortest route can be obtained by using the Traveling Salesperson Problem (TSP) algorithm approach, which is an algorithm that looks for the quickest and nearest optimal path length from the origin to the destination and returns to the source in a weighted graph connected with minimal costs.

2. Literature Review

Mathematics is one of the knowledge that forms the basis of other experience. No wonder why mathematics is dubbed "mathematics is the queen, but also a surfer," mathematics as the queen of science, but also at the same time administrators of other sciences. Mathematics is said to be the queen of science because mathematics can grow and develop for itself as science without the help of other sciences[1].

Of the two nodes can occur multiple paths, while the track with the minimum weight is referred to as the shortest path or route. The importance here can be in the form of distance, travel time, or transportation costs from one node to another that forms a confident route[2].

Traveling Salesperson Problem is known as one of the optimization problems that has attracted the attention of researchers since several trial publications. Traveling Salesperson Problem is included in a very well-known theory in graph theory[3]. The name of this discussion was inspired by traders who toured the city. The description is considered as follows: given the number of cities and the distance between cities. Determine the shortest circuit that must be passed by the merchant when the merchant departs from hometown and visits each city exactly once and returns to the hometown. The issue of merchant travel not specified is Hamilton's rule, which has a minimum weight on the connected graph[4].

To the extent that TSP is symmetrical which means for two cities A and B, the distance from city A to city B is the same as the distance from city B to city A. in this case, and we will get the same length of the trip around that we can change the journey there is no difference between traveling around and the opposite[5].

In this TSP problem, if each node has an edge to the other vertices, the graph that represents it is a complete weighted graph. In any chart full with n vertices (n> 2), the number of different Hamilton cycles is (n − 1)! 2. This formula results from the fact that starting from any node, we have n − 1 side to choose from the first node, n − 2 hands of the second node, n − 3 from the third node, and so on. This is an independent choice, so we get (n − 1)! Selection. The number must be divided by 2 because each Hamilton sikel is counted twice, so all of them are ((n − 1)! 2) Hamilton crickets[6].
In the scope of the search for the shortest circuit, it cannot be said directly which algorithm is the most optimum for all cases, because not necessarily the algorithm that has the highest optimization for one example has a top optimization also for other cases. Optimization that achieves the efficiency of the algorithm working time, the time needed to reach the final destination, and the short distance always depend on each condition. There are many algorithms for searching for the quickest circuit. The selection of the most optimum algorithm is still a problem in finding the quickest course, where each algorithm has advantages and disadvantages of each[7].

The search for the shortest path has been applied in various fields to minimize costs or speed up the running of a process. The shortest path problem is generally explained using the concept of graphs that can be directed or non-directed graphs[8]. The sides in a non-directed chart can be considered to allow travel in both directions. Conversely, the parties in directed graphs can only be used for a one-way trip. Usually in determining the shortest path using weighted graphs. Each side in a weighted graph has a value or weight[9].

In finding the shortest path, the more points and lines in a graph, the more complicated it will be. A graph structure is developed by giving weight to each side. Weighted graphs can be used to symbolize various concepts. For example, if a chart signifies a road network, its importance can mean the length of the road, the travel time and the highest speed limit of a particular way, so to determine the oldest trajectory a weighted graph is needed[10].

One method used to find a Hamiltonian nickel with close to minimum weights in a complete weighted graph can be used as a technique known as the optimal two-sided method. The optimal two-sided way is a method that begins by selecting an arbitrary Hamiltonian nick on a graph. Then make a line of modifications to the cycle and hope to find a Hamiltonian nickel that is smaller than the weight of the previous sikel. This process is continued until Hamilton is obtained, which can not be reduced anymore[11].

The problem of distributing goods is an essential factor in increasing a company's income. Expensive shipping costs will increase product prices. This allows a decrease in the number of requests for these products so that in the end, the company's revenue will decrease. To avoid this incident, in addition to reducing production costs, companies also need to reduce the cost of goods distribution. One way to reduce the cost of delivery of goods can be done with vehicle fuel costs is to choose the shortest travel route. In addition to saving fuel, by selecting the shortest travel route, the travel time-traveled will also be faster[12].

Distribution problems experienced by several industries in Indonesia. Determining the most optimal path from the place of origin to several distribution destinations is a complicated and time-consuming task if the points of destination are challenging to reach. There are several algorithms in graph theory that are used to find the shortest distance and path for a weighted graph[13].

Based on the description above, researchers are interested in taking the topic entitled "The Object Tracking System At The Service Delivery Center Of The Traveling Salesperson Problem Method." The formulation of the problem in this study are (1) How to choose and determine the shortest routes that are close to optimal for packet delivery from the city of origin to the destination city and then return to the town of birth? (2). How to implement the TSP algorithm in determining the route in the packet delivery process? (3). How to make an application to search for package delivery routes at the Lhokseumawe post office ?. The purpose of this study is to design and implement a package tracking system that can provide convenience for a tracking problem using the TSP algorithm approach to the Lhokseumawe Post Office.
3. Methodology
The methodology used is structured analysis and design with the following stages:

Field Research
- In conducting this research, the writer made observations, which is the method of data collection using direct observation and systematic recording of symptoms or related phenomena without asking questions;
- Interview with Head of Data Processing and Head of Information Center at Lhokseumawe Post Office. Techniques of analysis of existing or ongoing systems;
- Implementation, i.e., the method by implementing the design results that have been made into an attractive appearance making it easier to use learning about research objects;
- Trial Method, Namely a method in which the design that has been implemented into the program can be tested on the truth to others who want to learn it.

The method used is TSP algorithm

4. Proposed System Implementation
Calculation of a Graph of Neighbors, The neighborhood matrix of the graph above is:

Table 1. Neighboring matrix optimal route calculation for post office graphs in Aceh: The Shortest Route Using the TSP Algorithm

| Origin | Path | S |
|--------|------|---|
| A      | A    | 0 |
| B      | AB   | 100 |
| C      | AF   | 100 |
| D      | ABC  | 100 |
| E      | AK   | 100 |
| F      | ABED | 100 |
| G      | AKF  | 100 |
| H      | AFKL | 100 |
| I      | AKBE | 100 |
| J      | AKC  | 100 |
| K      | AFH  | 100 |
| L      | AFML | 100 |
| M      | AFJM | 100 |
| N      | ABCP | 100 |
| O      | AFKLMN | 100 |
| P      | AFKLMP | 100 |
| Q      | AFKLMNP | 100 |
| R      | ABCOPST | 100 |
| S      | ABCOPST | 100 |

Table 2. Calculation of the optimal route from the initial node \( a = A \) (Lsm) to all other nodes.
(For S Value)
Table 3. Calculation of the optimal route from the initial node $a = A (Lsm)$ to all other nodes. (For D value)

5. Results
From the above calculation, the optimal route for package delivery at the Lhokseumawe post office to the destination post office is as follows:

Table 4. Optimal path from the origin node to the destination node:

Collection System Implementation Index Page Tracking System

Figure 1. Graph Description
The TSP algorithm will search for all possible paths to the endpoint and then determine the shortest route.

6. Conclusion and Future Scope

After creating a packet tracking system application using the TSP Algorithm at PT. Pos Indonesia Persero Lhokseumawe, the following conclusions can be drawn:

- This system can find the sequence of visits (one place to visit once) the most optimal "value" (can be minimum or maximum can be obtained for approval). "Value' here can be in terms of distance, cost, convenience, and so on. Complaints were found in the order of delivery of the packages with the least minimum distance.
- This package tracking system application can be used to improve package search and selection of shipping packages and speed up package search delivery of packages that is effective and efficient and provides information that is fast and easy.
- The Package Tracking System provides security data for each branch office and also the head office that has access rights by providing a user ID and password that can be encrypted.

Some suggestions that can be given for developing this tracking system are as follows:

- The package tracking system only provides the facility of determining the route of the package with the optimal trajectory, tariff list, package expedition, criticism or suggestions, profile, and news. To further develop this system, you can add other modules that support this system;
- In determining the optimal route, the TSP algorithm cannot always provide away with a minimum value, because the principle used by the TSP algorithm here is that all methods are tried to find the optimal path, to be able to get optimal route search properly

References

[1] R. Hardi, “The Development of Smart Campus System in Indonesia,” Mulia Int. J. Sci. Tech., vol. 2, no. August, pp. 17–25, 2019.
[2] R. Hardi, “Genetic algorithm in solving the TSP on these mineral water,” in 2015 International Seminar on Intelligent Technology and Its Applications, ISITIA 2015 - Proceeding, 2015.
[3] J. T. Isaacs and J. P. Hespanha, “Dubins traveling salesman problem with neighborhoods: A graph-based approach,” Algorithms, 2013.
[4] R. Hardi, “IMPLEMENTASI ALGORITMA TSP DALAM PENYELESAIAN TRACKING PAKET PADA UNIT PROCESSING CENTER POS INDONESIA KOTA LHOKSEUMAWE ACEH,” Telematika, 2015.
[5] A. Ouaarab, B. Ahiod, and X. S. Yang, “Discrete cuckoo search algorithm for the travelling salesman problem,” Neural Comput. Appl., 2014.
[6] J. Monnot and S. Toulouse, “The Traveling Salesman Problem and its Variations,” in Paradigms of Combinatorial Optimization: Problems and New Approaches: 2nd Edition, 2014.
[7] C. C. Murray and A. G. Chu, “The flying sidekick traveling salesman problem: Optimization of drone-assisted parcel delivery,” Transp. Res. Part C Emerg. Technol., 2015.
[8] N. Agatz, P. Bouman, and M. Schmidt, “Optimization approaches for the traveling salesman problem with drone,” Transp. Sci., 2018.
[9] Q. M. Ha, Y. Deville, Q. D. Plam, and M. H. Hà, “On the min-cost Traveling Salesman Problem with Drone,” Transp. Res. Part C Emerg. Technol., 2018.
[10] M. H. Shaelaie, M. Salari, and Z. Naji-Azimi, “The generalized covering traveling salesman problem,” Appl. Soft Comput. J., 2014.
[11] M. Lihoreau, T. Gómez-Moracho, and C. Pasquaretta, “Traveling Salesman,” in Encyclopedia of Animal Cognition and Behavior, 2017.
[12] P. Shi, S. Ray, Q. Zhu, and M. A. Kon, “Top scoring pairs for feature selection in machine learning and applications to cancer outcome prediction,” BMC Bioinformatics, 2011.
[13] R. Hardi, “The Use Of Tsp For The Application Of Pos Indonesia Delivery Service,” VFAST Trans. Softw. Eng., 2015.