

Vehicle Routing Problem Implementation in Improving Efficiency of Distribution System (Case Study: PT XYZ Indonesia)

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Abstract

The problem of distribution of goods of PT REHAU Indonesia is a problem of Vehicle Routing Problem (VRP) which is the problem of finding an effective and efficient route from a depot to a scattered customer. This research tries to analyze nearest neighbor method in solving the problem. This research will use quantitative method with 7 delivery route as samples involving 30 location points and 900 matrix of distance between locations. Data collection was done by conducting field study, ie observation and tracing of secondary data. This study uses a causal associative method of research that aims to determine the causal relationship (causal) or is influential between two or more variables. The results of this study indicate that the method is able to reduce total mileage by 15% from 1,614 km to 1,372 km or decrease as much as 242 km, reduce the delivery time of 16% or as much as 7 hours 49 minutes, and reduce the cost of delivery as much as 16% or decreased as much Rp 689,718.

Keywords: Vehicle Routing Problem (VRP), Nearest Neighbor, Distribution, Route

Introduction

The problem of the distribution of goods to PT XYZ Indonesia is a common problem of the Vehicle Routing Problem (VRP), namely the problem of determining the optimal route to get a minimal cost from a depot or warehouse to a customer location that is spread and with a different number of requests. To help solve the VRP problem, the nearest neighbor method is used in this study where this method has the characteristics of distribution route formation that are in accordance with the real conditions of the field conditions and simple so that it is expected to get optimal distribution performance

Given this problem, it is expected that the VRP settlement is the determination of the delivery route using the nearest neighbor method to improve the efficiency of the optimal distribution system, which is reflected in the reduced

total mileage, delivery time so that it can reduce the cost burden borne by PT XYZ Indonesia.

Indicators of this problem can be seen from the increase in total shipping costs through an increase in diesel consumption of 5-8% per year and also the cost of overtime drivers and kernet over the last three years from 2015 to 2017 where there is an increase every year.

The increase in diesel consumption is influenced by the distance traveled by the vehicle, while overtime costs for drivers and kernet are affected by the delivery time of the trip because it is related to the normal working hours limit. This problem arises due to the absence of a plan and method of determining the delivery route that can optimize the distribution of goods.

Determining the order of delivery routes to customers every day, is currently still relying on subjective experience and decisions from drivers and kernet, so this is a problem in the distribution of goods to customers, namely the time of product distribution that is less than optimal and this causes longer delivery time and mileage which increases in length so that ultimately affects the increase in fuel consumption, increased truck maintenance costs, endangers the safety and health of workers and also the company must pay overtime for drivers and kernet because the time to return to the warehouse exceeds normal working hours.

Vehicle Routing Problem (VRP) according to Caric and Gold (2008: 5) is a method used to determine the optimal route used by groups of vehicles when serving a group of users. The aim is to minimize overall transportation costs. The solution to the classic VRP problem is to find a set of routes that all start and end at the depot, and that meets the constraints that all customers are only served once. Transportation costs can be increased by reducing the total mileage and by reducing the number of vehicles needed.

Method

Population is the whole symptom / unit that you want to study. (Bambang

Prasetyo, 2014: 119). Whereas according to Moh. Nazir (2011: 271) population is a collection of individuals with quality and characteristics that have been established. The quality or characteristics are called variables. A population with a certain number of individuals is called a variable.

Thus the population is the whole section to be studied. In this study, the population taken is all data delivery, namely the order of routes, distance, time, and shipping costs. Sample is part of the population that you want to study. (Bambang Prasetyo, 2014: 119). Whereas according to Moh. Nazir (2011: 271) sample is part of the population.

Thus the sample is a portion of the population taken to represent the entire population under study. What is learned in the sample is finally applied to the population. Therefore the sample is part of the population that has certain characteristics or circumstances to be studied. Because not all people or objects will be examined but enough to use the sample that represents them.

The sample in this study is delivery data consisting of information on distance, travel time, shipping costs, and shipping routes during the January-February 2018 period. Samples are taken using Purposive sampling techniques, namely when the sample selection is based on certain characteristics or characteristics based on the characteristics or characteristics of the population. (Widodo, 2012: 58)

In this study will use truck shipping data to the east of Jakarta. Because this area is far from the depot or warehouse of goods in the west of Jakarta. Data collection techniques are carried out by conducting field studies by observing and tracking secondary data where the data obtained by the researcher through a review of monthly documents / reports and annual reports to find data on shipping data for the 2015-2017 period and also conduct literature review to enrich writing analysis .

Direct observations made on the distribution system and the activity process in the Tangerang warehouse. And view historical data in the form of Daily Goods Delivery Report for March 2015 to December 2017, Monthly Transportation Cost Report for March 2015 to December 2017, Monthly Overtime

Cost Report for March 2015 to December 2017, and Documentation Flow of activities in the Warehouse

Library Studies is done by studying, exploring, and citing theories or concepts from a number of literatures, either books, journals, magazines, newspapers or other written papers that are relevant to the topic, focus or variable of the research. The method used is descriptive statistics by analyzing the daily delivery data, distance, travel time, transportation costs and monthly overtime costs, then compared with distance, travel time, transportation costs and monthly overtime costs by the nearest neighbor method by considering capacity limitations, service time, limited number of vehicles and number of customers.

After all goods distribution data is known. First of all, all vehicle routes are still empty. Starting from the first vehicle route, this method inserts one by one the nearest neighbor that has not been visited on the route, as long as entering the customer into the vehicle route does not violate the maximum vehicle capacity limit and limited working time (or restrictions - the limitations described by other VRP variants). Then the same process is also carried out for the next vehicles, until all vehicles are full or all customers have been visited.

Causal associative method is a research that aims to determine causal relationships or influence between two or more variables. With this research strategy, a theory can be built that can function to explain, predict, and control a symptom. In this research method is also used Ex post facto approach, which is research conducted to examine events that occur within a certain period of time. This method is chosen with the objectives and characteristics of the research to be achieved in accordance with the objectives and formulation of the problem.

Data from the company in the form of measurable quantitative data relating to relationships and comparisons between two variables, namely delivery distance (X1) and travel time (X2) and as the independent variable namely shipping costs (Y) in solving VRP using the nearest neighbor method. The purpose of this method is to find out the relationship and comparison between independent variables with the dependent variable.

Discussion and Result

This study uses data distribution of goods from PT. XYZ Indonesia in Bitung, Tangerang to the eastern part of Jakarta, whose shipments are scheduled for every Thursday from 9:00 - 18:00 WIB, including 1 hour of rest time, and is the longest route than other routes. The number of goods distribution routes analyzed is as many as 7 shipping routes during the period January - February 2018 and involves 29 delivery destinations and produces 900 shipping distance matrices.

From the results of the research on the determination of the route with nearest neighbor method in optimizing the distance, travel time and shipping costs, it is shown that determining the order of the shipping route using the nearest neighbor method can reduce the total distance of 15% from 1,614 km to 1,372 km or decrease by 242 km. reduce delivery time by 16% or as much as 7 hours 49 minutes, and reduce shipping costs by 16% or reduced by Rp. 689,718. This is in line with the five previous studies which showed positive results where the route determination with the nearest neighbor method was proven to be able to optimize distance, travel time and reduce shipping costs.

Hypothesis Testing, In the first hypothesis, it is assumed that the use of the nearest neighbor method in solving VRP has an effect on the delivery distance (X1). It is proven statistically that t tableitung thitung or 2.015 1 3.190 and shows the probability of significance $0.019 < 0.05$ means that H_0 is rejected and indicates the influence of the use of nearest neighbor method on delivery distance. In the second hypothesis, it is assumed that the use of the nearest neighbor method in VRP solving affects the delivery time of delivery (X2). It is proven statistically that t tableitung thitung or 2.015 2 3.219 and shows the probability of significance $0.018 > 0.05$ means that H_0 is rejected and indicates the influence of the use of nearest neighbor method with delivery time of delivery.

In the third hypothesis, it is assumed that the shipping distance (X1) in VRP solving with the nearest neighbor method affects the shipping cost (Y). It is

proven statistically that t table t_{hitung} or $2.015 \leq 3.612$ and shows the probability of significance $0.015 < 0.05$ means that H_0 is rejected and shows the influence of the distance traveled by the nearest neighbor method with shipping costs. In the fourth hypothesis, it is assumed that the delivery time (X_2) in VRP solving with the nearest neighbor method affects the shipping cost (Y). It is proven statistically that t table t_{hitung} or $2.015 \leq 7.776$ and shows the probability of significance $0.001 < 0.05$ means that H_0 is rejected and indicates the influence of the distance traveled by the nearest neighbor method with shipping costs. In the fifth hypothesis, namely the estimated distance (X_1) and the travel time (X_2), the sending of the neighbor neighbor method in solving VRP together affects the shipping cost (Y). It is proven statistically that F_{table} F_{count} or $6,942 \leq 267,910$ and shows the probability of significance $0,000 < 0.05$ means that H_0 is rejected and shows the influence of distance and travel time by nearest neighbor method together with shipping costs.

Assumption testing, Testing the assumption of data normality with Kolmogorov-Smirnov One Sample Test shows that the data is normally distributed, namely the probability of significance > 0.05 . Homoscedasticity assumption testing shows that independent variables do not occur heteroscedasticity as seen through scatterplot diagrams. The assumption of autocorrelation with the Durbin-Watson (DW) test shows whether there is an autocorrelation problem where DW is between -2 and +2. From the results of the multicollinearity test it is known that the VIF coefficient is 1.888. So it can be concluded that there are no cases of mulitcolinearity because the VIF value is < 10 .

Conclusion

In this study shows that the use of the nearest neighbor method in determining the route of delivery or distribution of goods can improve efficiency which can be seen from the reduced distance, travel time and shipping costs. Of the seven shipping routes involving 30 location points and 900 distance between location matrices, the method was able to reduce the total mileage by 15% from

1,614 km to 1,372 km or decrease by 242 km, and reduce delivery time by 16% or 7 hours 49 minutes, and reduce shipping costs by 16% or reduced by Rp. 689,718.

Theoretically this is in line or in accordance with the literature review that the author describes from five previous studies related to the use of the nearest neighbor method in determining the route of delivery of goods and how their impact in optimizing distance, travel time and shipping costs.

Statistically it can also be proven through the linkages between variables that influence the efficiency of the distribution system, where it is known that any increase in distance or travel time will affect the increase in shipping costs and vice versa. So that the efficiency of the distribution system can be controlled with measurable indicators

References

- Bräysy O, Gendreau M. (2005). *Vehicle routing problem with time windows, part II: metaheuristics*. *Transportation Science*; 39:119–39.
- Caric and Gold. 2008. *Vehicle Routing Problem*. Croatia: In-The
- Caplice, Chris. 2006. *Transportation Management Operational Networks*. Boston: MIT Center for Transportation and Logistics.
- Johnson, D.L., Bentley J.L., Mc Geoch L. A., dan Rothberg E. E., 1997, *Near-optimal solutions to very large travelling salesman problem, Monograph, in preparation*.