Optimization of Humanitarian Logistics Distribution Routes in East Jakarta

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Abstract

DKI Jakarta often experiences flood disasters when the rainy season hits. The floods caused a number of residents to be affected so that residents needed to evacuate to safer places, such as refugee posts. Citizens who secure themselves at the post certainly need some necessary needs such as humanitarian logistics goods. Humanitarian logistics goods need to be distributed quickly and precisely so that optimal distribution lines are needed. This research aims to find out the route of distribution of humanitarian logistics goods that occur in Jakarta, especially East Jakarta. This problem is solved by using the Saving Matrix Method with the Nearest Neighbour and Nearest Insertion Method as a route sorting method. The results of the route determination are known that the optimal distribution path is obtained from the first alternative using the Nearest Neighbour Method with a total distance of 130.25 m.

Keywords
Jakarta Flood, Humanitarian Logistics, Saving Matrix Method, Nearest Neighbour Method, Nearest Insertion Method.

1. Introduction
Indonesia is a country that has geographical, geological, hydrological, and demographic conditions that can lead to potential disasters. The disasters can be caused by natural, non-natural, and social factors. The disaster that occurred is certainly needed readiness from various parties to help the victims of natural disaster to reduce disasters experienced by the victims, such as humanitarian logistics. The logistics itself is goods that can be used by the victims that include goods for food, clothing, etc. This research will discuss the disaster preparedness in humanitarian logistics that occurred in DKI Jakarta, specifically in East Jakarta. According to data from the National Disaster Management Agency or Badan Nasional Penanggulangan Bencana (BNPB) in Indonesia, there has been a serious flood disaster in January 2020. Jakarta province has 31 flood points, each of which has urgent needs that need to be met. In addition, there are negative impacts for residents due to floods that have occurred in early 2020. Therefore, an evaluation is needed related to the handling of the disaster, especially related to the distribution route of logistics goods delivery or humanitarian logistics. Good distribution of humanitarian logistics is the distribution of logistics goods that can reach those who need (victims) in a short time so that victims can immediately use those goods. Humanitarian logistics distribution must certainly have a strategic route and location so that the distribution of goods from upstream to downstream can operate optimally, efficiently, effectively, and beneficially for various parties. For humanitarian logistics distribution activities to run well, research is needed so that it can help get the desired results., Vehicle Routing Problem (VRP) can be used to determine distribution routes to get optimal results. VRP completion can be done by collecting the necessary data, such as data on the location of natural disasters, places of refuge, and locations from distribution centers. This research aims to analyze the route of humanitarian logistics distribution activities in Jakarta that focused on East Jakarta. In addition, to determine how to optimize the distance on the route of humanitarian logistics distribution activities in Jakarta with the VRP Method, such as Saving Matrix, Nearest Neighbor, and Nearest Insertion.

2. Literature Review

2.1 Disaster
According to the Law of the Republic of Indonesia No. 24 of 2007 on disaster management, disasters have a definition as events or series of events that threaten and disrupt people's lives and livelihoods caused, either by natural factors and / or non-natural factors and human factors resulting in human fatalities, environmental damage, property losses, and psychological impacts. Sukoco (2021) describes the definition of disaster according to the World Health Organization (WHO), which is an event that causes various ecological disturbances, damage, even loss of human life, and worsening of human life, ranging from declining health on a certain scale that requires a response from communities outside the disaster site. According to the International Federation of Red Cross (IFRC), a disaster is a sudden event that seriously disrupts the functioning of a community or society and causes human, material, and economic or environmental harm that exceeds the ability of a community to cope by using its own resources. Although often caused by nature, disasters can come from humans (Al-Jazairi, 2018).

2.2 Humanitarian Logistics
Humanitarian logistics is the management of humanitarian emergency assistance (Sukoco, 2021). Logistics of humanitarian assistance is the process of planning, implementing, and controlling the flow of materials and storage of goods and related information effectively and efficiently; from the beginning to the point where the assistance provided can reduce the suffering of victims (Susanty, Bakhtiar, & Sulistyawan, 2016). Therefore, humanitarian logistics is designed to meet the needs of vulnerable individuals to alleviate the suffering of victims which refers to the activities of managing logistics in the event of a disaster that aims to save lives and provide resources in accordance with the needs by respecting the type and level of impact of disasters, expected services, safety and security conditions that are considered satisfactory (Raillani, Hammadi, Samed, Ballouti, & Barbu, 2020). Charbel et al (2017) explained that humanitarian logistics is related to supply chain management where there is a relationship as Humanitarian Logistics Supply Chain Management (HLSCM). HLSCM has two main components in it, namely Humanitarian Supply Chains (HSC) and Humanitarian Logistics (HL). Logistics management and disaster relief require complex logistics activities, such as needed resources are rarely available at disaster sites, so these logistics activities are commonly referred to as Humanitarian Logistics (HL) (Kunz, Reiner, &Gold, 2014).

Frameworks for emergency logistics including pre-disaster and post-disaster operations have been created by Cauhnye, Nie, and Pokharel (2012). Before disasters occur, evacuation, stock preposition, and facility location are critical to this activity (Rodriguez-Espindola, Albores, & Brewster, 2017). The disaster management process itself has several objects that need to be considered, namely (Ridha, 2017):

A. Equipment

Logistical needs needed in an emergency or during a disaster include:

1. Transportation equipment
2. Heavy equipment
3. Tent
4. Medical equipment and medicines
5. Fast food
6. Clean water provider

B. Logistics

Stages for logistics management for disaster management include:

1. Planning or inventory needs
2. Procurement and/or receipt
3. Warehousing and/or storage
4. Distribution
5. Transportation
6. Reception at the destination

2.3 Vehicle Routing Problem (VRP)
Vehicle Routing Problem (VRP) is a problem in the world of transportation to form optimal routes in order to minimize transportation-related costs (Toth & Vigo, 2015). Distribution routes commonly used in supply chain management

usually use costs related to vehicles, while for this case will be represented by vehicle travel time in one route (Andriansyah & Sentia, 2018). The purposes of VRP are as follows (Toth & Vigo, 2015):

1. Minimize transportation costs
2. Minimize the number of vehicles to serve customers
3. Balancing the route and load of the vehicle
4. Minimize penalties, which relate to service to customers

The VRP method that can be used is the Saving Matrix Method. This method was invented in 1964 by Clarke and Wright. The Saving Matrix Method can be used to determine the route by minimizing the mileage. The steps taken in the Saving Matrix Method are as follows:

1. Identify the distance matrix

The first step of this method is to determine the distance between the warehouse and each intended location. The formula used in this calculation is as follows:

$$J(1,2) = \sqrt{(x_1 - x_2)^2 + (y_1 - y_2)^2}$$

Information:
J(1,2) = Distance from location 1 to location 2
x = Coordinate point x
y = Coordinate point y

2. Identifying the austerity matrix

This step assumes that each intended location will be visited by one truck. The distance saving matrix can be determined using formulas spelled out using warehouse distance data, as well as starting and ending points.

$$S(x,y) = J(x,G) + J(G,y) - J(x,y)$$

Information:
S(x,y) = Distance of the starting and ending points of the destination
J(x,G) = Distance of warehouse to original destination
J(G,y) = Distance of warehouse to final destination

3. Allocate the destination location to the vehicle or route

The allocation of destination locations can be done based on the calculation of the savings matrix. The destination location combined into one delivery route will be worth combining until the truck's capacity reaches its limit.

Methods that can be used to perform route sequencing are the Nearest Neighbor Method and the Nearest Insertion Method. The Nearest Neighbor Method is done by searching for the nearest customer, in this case the location of the refuge with the next customer, namely the location of the next refuge. The steps to perform the Nearest Neighbor Algorithm are as follows (Pop, Sitar, & Chira, 2011):

1. The process starts from the warehouse, then continues by finding the location of customers who have not been visited with the shortest distance from the warehouse
2. The process proceeds to another location with the closest distance from the previous selected location and the number of deliveries does not have vehicle capacity
   a. If there is a location selected as the next location and there is residual capacity in the transport vehicle, then the process returns to step (2)
   b. If the vehicle does not have any remaining capacity, then the process returns to step (1)
   c. If no location is selected because the number of shipments exceeds the vehicle capacity, then return to step (1)
   d. The process is restarted from the warehouse and visits customers who have not been visited and have the closest distance.
3. If all customers have been visited exactly once, then the algorithm process ends.

In addition, there is a Nearest Insertion Method which is a method to determine the optimal distance of a distribution line with the aim of shortening the distribution distance by inserting a route or path in a subtour distribution line. The steps to perform the Nearest Insertion Algorithm are as follows (Suryani, 2018):

1. Search starts from the first location connected to the last location
2. A subtour is created between the two locations, this is the journey from the first location and ends at the last location, such as (1,3) to (3,2) to (2,1)
3. Replace one of the arc relationship directions of two cities with a combination of two arcs
4. Repeat step 3 until the entire location goes to the subtour

The literature review that has been discussed will be used to understand the basic concepts for the whole research. The definition of disaster itself can help researchers to find out the basis of disaster, humanitarian logistics topic can be the basis for knowing what type of logistics is suitable for this case, while the Saving Matrix, Nearest Neighbor, and Nearest Insertion Methods will be used as methods that can help solve the problem in this research.

3. Methods

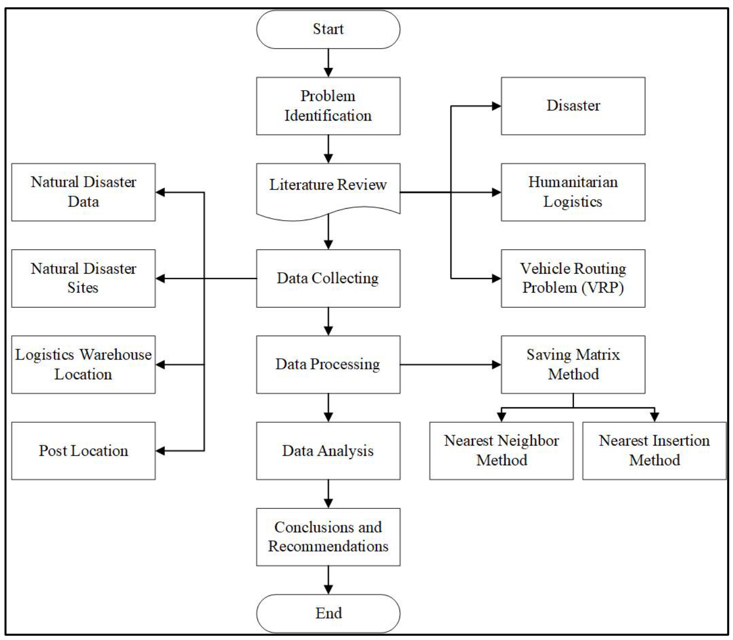

Figure 1. Research Methodology Flowchart

The research methodology starts from problem identification to provide conclusions and suggestions. (Figure 1). Each stage will be explained as follows:

1. Problem Identification
   Researchers identify problems to find out to solve problems and provide solutions to the object of research. The problem found in this study is regarding the distribution of humanitarian logistics in Jakarta in early 2020.
2. Literature Review
   Literature studies are carried out to broaden knowledge and insight to solve the problems being observed. Literature studies can be obtained from books, websites, and related journals.
3. Data Collecting
   Data collecting is done to obtain the information needed to be able to achieve research objectives. The data collection technique for this study is with observation techniques and documents
4. Data Processing

Data processing is done by using the results of data collection that has been obtained. It will be done using problem solving from Vehicle Routing Problem (VRP). The process of processing data is carried out into several stages, namely:

a. Matrix Saving Method
   - Calculate distance using data from Google Maps
   - Calculate the savings distance based on the distance you have
   - Allocate locations by route
   - Sort routes; Nearest Neighbor and Nearest Insertion Methods
b. Nearest Neighbor Method
   - Sort postal routes according to the closest distance between locations
c. Nearest Insertion Method
   - Sort postal routes according to the shortest distance for round-trip conditions

5. Data Analysis
   Data analysis is done by analyzing the data that has been processed in data processing. The data analysis technique used is descriptive analysis. Descriptive analysis is a description based on data that has been collected and processed for easy understanding.
6. Conclusions and Recommendations
   Conclusions and recommendations are the last stage of the research. The conclusion is a summary of the results of data processing and analysis that has been carried out which has important points while suggestions are suggestions that can be given in order to improve deficiencies for the better.

4. Data Collection

Data collection is done to obtain the information needed to be able to achieve research objectives. The data collection technique for this study is with observation techniques and documents. The observation technique used is a non-participant observation where data is collected based on matters related to research while the document technique is obtained from searching information over the internet. The process of collecting data is done by searching for sources and information over the internet by using Google as a search engine. Government websites that have an open access data are used as a source of data. The data that has been collected includes:

a. Natural Disaster Data, especially Floods.
   - Flood-prone areas of DKI Jakarta 2020
   - Data affected by DKI Jakarta floods 2020
   - Jakarta 2020 flood victim data
   - Affected villages in DKI Jakarta 2020
   - Number of DKI Jakarta flood refugees 2016-2020

b. Natural Disaster Location
   The location of natural disasters, especially floods that are used as a focus is East Jakarta based on the results of comparison of flood-affected areas.

c. Location of Logistics Warehouse
   The location of the warehouse that is used as a supply center is BNPB Warehouse at Halim, East Jakarta.

d. Location of Refugee Posts
   Refugee post location was held by DKI Jakarta Health Office.

5. Results and Discussion

Jakarta has been hit by extreme flooding due to high rainfall. The total number of affected villages in DKI Jakarta is 157 with each total from East Jakarta as many as 50, South Jakarta as many as 35, West Jakarta as many as 32, North Jakarta as many as 23, and Central Jakarta as many as 17. It is known that the district with the highest number of flood-affected villages is East Jakarta. The data was taken from the official government website. The number of affected and flood-free areas as of January 1, 2020, is presented in Figure 2.

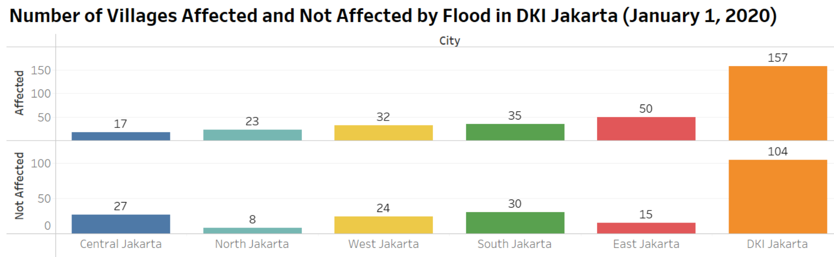

Figure 2. Number of Villages Affected in Each Administrative City

The number of sub-districts that are flood-prone areas in Jakarta, each is 6 sub-districts in West and North Jakarta, 1 sub-district in Central Jakarta, and 9 sub-districts in South and East Jakarta. Based on the data, it is known that South and East Jakarta have a greater number of sub-districts for flood-prone areas. Jakarta's flood-prone areas based on sub-districts during 2020 is presented in Figure 3.

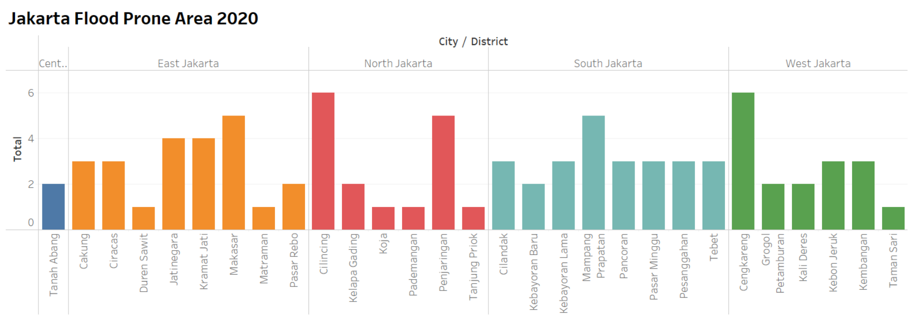

Figure 3. Jakarta Flood Prone Area 2020

The highest recapitulation data was obtained in January 2020 so the study will focus on the flood disaster that occurred in East Jakarta on January 2020. The data was also taken from the official government website. The highest data recapitulation in 2020 is presented in Table 1.

Table 1. Highest Data Recapitulation in 2020

Data	Value
District	35
Neighborhoods	151
Average Water Level (cm)	10 s.d 350 cm
Long Puddle (day)	4
RW Affected	390
KK Affected	22.148
Affected Souls (people)	83.406
The victim died (person)	19
Missing Victims (people)	-
Severely Injured (persons)	-
Minor Injuries (persons)	-
Highest Number of Refugees (persons)	36.445
Number of refuges	269

Data	Value
Amount of Loss Value	n.a
Highest Rainfall	377

The relief items needed by the post are food, blankets, clean water, and carpets. Based on the four items needed by the post, it is assumed that the supplier of goods does packaging using cardboard measuring 35x20x24 cm. The number of requests from each post will be equalized which amounts to 200 cardboard boxes.

Distances between locations can be searched using Google Maps. Google Maps can automatically calculate the distance between two desired locations. The way to find the distance for the two desired locations is to enter the initial location and destination location on Google Maps so that Google Maps can display the distance for both locations. The distance matrix using Google Maps is presented in Table 2.

Table 2. Distance Matrix Using Google Maps

	W	JT1	JT2	JT3	JT4	JT5	JT6	JT7	JT8	JT9	JT10	JT11	JT12	JT13	JT14	JT15	JT16	JT17	JT18	JT19	JT20	JT21	JT22	JT23	JT24	JT25	JT26	JT27
W	0	6,2	1,2	3,1	2,7	7	5,4	7	6,8	5,4	7	4,1	16,9	7,3	7,9	7,4	7,7	2	1,8	3,3	9,1	4,4	6,7	12,4	13,4	7,7	10,5	7,2
JT1	6,2	0	7	10,6	8,5	6,7	1	7,1	3,2	4,9	5,7	3,1	16,7	7,4	9,7	1,9	3,7	6,3	6,2	8,1	15,9	10	11,8	16	16,6	12,9	14,2	15,7
JT2	1,2	7	0	2,2	1,5	5,8	6,1	9	8,8	6,1	7,6	4,9	18,1	9,3	10,6	8,2	9,1	2,8	2,6	2,6	7,9	3,3	5,4	11,7	12,2	7,4	9,8	11,4
JT3	3,1	10,6	2,2	0	12,8	9,3	8	14,7	9,5	8	10,8	6,7	23	10	11,4	10	10,9	4,4	4,2	2,3	7,4	3,8	5,2	9,8	10,3	5,1	7,9	6
JT4	2,7	8,5	1,5	12,8	0	9	7,6	9,4	9,2	7,6	9,3	6,4	26,5	14,4	11	9,7	11,5	4,3	4,1	2,2	7,3	2,9	5,1	9,7	10,2	5	7,8	5,4
JT5	7	6,7	5,8	9,3	9	0	7	2,5	2,3	7	2,1	5,5	14,2	4,1	4,1	5,8	6,6	6,3	6,2	9	16,6	9,7	11,9	19,8	20,4	14,3	17,1	14,8
JT6	5,4	1	6,1	8	7,6	7	0	6,2	1,1	6	2,1	4,7	11,9	1,3	2,7	5,6	6,3	6	5,9	8,7	15,6	9,4	11,6	18	18,5	13,3	16,1	14,3
JT7	7	7,1	9	14,7	9,4	2,5	6,2	0	0,6	6,6	2,7	5,3	12,5	0,9	2,3	6,1	6,9	6,6	6,5	9,3	16,2	10	12,2	18,5	19,1	13,9	16,6	15,1
JT8	6,8	3,2	8,8	9,5	9,2	2,3	1,1	0,6	0	6	2,1	4,7	11,9	1,3	2,7	5,6	6,3	6	5,9	8,7	15,6	9,4	11,6	18	18,5	13,3	16,1	14,3
JT9	5,4	4,9	6,1	8	7,6	7	6	6,6	6	0	5,8	2,2	12,3	6,5	7,9	2,2	4	5,5	5,7	7,2	12,8	8,9	11,3	16	16,6	10,5	13,3	8,8
JT10	7	5,7	7,6	10,8	9,3	2,1	2,1	2,7	2,1	5,8	0	5	12,3	0,8	2,2	5,9	6,6	6,4	6,2	9,1	15,9	9,7	15,7	18,3	18,8	13,6	16,4	14,7
JT11	4,1	3,1	4,9	6,7	6,4	5,5	4,7	5,3	4,7	2,2	5	0	14,5	5,7	7,1	3,9	5,4	4,6	4,5	6,4	6,2	4,8	1,3	5,7	6,5	9,7	5,6	8,9
JT12	16,9	16,7	18,1	23	26,5	14,2	11,9	12,5	11,9	12,3	12,3	14,5	0	14	15,3	10,3	9,9	20,1	18,1	24,9	25,1	21,5	24,9	27,2	27,8	23,9	25,4	22,8
JT13	7,3	7,4	9,3	10	14,4	4,1	1,3	0,9	1,3	6,5	0,8	5,7	14	0	1,8	6,2	6,9	6,7	6,5	9,4	16,3	10	16	18,6	19,1	13,9	16,7	15
JT14	7,9	9,7	10,6	11,4	11	4,1	2,7	2,3	2,7	7,9	2,2	7,1	15,3	1,8	0	9,3	10,1	9,8	9,7	12,5	19,4	13,2	19,1	24,7	25,3	17,1	22	18,3
JT15	7,4	1,9	8,2	10	9,7	5,8	5,6	6,1	5,6	2,2	5,9	3,9	10,3	6,2	9,3	0	1,8	7,5	7,8	9,2	14,9	11,1	15,8	18,1	18,6	12,5	15,3	8,8
JT16	7,7	3,7	9,1	10,9	11,5	6,6	6,3	6,9	6,3	4	6,6	5,4	9,9	6,9	10,1	1,8	0	9,3	9,1	10,7	16,9	12,9	16,6	20,1	20,6	14,6	17,3	10,9
JT17	2	6,3	2,8	4,4	4,3	6,3	6	6,6	6	5,5	6,4	4,6	20,1	6,7	9,8	7,5	9,3	0	0,55	3,5	8,8	4,1	8,3	12,5	13,1	7,9	10,7	9,2
JT18	1,8	6,2	2,6	4,2	4,1	6,2	5,9	6,5	5,9	5,7	6,2	4,5	18,1	6,5	9,7	7,8	9,1	0,55	0	4,2	9,5	4,9	9	13,3	13,8	8,6	11,4	9,9
JT19	3,3	8,1	2,6	2,3	2,2	9	8,7	9,3	8,7	7,2	9,1	6,4	24,9	9,4	12,5	9,2	10,7	3,5	4,2	0	5,3	0,65	4,8	9,1	9,6	4,4	7,2	5,7
JT20	9,1	15,9	7,9	7,4	7,3	16,6	15,6	16,2	15,6	12,8	15,9	6,2	25,1	16,3	19,4	14,9	16,9	8,8	9,5	5,3	0	4,8	1,3	5,7	6,5	6,1	5,6	8,9
JT21	4,4	10	3,3	3,8	2,9	9,7	9,4	10	9,4	8,9	9,7	4,8	21,5	10	13,2	11,1	12,9	4,1	4,9	0,65	4,8	0	4,2	9,3	9,8	4,6	7,4	5,9
JT22	6,7	11,8	5,4	5,2	5,1	11,9	11,6	12,2	11,6	11,3	15,7	1,3	24,9	16	19,1	15,8	16,6	8,3	9	4,8	1,3	4,2	0	6,9	7,7	5,9	6,8	8,8
JT23	12,4	16	11,7	9,8	9,7	19,8	18	18,5	18	16	18,3	5,7	27,2	18,6	24,7	18,1	20,1	12,5	13,3	9,1	5,7	9,3	6,9	0	0,85	4,4	1,6	6,9
JT24	13,4	16,6	12,2	10,3	10,2	20,4	18,5	19,1	18,5	16,6	18,8	6,5	27,8	19,1	25,3	18,6	20,6	13,1	13,8	9,6	6,5	9,8	7,7	0,85	0	5	2,2	7,4
JT25	7,7	12,9	7,4	5,1	5	14,3	13,3	13,9	13,3	10,5	13,6	9,7	23,9	13,9	17,1	12,5	14,6	7,9	8,6	4,4	6,1	4,6	5,9	4,4	5	0	3,3	6,1
JT26	10,5	14,2	9,8	7,9	7,8	17,1	16,1	16,6	16,1	13,3	16,4	5,6	25,4	16,7	22	15,3	17,3	10,7	11,4	7,2	5,6	7,4	6,8	1,6	2,2	3,3	0	5,3
JT27	7,2	15,7	11,4	6	5,4	14,8	14,3	15,1	14,3	8,8	14,7	8,9	22,8	15	18,3	8,8	10,9	9,2	9,9	5,7	8,9	5,9	8,8	6,9	7,4	6,1	5,3	0

After obtaining the distance matrix for the location of posts and warehouses, the next step is to create a savings matrix. The saving matrix method is used as the second alternative. The researcher uses distance calculations that have been calculated directly from Google Maps which are presented in Table 2. The next step is to make savings or can be called a saving matrix. Examples of calculations to be taken into account are carried out between warehouses with initial and final locations, namely the Borobudur University Health Post and the Halim Village Head Office.

$$S(x, y) = J(x, G) + J(G, y) - J(x, y)$$
$$S(x, y) = 6{,}2 + 1{,}2 - 7$$
$$S(x, y) = 0{,}4$$

The calculation results of the distance saving matrix are presented in Table 3.

Table 3. Saving Matrix

	JT1	JT2	JT3	JT4	JT5	JT6	JT7	JT8	JT9	JT10	JT11	JT12	JT13	JT14	JT15	JT16	JT17	JT18	JT19	JT20	JT21	JT22	JT23	JT24	JT25	JT26	JT27
JT1	0	0,4	-1,3	0,4	6,5	10,6	6,1	9,8	6,7	7,5	7,2	6,4	6,1	4,4	11,7	10,2	1,9	1,8	1,4	-0,6	0,6	1,1	2,6	3	1	2,5	-2,3
JT2	0,4	0	0,3	0	0	1,9	3,2	3,2	1,9	1,8	2	2,4	3,2	3,9	2	2,6	2	2	0,5	0	0,1	-0,1	0,5	0	0,9	0,5	5,4
JT3	-1,3	0,3	0	-7	0,8	0,5	-4,6	0,4	0,5	-0,7	0,5	-3	0,4	-0,4	0,5	-0,1	0,7	0,7	4,1	4,8	3,7	4,6	5,7	6,2	5,7	5,7	4,3
JT4	0,4	0	-7	0	0,7	0,5	0,3	0,3	0,5	0,4	0,4	-6,9	-4,4	-0,4	0,4	-1,1	0,4	0,4	3,8	4,5	4,2	4,3	5,4	5,9	5,4	5,4	4,5
JT5	6,5	0	0,8	0,7	0	5,4	11,5	11,5	5,4	11,9	5,6	9,7	10,2	10,8	8,6	8,1	2,7	2,6	1,3	-0,5	1,7	1,8	-0,4	0	0,4	0,4	-0,6
JT6	10,6	1,9	0,5	0,5	5,4	0	6,2	11,1	4,8	10,3	4,8	10,4	11,4	10,6	7,2	6,8	1,4	1,3	0	-1,1	0,4	0,5	-0,2	0,3	-0,2	-0,2	-1,7
JT7	6,1	3,2	-4,6	0,3	11,5	6,2	0	13,2	5,8	11,3	5,8	11,4	13,4	12,6	8,3	7,8	2,4	2,3	1	-0,1	1,4	1,5	0,9	1,3	0,8	0,9	-0,9
JT8	9,8	3,2	0,4	0,3	11,5	11,1	13,2	0	6,2	11,7	6,2	11,8	12,8	12	8,6	8,2	2,8	2,7	1,4	0,3	1,8	1,9	1,2	1,7	1,2	1,2	-0,3
JT9	6,7	1,9	0,5	0,5	5,4	4,8	5,8	6,2	0	6,6	7,3	10	6,2	5,4	10,6	9,1	1,9	1,5	1,5	1,7	0,9	0,8	1,8	2,2	2,6	2,6	3,8
JT10	7,5	1,8	-0,7	0,4	11,9	10,3	11,3	11,7	6,6	0	6,1	11,6	13,5	12,7	8,5	8,1	2,6	2,6	1,2	0,2	1,7	-2	1,1	1,6	1,1	1,1	-0,5
JT11	7,2	2	0,5	0,4	5,6	4,8	5,8	6,2	7,3	6,1	0	6,5	5,7	4,9	7,6	6,4	1,5	1,4	1	7	3,7	9,5	10,8	11	2,1	9	2,4
JT12	6,4	2,4	-3	-6,9	9,7	10,4	11,4	11,8	10	11,6	6,5	0	10,2	9,5	14	14,7	-1,2	0,6	-4,7	0,9	-0,2	-1,3	2,1	2,5	0,7	2	1,3
JT13	6,1	3,2	0,4	-4,4	10,2	11,4	13,4	12,8	6,2	13,5	5,7	10,2	0	13,4	8,5	8,1	2,6	2,6	1,2	0,1	1,7	-2	1,1	1,6	1,1	1,1	-0,5
JT14	4,4	3,9	-0,4	-0,4	10,8	10,6	12,6	12	5,4	12,7	4,9	9,5	13,4	0	6	5,5	0,1	0	-1,3	-2,4	-0,9	-4,5	-4,4	-4	-1,5	-3,6	-3,2
JT15	11,7	2	0,5	0,4	8,6	7,2	8,3	8,6	10,6	8,5	7,6	14	8,5	6	0	13,3	1,9	1,4	1,5	1,6	0,7	-1,7	1,7	2,2	2,6	2,6	5,8
JT16	10,2	2,6	-0,1	-1,1	8,1	6,8	7,8	8,2	9,1	8,1	6,4	14,7	8,1	5,5	13,3	0	0,4	0,4	0,3	-0,1	-0,8	-2,2	0	0,5	0,8	0,9	4
JT17	1,9	2	0,7	0,4	2,7	1,4	2,4	2,8	1,9	2,6	1,5	-1,2	2,6	0,1	1,9	0,4	0	3,25	1,8	2,3	2,3	0,4	1,9	2,3	1,8	1,8	0
JT18	1,8	2	0,7	0,4	2,6	1,3	2,3	2,7	1,5	2,6	1,4	0,6	2,6	0	1,4	0,4	3,25	0	0,9	1,4	1,3	-0,5	0,9	1,4	0,9	0,9	-0,9
JT19	1,4	0,5	4,1	3,8	1,3	0	1	1,4	1,5	1,2	1	-4,7	1,2	-1,3	1,5	0,3	1,8	0,9	0	7,1	7,05	5,2	6,6	7,1	6,6	6,6	4,8
JT20	-0,6	0	4,8	4,5	-0,5	-1,1	-0,1	0,3	1,7	0,2	7	0,9	0,1	-2,4	1,6	-0,1	2,3	1,4	7,1	0	8,7	14,5	15,8	16	10,7	14	7,4
JT21	0,6	0,1	3,7	4,2	1,7	0,4	1,4	1,8	0,9	1,7	3,7	-0,2	1,7	-0,9	0,7	-0,8	2,3	1,3	7,05	8,7	0	6,9	7,5	8	7,5	7,5	5,7
JT22	1,1	-0,1	4,6	4,3	1,8	0,5	1,5	1,9	0,8	-2	9,5	-1,3	-2	-4,5	-1,7	-2,2	0,4	-0,5	5,2	14,5	6,9	0	12,2	12,4	8,5	10,4	5,1
JT23	2,6	0,5	5,7	5,4	-0,4	-0,2	0,9	1,2	1,8	1,1	10,8	2,1	1,1	-4,4	1,7	0	1,9	0,9	6,6	15,8	7,5	12,2	0	24,95	15,7	21,3	12,7
JT24	3	0	6,2	5,9	0	0,3	1,3	1,7	2,2	1,6	11	2,5	1,6	-4	2,2	0,5	2,3	1,4	7,1	16	8	12,4	24,95	0	16,1	21,7	13,2
JT25	1	0,9	5,7	5,4	0,4	-0,2	0,8	1,2	2,6	1,1	2,1	0,7	1,1	-1,5	2,6	0,8	1,8	0,9	6,6	10,7	7,5	8,5	15,7	16,1	0	14,9	8,8
JT26	2,5	0,5	5,7	5,4	0,4	-0,2	0,9	1,2	2,6	1,1	9	2	1,1	-3,6	2,6	0,9	1,8	0,9	6,6	14	7,5	10,4	21,3	21,7	14,9	0	10,5
JT27	-2,3	5,4	4,3	4,5	-0,6	-1,7	-0,9	-0,3	3,8	-0,5	2,4	1,3	-0,5	-3,2	5,8	4	0	-0,9	4,8	7,4	5,7	5,1	12,7	13,2	8,8	10,5	0

After getting the saving matrix table, ranking sorting is done to group the route to be used. Ranking is sorted from largest to smallest distance. The ranking sorting table is presented in Table 4.

Table 4. Saving Matrix Ranking

Rank	(x,y)	Value
1	S23,24	24,95
2	S24,26	21,7
3	S23,26	21,3
4	S24,25	16,1
5	S20,24	16
6	S20,23	15,8
7	S23,25	15,7
…	…	…
351	S3,4	-7

Based on the sorting of distance savings from largest to smallest, there are several alternative routes for the Saving Matrix Method. The posts can be combined up to a limit existing truck capacity and not exceeding the fleet capacity. The routes will be merge and start from the value of the largest savings because it seeks to maximize savings. The results of grouping routes using the Saving Matrix Method are presented in Table 5.

Table 5. Saving Matrix Route Grouping Results

Route
Warehouse-23-20-22-11-24-26-25-27-W
Warehouse-5-10-7-6-13-2-14-8-W
Warehouse-12-9-16-1-15-W
Warehouse-17-18-W
Warehouse-3-19-4-21-W

Grouping the routes that have been formed is also presented in Figure 4 with the caption on each point color distinguished according to the group of routes formed.

Figure 4. Distribution Map Grouping Saving Matrix Routes

Based on the Saving Matrix route, the results of the route design using the Nearest Neighbor Method get 1 alternative route. The design results of the first alternative route using the Nearest Neighbor Method are presented in Table 6. The first alternative is divided into 5 routes that all begin and end at the center of goods, namely warehouses. The first and second routes have 8 postal locations to be visited, the third route has 5 postal locations to be visited, the fourth route has 2 postal locations to be visited, and the fifth route has 4 postal locations to be visited. The total distance from alternative 1 is 130.25 m.

Table 6. Alternative 1 Nearest Neighbor Method

Route	Distance
Warehouse, JT11, JT22, JT20, JT26, JT23, JT24, JT25, JT27, W	33.05
Warehouse, JT2, JT5, JT10, JT13, JT7, JT8, JT6, JT14, W	23.1
Warehouse, JT15, JT16, JT1, JT9, JT12, W	42.7
Warehouse, JT18, JT17, W	18.95
Warehouse, JT4, JT19, JT21, JT3, W	12.45
Total	130.25 m

Route sorting using the Nearest Neighbor Method is enough to see the closest distance from the initial location to the next destination location, for example on route 1 where there is a route Warehouse-JT11-JT22-JT20-JT26-JT23-JT24-JT25-JT27-W, it means that the route starts from the warehouse, then goes to the location of JT11 post, then goes to the location of JT22 post, then to the location of JT20 post, and followed by JT26 location, JT23, JT24, JT25, JT27, and end up in the warehouse. The determination of this route is seen from the closest distance between locations, as the case of the 1st route is the distance from the warehouse to the location of JT11 post is the shortest distance when compared to the other 26 posts. After from the location of JT11 post, the route will be continued to the location of JT22 post, this is because JT22 has the shortest distance when compared to other postal locations. This is done until the truck meets capacity, in this case the truck can only carry 1,700 cardboard boxes with each post assumed there are 200 cardboard requests so that the truck can deliver the request to a maximum of 8 postal locations. If the truck has passed through 8 posts, then the cardboard or demand transported by the truck has run out so that the truck needs to complete its journey and return to the warehouse.

The result of the route design using the Nearest Insertion Method has 2 alternatives that will be the 2nd and 3rd alternative routes. This happens due to the branching of the route that occurs due to the total value of the distance to go and back again with the same shortest result. The total distance from alternative 2 is 137.65 m. The route to the 2nd alternative is presented in Table 7.

Table 7. Alternative 2 Nearest Insertion Method

Route	Distance
Warehouse, JT11, JT22, JT20, JT25, JT27, JT26, JT23, JT24, W	40.05
Warehouse, JT2, JT5, JT10, JT6, JT8, JT7, JT13, JT14, W	23.5
Warehouse, JT15, JT16, JT1, JT9, JT12, W	42.7
Warehouse, JT18, JT17, W	18.95
Warehouse, JT4, JT19, JT21, JT3, W	12.45
Total	137.65 m

Route sequencing using the Nearest Insertion Method is to look at the total distance traveled from the back-and-forth journey between warehouses with the destination location, for example on route 1 where there is a Warehouse-JT11-JT22-JT20-JT25-JT27-JT26-JT23-JT24-W route. The determination of the route using the Nearest Insertion Method begins with looking at the distance from the warehouse to the intended location and then back again to the warehouse. In the case of route 1, it can be seen that the W-JT11-W has the shortest distance when compared to the distance from the warehouse to other locations and back again to the warehouse. After that, the distance will be seen from the truck away from the warehouse, then go to the location of JT11 post, after which it needs to be searched and compared back to the location after which if the truck goes to that location and returns to the warehouse has the shortest mileage. In this case, it can be seen that the W-JT11-JT22-W has the shortest route when compared to other destination locations. This determination is done until the capacity of the truck does not exceed the carry limit.

Table 8. Alternative 3 Nearest Insertion Method

Route	Distance
Warehouse, JT11, JT22, JT20, JT25, JT27, JT26, JT23, JT24, W	40.05
Warehouse, JT2, JT5, JT8, JT6, JT13, JT10, JT7, JT14, W	24.9
Warehouse, JT15, JT16, JT1, JT9, JT12, W	42.7
Warehouse, JT18, JT17, W	18.95
Warehouse, JT4, JT19, JT21, JT3, W	12.45
Total	139.1 m

The design of the 3rd alternative route using the Nearest Insertion Method is presented in Table 8. The results of alternative 2 are also divided into 5 routes with the number of locations visited equal to alternative 1. The difference between alternative 2 and alternative 3 can be seen on route 2 where the intended location in alternative 2 is JT5 to JT10, while in alternative 2 is JT5 to JT8 post. This happens because the total distance to go and return from the warehouse to JT5 to JT10 and to JT8 has the same distance and is the shortest distance when compared to the total distance to other postal locations. The total distance from the 3rd alternative is 139.1 m.

Based on the discussion that has been described, through this research, the government can find out the routes that can help flood victims to get humanitarian logistics goods effectively and efficiently. In addition, the government can use these alternative routes to be taken into consideration in choosing the route to be used. Therefore, the government can implement the proposed alternative if the government wants to use an effective and efficient route.

6. Conclusion

There are several conclusions that can be drawn based on this research, namely:

1. East Jakarta is a very affected area in 2020 because East Jakarta has 50 wards out of a total of 157 wards affected by flooding in DKI Jakarta. So that, there are 5 routes formed based on the Saving Matrix Method, namely W-JT23-JT20-JT22-JT11-JT24-JT26-JT25-JT27-W, W-JT5-JT10-JT7-JT6-JT13-JT2-JT14-JT8-W, W-JT12-JT9-JT16-JT1-JT15-W, W-JT17-JT18-W, and W-JT3-JT19-JT4-JT21-W.
2. There is one alternative route that is formed based on route sequencing using the Nearest Neighbor Method. The route for the 1st alternative has a total distance of 130.25 m. There are 2 alternative routes formed based on route sequencing using the Nearest Insertion Method. The route for the 2nd alternative has a total distance of 137.65 m, while the total distance for the 3rd alternative is 139.1 m. If both routes based on the Nearest Insertion Method are compared, then the shortest route is obtained on the 2nd alternative route. Based on the three alternatives formed, it is known that the alternative route using the Nearest Neighbor Method has the shortest total distance when compared to all the alternatives formed. The shortest total distance of the three alternatives has 130.25 m.

The advice that can be given based on this research is that the DKI Jakarta government can consider determining the route using the Saving Matrix Method with the Nearest Neighbor Method as a method of sorting the route.

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