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NORTHWEST CORNER METHOD FOR NATURAL DISASTER NOTIFICATION

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Abstract. *Indonesia is a country that is prone to disasters such as earthquakes, floods, landslides, volcanic eruptions to whirlwinds. About 13 percent of the world's volcanoes in Indonesia has the potential to cause natural disasters with different strengths. Therefore, the government needs to take action quickly. One alternative that affects the speed of aid reaching the disaster area is transportation. In channeling natural disasters is still far from ideal, on the other hand the main object of the emergency response period is how to alleviate the burden of people affected by the disaster. So that it is needed to channel aid to every place affected by the disaster. In the distribution of assistance, constraints often occur, such as late notification and requests that do not match the supply of goods owned by the aid provider. In distributing aid to areas affected by natural disasters other than the central government, local governments have many organizations participating in it. In order to overcome these problems a system that can provide notifications and perform precise calculations is needed to find out how much assistance should be given based on existing demand and supplies. This paper discusses the optimization of the delivery of assistance through the car vehicle from the sending city of aid to the disaster area, by first determining the minimum distance from some of the sending towns to the disaster area. The method used is the northwest corner method, MySQL, and SQLyog. The optimal solution obtained is web-based notification software in the form of SMS notifications.*

Keywords: *stochastic programming, northwest corner method, MySQL, SQLyog, notification .*

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1. INTRODUCTION

A natural disaster is a natural event that can have a large impact on humans. Natural disasters are natural disasters. Natural disaster events including into stochastic events. There are several types of natural disasters such as landslides, earthquakes, tsunamis, floods, volcanic eruptions and so forth. Natural disasters that occur can cause a variety of impacts including damaging economic, social and environmental fields.

Indonesia is a country that is prone to disasters such as earthquakes, floods, landslides, volcanic eruptions to whirlwinds. About 13 percent of the world's volcanoes in Indonesia has the potential to cause natural disasters with different strengths. Therefore, the government needs to take action quickly. One alternative that affects the speed of aid reaching the disaster area is transportation.

Transportation is a tool used to transport humans, animals and goods to their destination. There are various types of transportation, including land, air and sea transportation. Ihda at all have conducted research on transportation in 2017 [1], 2019 [2], [3] and [4].

Transportation to disaster areas is usually transportation that can be used to send aid in the form of goods or volunteers. The transportation used is transportation that can travel through disaster areas quickly, safely and efficiently.

In channeling natural disasters is still far from ideal, on the other hand the main object of the emergency response period is how to alleviate the burden of people affected by the disaster. So that it is needed to channel aid to every place affected by the disaster. In the distribution of assistance, constraints often occur, such as late notification and requests that do not match the supply of goods owned by the aid provider. In distributing aid to areas affected by natural disasters other than the central government, local governments have many organizations participating in it. In order to overcome these problems a system that can provide notifications and perform precise calculations is needed to find out how much assistance should be given based on existing demand and supplies [5], [6], [7], [8], [9] and [10].

Notifications relating to a notification that can be notified to users either via email, cell phone, or the internet so that the notification system can quickly find out an event. The method used is the Northwest Corner method, one of the transportation models in operations research. Northwest Corner Method is one of the solution techniques in transportation. This method is based on the normative rules or allocations of supply and source requirements in a transportation matrix without massive economic calculations. The normative rule is to burden as much as possible to the maximum limit of supply or need (which is achieved first) in the allocation matrix at the top left and continue to the bottom right so that all the need for resources can be met.

2. RESEARCH METHODS

In this section, we will explain about transportation issues, northwest corner method, system and notification, API Gateway, PHP, MySQL, and SQLyog, flowchart of the northwest corner method, notification system flowchart and stages of the notification system.

2.1 Transportation Issues

This section discusses transportation issues. Clearly from its name, the model is related to minimum financing planning to send a type of commodity from a number of sources to a number of destinations or destinations. This model can be expanded directly to cover practical situations in the fields of inventory control, work scheduling, personnel assignments, cash flow, and many others. This model can also be changed according to multiple commodity issues [11], [12] and [13].

The general model of transportation is given as follows,

For example

c_{ij} : shipping costs per unit of goods from factory i to warehouse j.

s_i : total inventory from sources i

d_j : number of requests from destination j

$i = 1, 2, 3, \cdots, m$

$j = 1, 2, 3, \cdots, n$

The general form of transportation problems can be written,

$$\min Z = \sum_{i=1}^{m}\sum_{j=1}^{n} c_{ij}x_{ij}$$

Constraint:

$\sum_{j=1}^{n} x_{ij} = s_i,\ i = 1,2,3,\cdots,m$ (Constraint supply)

$\sum_{i=1}^{m} x_{ij} = d_i,\ j = 1,2,3,\cdots,n$ (Constraint demand)

$x_{ij} \geq 0$ And integer (the automatic integer condition is obtained)

On the issue of balanced transportation, the transportation model is given as follows,

$$\sum_{i=1}^{m} s_i = \sum_{j=1}^{n} d_i$$

2.2 Northwest Corner Method

The method starts at the northwest corner cell (route) of the table [12].

Step 1. Allocate as much as possible to the selected cell and adjust the associated amounts of supply and demand by subtracting the allocated amount.

Step 2. Cross out the row or column with zero supply or demands it indicated that no further assignments can be made in that row or column. If both a row and a column net to zero simultaneously, cross out one only, and leave a zero supply (demand) in the uncrossed out row (column).

Step 3. If exactly one row or column is left uncrossed out, stop. Otherwise, move to the cell to the right if column has just been crossed out or below if a row has been crossed out. Go to step 1.

2.3 System and Notification

The system is a collection of objects, ideas, following the interrelationships between relations in achieving common goals or objectives.

In general, the system is a collection of several parts that are interconnected in harmony to achieve a certain goal. The elements that represent a common system, input and processing.

According to KBBI (Great Dictionary of Bahasa Indonesia), the meaning of notification is notification or news about the offer of goods and so on. Notifications relating to a system can be interpreted as a notification that a system can give to users either via email, cellphone, or the internet. Notifications can be in the form of notifications containing text of words, images, videos, or sounds.

2.4 API Gateway

Application programming interface (API) is a programming interface to applications that provide a way to connect, integrate from one device to another. The API provides several means of accessing services and data at an API provider agency, which connects matters about how services or can be found, data becomes available and can interact. The API Gateway is a gateway for several APIs that function as API management, protecting data, and minimizing API downtime. This API Gateway is actually a network component that can take the form of hardware or virtual that acts as a proxy so that the API does not need to interact with client applications. The API Gateway architecture is provided in Figure 1 below,

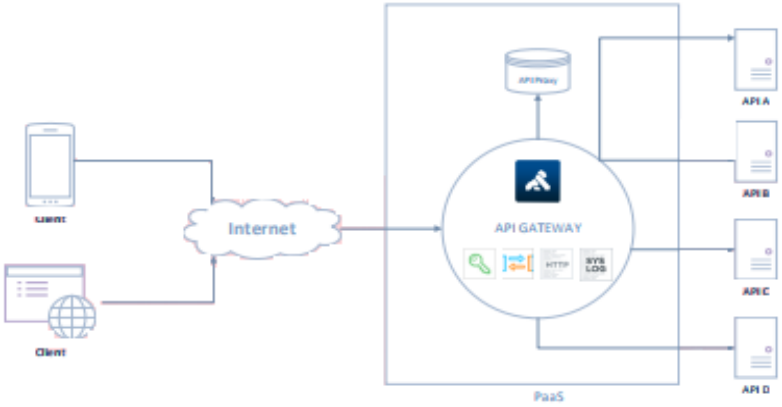

Figure 1. Gateway API Architecture

2.5 PHP

PHP is a server side specifically designed for web applications. PHP is inserted between the HTML language and because of the server side language, the PHP language will be executed on the server, so that what is sent to the browser is the finished result in HTML form, and the PHP code will not be seen. PHP includes Open Source Products. So, the source code can be changed and distributed freely [12].

2.6 MYSQL

MySQL is the standard use of databases in the world for data processing. MySQL is an open source database server that works using SQL Language (Structure Query Language) commonly used with PHP to create dynamic and powerful server applications.

MySQL is a database management system that is open source. MySQL is a relational database management system. This means that data managed in a database will be placed in several tables so that data manipulation will be faster. MySQL is also a software or software management system based on SQL or multi-user data.

2.7 SQLyog

SQLyog is a very popular MySQL client system used in Indonesia. This system has many features that make it easy for users to administer and perform MySQL data processing. SQLyog is a system used to connect one computer to another, so that one computer with a computer can access each other, it can be said that the system is a system that can be used to implement a client server.

2.8 Flowchart of the Northwest Corner Method

The following is given flowchart of the northwest corner method,

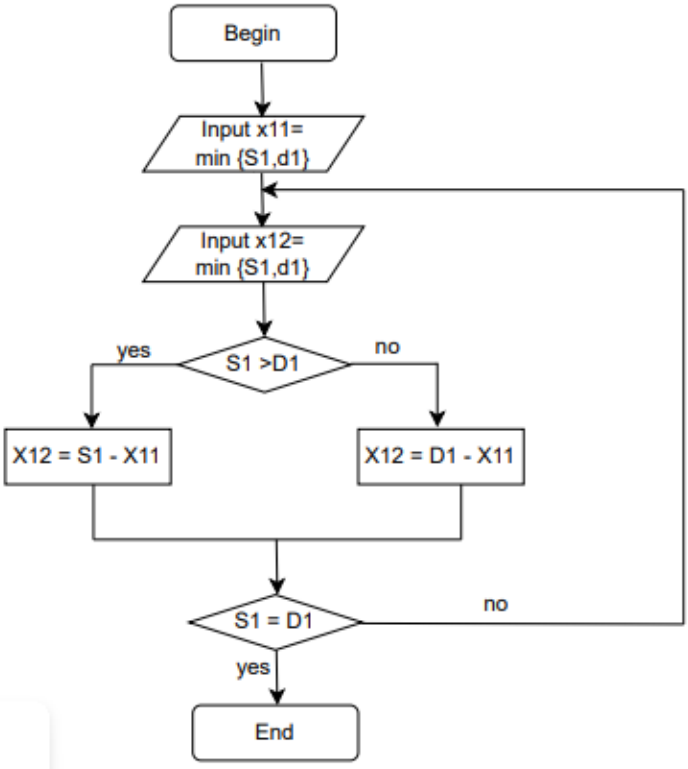

Figure 2. Flowchart of The Northwest Corner Method

2.9 Notification System Flowchart

The following is given notification system flowchart,

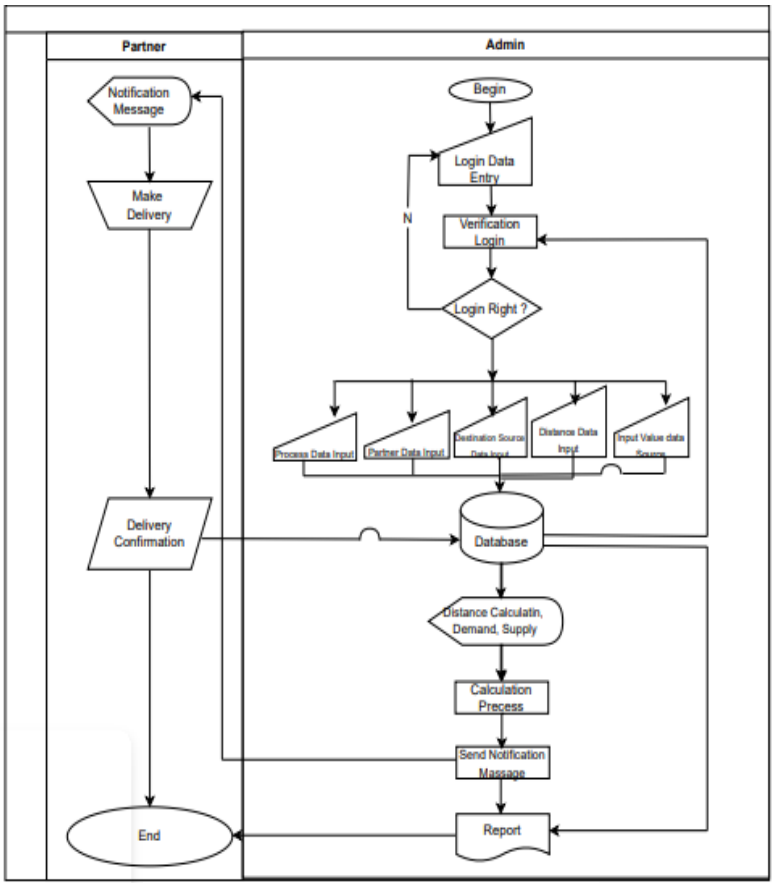

Figure 3. Notification System Flowchart

2.10 Stages of the Notification System

The following is given stages of the notification system,

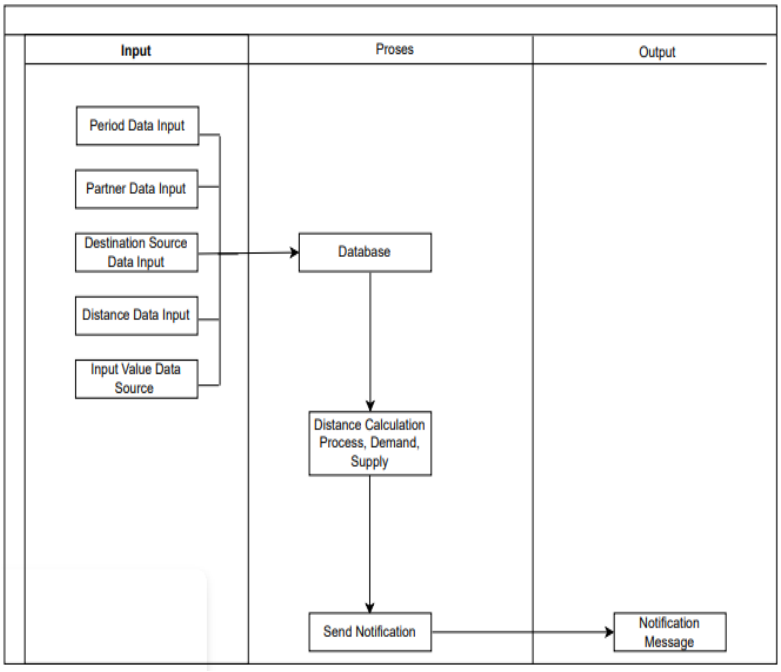

Figure 4. Stages of the Notification System

3. RESULTS AND DISCUSSION

This section provides procedures for getting SMS notifications starting with the Northwest Corner Method, and the notification system stages.

3.1 Northwest Corner Method

For the same data, will be done with three trials.
Trial 1, given the following table,

Table 1. Trial 1 for distance from source city to destination city with supply and demand

Destination \ Source	Padang	Pariaman	Solok	Bungus	Supply
Pekanbaru	310.0 km	278.8 km	274.2 km	326.8 km	10
	9	1			
Jambi	519.2 km	565.7 km	466.4 km	537.6 km	10
		6	4		
Bengkulu	548.2 km	599.5 km	599.10 km	529.7 km	8
			8		
Medan	773.2 km	717.9 km	743.8 km	790.0 km	12
			2	10	
Demand	9	7	14	10	40

The optimization model for Table 1 is as follows,

$$\text{Min Z} = 310.0\,x_{11} + 278.8\,x_{12} + 274.2\,x_{13} + 326.8\,x_{14} + 519.2\,x_{21} + 565.7\,x_{22} + 466.4\,x_{23} + 537.6\,x_{24} + 548.2\,x_{31} + 599.5\,x_{32} + 599.1\,x_{33} + 529.7\,x_{34} + 773.2\,x_{41} + 717.9\,x_{42} + 743.78\,x_{43} + 790.0\,x_{44}$$

Constraint:

$$x_{11} + x_{12} + x_{13} + x_{14} \leq 10$$
$$x_{21} + x_{22} + x_{23} + x_{24} \leq 10$$
$$x_{31} + x_{32} + x_{33} + x_{34} \leq 8$$
$$x_{41} + x_{42} + x_{43} + x_{44} \leq 12$$
$$x_{11} + x_{21} + x_{31} + x_{41} \leq 9$$
$$x_{12} + x_{22} + x_{32} + x_{42} \leq 7$$
$$x_{13} + x_{23} + x_{33} + x_{43} \leq 14$$
$$x_{14} + x_{24} + x_{34} + x_{44} \leq 10$$

Furthermore, using the northwest corner method, the initial base solution is obtained:

$$x_{11} = 9, x_{12} = 1, x_{22} = 6, x_{23} = 4, x_{33} = 8, x_{43} = 2, x_{44} = 10$$

Furthermore, from the initial base solution the optimal solution is obtained as follows:

$$\begin{aligned} \text{Z} &= 9x_{11} + x_{12} + 6x_{22} + 4x_{23} + 8x_{33} + 2x_{43} + 10x_{44} \\ &= 9(310.0) + 278.8 + 6(565.7) + 4(466.4) + 8(599.1) + 2(743.8) + 10(790.0) \\ &= 2790 + 278.8 + 3394.2 + 1865.6 + 4792.8 + 1487.6 + 7900 \\ &= 22509\ km \end{aligned}$$

Trial 2, given table 2 with the distance from the source city to the destination city is the same as table 1 only it differs in supply and demand.

Table 2. Trial 2 for distance from source city to destination city with supply and demand

Destination \ Source	Padang	Pariaman	Solok	Bungus	Supply
Pekanbaru	310.0 km	278.8 km	274.2 km	326.8 km	10
	9	1			
Jambi	519.2 km	565.7 km	466.4 km	537.6 km	10
		6	4		
Bengkulu	548.2 km	599.5 km	599.10 km	529.7 km	8
			8	2	
Medan	773.2 km	717.9 km	743.8 km	790.0 km	12
				10	
Demand	9	7	14	10	40

The optimization model for Table 2 is as follows,

$$\text{Min Z} = 310.0\,x_{11} + 278.8\,x_{12} + 274.2\,x_{13} + 326.8\,x_{14} + 519.2\,x_{21} + 565.7\,x_{22} + 466.4\,x_{23} + 537.6\,x_{24} + 548.2\,x_{31} + 599.5\,x_{32} + 599.1\,x_{33} + 529.7\,x_{34} + 773.2\,x_{41} + 717.9\,x_{42} + 743.78\,x_{43} + 790.0\,x_{44}$$

Constraint:

$$x_{11} + x_{12} + x_{13} + x_{14} \leq 10$$
$$x_{21} + x_{22} + x_{23} + x_{24} \leq 10$$
$$x_{31} + x_{32} + x_{33} + x_{34} \leq 10$$
$$x_{41} + x_{42} + x_{43} + x_{44} \leq 10$$
$$x_{11} + x_{21} + x_{31} + x_{41} \leq 9$$
$$x_{12} + x_{22} + x_{32} + x_{42} \leq 7$$
$$x_{13} + x_{23} + x_{33} + x_{43} \leq 12$$
$$x_{14} + x_{24} + x_{34} + x_{44} \leq 12$$
$$x_{11}, x_{12}, x_{13}, x_{14}, x_{21}, x_{22}, x_{23}, x_{24}, x_{31}, x_{32}, x_{33}, x_{34}, x_{41}, x_{42}, x_{43}, x_{44} \geq 0$$

Furthermore, using the northwest corner method, the initial base solution is obtained:

$$x_{11} = 9, x_{12} = 1, x_{22} = 6, x_{23} = 4, x_{33} = 8, x_{43} = 2, x_{44} = 10$$

Furthermore, from the initial base solution the optimal solution is obtained as follows:

$$\begin{aligned} \text{Z} &= 9x_{11} + x_{12} + 6x_{22} + 4x_{23} + 8x_{33} + 2x_{43} + 10x_{44} \\ &= 9(310.0) + (278.8) + 6(565.7) + 4(466.4) + 8(599.1) + 2(529.7) + 10(790.0) \\ &= 2790 + 278.8 + 3394.2 + 1865.6 + 4797.8 + 1059.4 + 7900 \\ &= 22080.8\ km \end{aligned}$$

Trial 3, given table 3 with the distance from the source city to the destination city is the same as table 1 only it differs in supply and demand.

Table 3. Trial 3 for distance from source city to destination city with supply and demand

Destination \ Source	Padang	Pariaman	Solok	Bungus	Stock
Pekanbaru	310.0 km	278.8 km	274.2 km	326.8 km	30
	[30]				
Jambi	519.2 km	565.7 km	466.4 km	537.6 km	20
		[15]	[5]		
Bengkulu	548.2 km	599.5 km	599.10 km	529.7 km	25
			[20]	[5]	
Medan	773.2 km	717.9 km	743.8 km	790.0 km	15
				[15]	
Demand	30	15	25	20	90

The optimization model for Table 3 is as follows,

$$\text{Min Z} = 310.0\,x_{11} + 278.8\,x_{12} + 274.2\,x_{13} + 326.8\,x_{14} + 519.2\,x_{21} + 565.7\,x_{22} + 466.4\,x_{23} + 537.6\,x_{24} + 548.2\,x_{31} + 599.5\,x_{32} + 599.1\,x_{33} + 529.7\,x_{34} + 773.2\,x_{41} + 717.9\,x_{42} + 743.78\,x_{43} + 790.0\,x_{44}$$

Constraint:

$$x_{11} + x_{12} + x_{13} + x_{14} \leq 30$$
$$x_{21} + x_{22} + x_{23} + x_{24} \leq 20$$
$$x_{31} + x_{32} + x_{33} + x_{34} \leq 25$$
$$x_{41} + x_{42} + x_{43} + x_{44} \leq 15$$
$$x_{11} + x_{21} + x_{31} + x_{41} \leq 30$$
$$x_{12} + x_{22} + x_{32} + x_{42} \leq 15$$
$$x_{13} + x_{23} + x_{33} + x_{43} \leq 25$$
$$x_{14} + x_{24} + x_{34} + x_{44} \leq 20$$
$$x_{11}, x_{12}, x_{13}, x_{14}, x_{21}, x_{22}, x_{23}, x_{24}, x_{31}, x_{32}, x_{33}, x_{34}, x_{41}, x_{42}, x_{43}, x_{44} \geq 0$$

Furthermore, using the northwest corner method, the initial base solution is obtained:

$$x_{11} = 30, x_{22} = 15, x_{23} = 5, x_{33} = 20, x_{43} = 5, x_{44} = 15$$

Furthermore, from the initial base solution the optimal solution is obtained as follows:

$$\begin{aligned} Z = {} & 30x_{11} + 15x_{22} + 5x_{23} + 20x_{33} + 5x_{43} + 15x_{44} \\ & = 30(310.0) + 15(565.7) + 5(466.4) + 20(599.1) + 5(529.7) + 15(790.0) \\ & = 9300 + 8485.5 + 2332 + 11982 + 2648.5 + 11850 \\ & = 38961\ km \end{aligned}$$

The west angle method was applied with three trials. the three trials used the same distance between cities, taken from google maps, the difference was in the number of requests and the number of supplies. This experiment was conducted to see how the results of the optimal solution given, of the three trials gave different results, depending on the amount of supply and demand. trial 1 gives a smaller optimal solution value than trial 3. The optimal solution for trial 1 is 22509 km, trial 2 is 22080.8 km and trial 3 is 38961 km.

3.2 System Descriptions

An overview of the system is given as follows,

1. Admin login to the system.
2. Admin enters login data:
   - Username
   - Password
3. If the login is successful (the username and password are correct), the admin can access the menus.
4. If the login fails (incorrect username and password), the admin cannot access the menus.
5. Admin login successful, admin inputting data:
   - Period data (when the disaster occurred)
   - Partner data (who are involved in this system)
   - Destination source data (source of assistance and destination of assistance)
   - Mileage data (distance from the source of assistance to the destination of assistance)
   - Source value data (containing supply and demand data).
6. After entering all the necessary data, the data is stored in the database.
7. Then to do the counting process, to get the optimal distance and how many vehicles are needed to send assistance to the location of the disaster based on data of supply, demand and distance to each place of disaster, by clicking on the calculation process menu.
8. When clicking on the calculation process it will be asked to choose a period (the time of the disaster).
9. When the period (time of disaster) has been selected, then click the calculation process button, then all data:
   - Distance
   - Stock
   - Request

   Will be processed using the northwest corner method, as explained in the northwest corner flowchart method.
10. When the calculation process has been completed, the data from the calculation process will be displayed in a table, then the optimal distance will be shown, and at the same time the data will be automatically sent to the telephone numbers of partners that have been registered to the system in the form of SMS (Short Message Service).
11. After that the driver from the partner who sends the aid to the disaster location will confirm the delivery has been completed in the form of a delivery report.
12. Message Notification

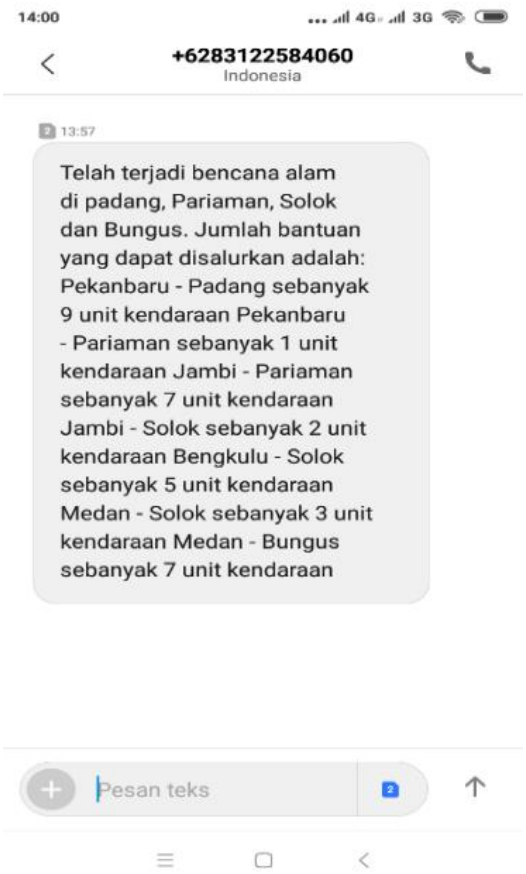

Figure 5. Message Notification

4. CONCLUSIONS

Notification system is a system that is very helpful for the distribution of aid to disaster areas. In addition, the system with a message notification also helps what needs and how many vehicles must be sent to the affected area. The northwest corner method, MySQL, and SQL Yog are the methods used to produce a notification system by providing the minimum distance from the city sending aid to the disaster area. The results obtained are the optimal solution in the form of SMS notifications

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