Set Covering Problem with the Reduction Heuristic Method in Determining the Temporary Disposal Site Locations in Pulau Semambu Village in South Sumatra

Fitri Maya Puspita[1], Novi Rustiana Dewi[2], Evi Yuliza[3], Sisca Octarina[4], and Yulia Anisawati[5]

{fitrimayapuspita@unsri.ac.id[1], novi_rustianadewi@yahoo.co.id[2], eviyuliza@mipa.unsri.ac.id[3], sisca_octarina@unsri.ac.id[4], yuliaanisa705@gmail.com[5]}

Faculty of Mathematics and Natural Sciences, Universitas Sriwijaya[1,2,3,4,5]

Corresponding author: fitrimayapuspita@unsri.ac.id

Abstract. The research attempts to show the Set Covering Problem (SCP) in finding the optimal location of Temporary Disposal Site (TDS) in Pulau Semambu Village, South Sumatra. Those attempts occur due to the least awareness of people in that village to have TDS permanently. Then, the design for TDS is needed critically. The data used then are hamlet name, TDS name, variables used for each model, and distance measurement between TDS. Having 6 hamlets with 12 waste disposal sites makes Pulau Semambu Village need to arrange the optimal location of the TDS. Models designed are classified as Location Set covering Problem (LSCP) and P-Median Problem by utilizing the LINGO 13.0 Software and Reduction Heuristic (RH). The minimum distances applied are 500m, 850m, and 1000m. Based on the results obtained, it can be concluded that a minimum distance of 500 meters is for 6 TDS, namely TDS B Hamlet A, TDS A Hamlet B, TDS B Hamlet C, TDS B Hamlet D.

Keywords: Set Covering Problem, Reduction Heuristic, Location Set covering Problem, P-Median Problem, Pulau Semambu Village, Temporary Disposal Site,

1 Introduction

Cleanliness is an important element that reflects the daily health of every human being. Cleanliness is not only personal hygiene but also environmental cleanliness. Environmental cleanliness includes cleaning public places, cleaning the house, and cleaning the workplace [1]. Awareness of each individual is needed in maintaining the cleanliness of the environment [2]. One of the environmental problems [1] that is still in the public spotlight is the waste problem. Garbage is the result of waste from a production process both from industry and domestic or household [3]. An increase in population has an impact on increasing the amount of waste produced [4].

Waste problems [5], do not only occur in big cities but are one of the biggest problems in villages such as Pulau Semambu Village, Ogan Ilir Regency, South Sumatra Province [6]. Pulau Semambu Village is a village that has an area of approximately 1200 hectares with a total of 6

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hamlets [7]. Pulau Semambu Village is a village that does not yet have a TDS for waste. To reduce landfill waste, the people in Pulau Semambu Village still carry out the tradition of burning garbage. Burning garbage can cause air pollution, causing health problems to the respiratory system, and can lead to Global Warming [8]. Making TDS for garbage in Pulau Semambu Village is an excellent solution to deal with this problem. Therefore, the determination of strategic TDS locations needs attention.

The optimization problem that can be modeled in the form of Integer Linear Programming [9,10] is the Set Covering Problem (SCP) [11-16]. Based on the distance traveled and the minimum number of facilities, SCP is used to determine the optimum location of the facility to provide convenience in gaining access to the facility [17-20]. The SCP model is divided into 4, namely Location Set Covering Problem (LSCP), Maximal Covering Location Problem (MLCP), P-Centre Problem, and p-Median Problem [14,21-23]. There exist the heuristics methods for solving SCP [15,24]. Reduction Heuristics (RH) is one method that can be used to solve optimization problems, namely finding the most optimal solution. The RH method consists of three completion stages, namely Reduction Heuristic 1 (RH1), Reduction Heuristic 2 (RH2), and Repeated Reduction Heuristic (RRH) [25]. The advantage of the RH compared to other algorithms is that it produces optimal facility allocation locations with solutions from several phased tests.

The data used for this research is data on the distance between garbage TDS and other TDS in Pulau Semambu Village taken using Google Maps and a speedometer. Simamora [26] determined the location of TDS for garbage in Pulau Semambu Village using the SCP model with the Greedy Reduction Algorithm and Kemit [27] determined the location of TDS for garbage in Pulau Semambu Village using the SCP model with the Myopic Algorithm [28,29]. It is necessary to determine the location of TDS using the SCP model using the RH method to be able to compare the results with previous research [28]. This study formulates the LSCP and p-Median Problem models using the RH method and LINGO 13.0 to determine the optimum amount and location of TDS waste in Pulau Semambu Village. This research also compares the results of the LSCP model using LINGO 13.0, the P-Median Problem model using LINGO 13.0, and the p-Median Problem model using the Reduction Heuristic method. This study determines whether the RH method is a better method or not and obtains optimal location results.

2 Materials and methods

The research area is classified as the combinatorial optimization dealing with the optimization of finding the optimal location of TDS in Pulau Semambu Village. The optimization problem is categorized as SCP and its variants including LSCP and p-median. The utilization of the heuristics method namely RH compared to previous methods used namely Myopic algorithm and greedy reduction algorithm.

2.1 Research procedures

Steps taken in conducting the research are as follows.

1. Describe the data used, such as the number of garbage TDS, the number of hamlets, and the distance between the garbage TDS in Pulau Semambu Village. The data used in this study are data from previous studies.

2. Describe the variables and parameters for the LSCP model and the p-Median Problem in Pulau Semambu Village.
3. Formulate the SCP model, namely the LSCP and the p-Median Problem.
4. Determine the SCP model solutions, namely the LSCP and p-Median Problem using the help of LINGO 13.0 software.
5. Determine the solution by applying the RH method to determine the optimal solution.
6. Compare the results using the RHmethod with the results of previous studies.
7. Analyze the final results that have obtained the results of the optimum location of waste TDS.

2.2 Data analysis

Data description

The data to be used includes data on the name of the garbage TDS, data on the name of the hamlet, defining variables for each model, and data on measuring the distance traveled from one garbage TDS to another garbage TDS in Pulau Semambu Village.

Table 1. List of TDS Names in Every Hamlet in Pulau Semambu Village

No	Hamlet	TDS
1.	Hamlet A	- TDS A - TDS B
2.	Hamlet B	- TDS A - TDS B
3.	Hamlet C	- TDS A - TDS B
4.	Hamlet D	- TDS A - TDS B
5.	Hamlet E	- TDS A - TDS B
6.	Hamlet F	- TDS A - TDS B

Table 2. Distance Data Between TDS (in Meters)

M_{xy}	1	2	3	4	5	6	7	8	9	10	11	12
1	0	390	1390	1540	2990	3350	1650	1950	2030	2300	2870	3190
2	390	0	1580	1730	3180	3540	1840	2140	2220	2490	3060	3380
3	1390	1580	0	230	1680	2040	440	740	720	990	1560	1880
4	1540	1730	230	0	1830	2190	590	890	870	1140	1710	2030
5	2990	3180	1680	1830	0	360	2040	2340	1260	1530	120	200
6	3350	3540	2040	2190	360	0	2400	2700	1620	1890	480	160
7	1650	1840	440	590	2040	2400	0	300	1080	1350	1920	2240
8	1950	2140	740	890	2340	2700	300	0	1380	1650	2220	2540
9	2030	2220	720	870	1260	1620	1080	1380	0	270	1140	1460
10	2300	2490	990	1140	1530	1890	1350	1650	270	0	1410	1730
11	2870	3060	1560	1710	120	480	1920	2220	1140	1410	0	320
12	3190	3380	1880	2030	200	160	2240	2540	1460	1730	320	0

Pulau Semambu Village has an area of 1200 Ha which consists of 6 hamlets with a total of 12 garbage disposal sites. Table 1 states the list of TDS names in every hamlet, Table 2 states the distance data between TDSs and Table 3 states the variables used for designing the model, respectively.

Table 3. Variables for Each Hamlet

Variable	Variable Description	Variable	Variable Description
B_1	Hamlet A	B_4	Hamlet D
B_2	Hamlet B	B_5	Hamlet E
B_3	Hamlet C	B_6	Hamlet F

Table 4. TDS Variables in Pulau Semambu Village

Variable	List of TDS Names	Variable	List of TDS Names	Variable	List of TDS Names
A_1	TDS A Hamlet A	A_7	TDS A Hamlet D	A_4	TDS B Hamlet B
A_2	TDS B Hamlet A	A_8	TDS B Hamlet D	A_5	TDS A Hamlet C
A_3	TDS A Hamlet B	A_9	TDS A Hamlet E	A_6	TDS B Hamlet C

Table 5. Variable Distance of Each Hamlet to the TDS

Variable	Information	Variable	Information
$B_{1,1}$	Hamlet A to TDS A Hamlet A	$B_{4,1}$	Hamlet D to TDS A Hamlet A
$B_{1,2}$	Hamlet A to TDS B Hamlet A	$B_{4,2}$	Hamlet D to TDS B Hamlet A
$B_{1,3}$	Hamlet A to TDS A Hamlet B	$B_{4,3}$	Hamlet D to TDS A Hamlet B
$B_{1,4}$	Hamlet A to TDS B Hamlet B	$B_{4,4}$	Hamlet D to TDS A Hamlet D
$B_{1.5}$	Hamlet A to TDS A Hamlet C	$B_{4,5}$	Hamlet D to TDS A Hamlet C
$B_{1,6}$	Hamlet A to TDS B Hamlet C	$B_{4,6}$	Hamlet D to TDS B Hamlet C
$B_{1,7}$	Hamlet A to TDS A Hamlet D	$B_{4,7}$	Hamlet D to TDS A Hamlet D
$B_{1,8}$	Hamlet A to TDS B Hamlet D	$B_{4,8}$	Hamlet D to TDS B Hamlet D
$B_{1,9}$	Hamlet A to TDS A Hamlet E	$B_{4,9}$	Hamlet D to TDS A Hamlet E
$B_{1.10}$	Hamlet A to TDS B Hamlet E	$B_{4,10}$	Hamlet D to TDS B Hamlet E
$B_{1.11}$	Hamlet A to TDS A Hamlet F	$B_{4,11}$	Hamlet D to TDS A Hamlet F
$B_{1.12}$	Hamlet A to TDS B Hamlet F	$B_{4,12}$	Hamlet D to TDS B Hamlet F
$B_{2,1}$	Hamlet B to TDS A Hamlet A	$B_{5,1}$	Hamlet E to TDS A Hamlet A
$B_{2,2}$	Hamlet B to TDS B Hamlet A	$B_{5,2}$	Hamlet E to TDS B Hamlet A
$B_{2,3}$	Hamlet B to TDS A Hamlet B	$B_{5,3}$	Hamlet E to TDS A Hamlet B
$B_{2,4}$	Hamlet B to TDS A Hamlet D	$B_{5,4}$	Hamlet E to TDS A Hamlet D
$B_{2,5}$	Hamlet B to TDS A Hamlet C	$B_{5,5}$	Hamlet E to TDS A Hamlet C
$B_{2,6}$	Hamlet B to TDS B Hamlet C	$B_{5,6}$	Hamlet E to TDS B Hamlet C
$B_{2,7}$	Hamlet B to TDS A Hamlet D	$B_{5,7}$	Hamlet E to TDS A Hamlet D
$B_{2,8}$	Hamlet B to TDS B Hamlet D	$B_{5,8}$	Hamlet E to TDS B Hamlet D
$B_{2,9}$	Hamlet B to TDS A Hamlet E	$B_{5,9}$	Hamlet E to TDS A Hamlet E
$B_{2,10}$	Hamlet B to TDS B Hamlet E	$B_{5,10}$	Hamlet E to TDS B Hamlet E
$B_{2,11}$	Hamlet B to TDS A Hamlet F	$B_{5,11}$	Hamlet E to TDS A Hamlet F
$B_{2,12}$	Hamlet B to TDS B Hamlet F	$B_{5,12}$	Hamlet E to TDS B Hamlet F
$B_{3,1}$	Hamlet C to TDS A Hamlet A	$B_{6,1}$	Hamlet F to TDS A Hamlet A
$B_{3,2}$	Hamlet C to TDS B Hamlet A	$B_{6,2}$	Hamlet F to TDS B Hamlet A
$B_{3,3}$	Hamlet C to TDS A Hamlet B	$B_{6,3}$	Hamlet F to TDS A Hamlet B
$B_{3,4}$	Hamlet C to TDS A Hamlet D	$B_{6,4}$	Hamlet F to TDS A Hamlet D
$B_{3,5}$	Hamlet C to TDS A Hamlet C	$B_{6,5}$	Hamlet F to TDS A Hamlet C
$B_{3,6}$	Hamlet C to TDS B Hamlet C	$B_{6,6}$	Hamlet F to TDS B Hamlet C

$B_{3,7}$	Hamlet C to TDS A Hamlet D	$B_{6,7}$	Hamlet F to TDS A Hamlet D
$B_{3,8}$	Hamlet C to TDS B Hamlet D	$B_{6,8}$	Hamlet F to TDS B Hamlet D
$B_{3,9}$	Hamlet C to TDS A Hamlet E	$B_{6,9}$	Hamlet F to TDS A Hamlet E
$B_{3,10}$	Hamlet C to TDS B Hamlet E	$B_{6,10}$	Hamlet F to TDS B Hamlet E
$B_{3,11}$	Hamlet C to TDS A Hamlet F	$B_{6,11}$	Hamlet F to TDS A Hamlet F
$B_{3,12}$	Hamlet C to TDS B Hamlet F	$B_{6,12}$	Hamlet F to TDS B Hamlet F

Table 3. defines the variables for each hamlet, Table 4 for TDS variables in Pulau Semambu Village, and Table 5 for the variable distance of each hamlet to TDS.

3 Results

Calculations with the LSCP Model

The next calculation taken is to determine the location of TDS with the optimal amount of waste. The LSCP model for determining the location used is intending to optimizize the number of TDS in Pulau Semambu Village and be able to serve all demand points. This calculation is done using LINGO 13.0 software.

1. LSCP calculations using LINGO 13.0 with a minimum distance of 500 m LSCP Model with 500m Range:

Minimize:

$$Z_{LSCP} = A_1 + A_2 + A_3 + A_4 + A_5 + A_6 + A_7 + A_8 + A_9 + A_{10} + A_{11} + A_{12} \quad (1)$$

subject to

$$A_1 + A_2 \geq 1 \quad (2)$$

$$A_3 + A_4 + A_7 \geq 1 \quad (3)$$

$$A_3 + A_4 \geq 1 \quad (4)$$

$$A_5 + A_6 + A_{11} + A_{12} \geq 1 \quad (5)$$

$$A_3 + A_7 + A_8 \geq 1 \quad (6)$$

$$A_7 + A_8 \geq 1 \quad (7)$$

$$A_9 + A_{10} \geq 1 \quad (8)$$

$$A_5 + A_6 + A_{11} + A_{12} \geq 1 \quad (9)$$

$$A_1, A_2, A_3, A_4, A_5, A_6, A_7, A_8, A_9, A_{10}, A_{11}, A_{12} \geq 0 \text{ and integers} \quad (10)$$

Table 6. LSCP Calculation Results with a Minimum Distance of 500 m

No	TDS Candidate Names
1	TDS B of Hamlet A
2	TDS A of Hamlet B
3	TDS B of Hamlet C
4	TDS B of Hamlet D
5	TDS B of Hamlet E

Table 6 explains the result of LINGO 13.0 for Eq(1)-(10).

2. LSCP calculations using LINGO 13.0 with a minimum distance of 850 m

LSCP Model with 850m choice:

Minimize:

$$Z_{SCLP} = A_1 + A_2 + A_3 + A_4 + A_5 + A_6 + A_7 + A_8 + A_9 + A_{10} + A_{11} + A_{12} \quad (11)$$

subject to

$$A_1 + A_2 \geq 1 \quad (12)$$
$$A_3 + A_4 + A_7 + A_8 + A_9 \geq 1 \quad (13)$$
$$A_3 + A_4 + A_7 \geq 1 \quad (14)$$
$$A_5 + A_6 + A_{11} + A_{12} \geq 1 \quad (15)$$
$$A_3 + A_4 + A_7 + A_8 \geq 1 \quad (16)$$
$$A_3 + A_7 + A_8 \geq 1 \quad (17)$$
$$A_3 + A_9 + A_{10} \geq 1 \quad (18)$$
$$A_9 + A_{10} \geq 1 \quad (19)$$
$$A_5 + A_6 + A_{11} + A_{12} \geq 1 \quad (20)$$
$$A_1, A_2, A_3, A_4, A_5, A_6, A_7, A_8, A_9, A_{10}, A_{11}, A_{12} \geq 0 \text{ and integers} \quad (21)$$

Table 7. LSCP Calculation Results with a Minimum Distance of 850 m

No	TDS Candidate Names
1	TDS B Hamlet A
2	TDS A Hamlet D
3	TDS A Hamlet E
4	TDS B Hamlet F

Table 7 displays the result for Eq. (11)-(21). Table 8 displays the calculation of LSCP for 1000 m using LINGO 13.0

3. LSCP calculations using LINGO 13.0 with a minimum distance of 1000 m
LSCP Model with 850m.
Minimize:
$$Z_{SCLP} = A_1 + A_2 + A_3 + A_4 + A_5 + A_6 + A_7 + A_8 + A_9 + A_{10} + A_{11} + A_{12} \quad (22)$$
subject to
$$A_1 + A_2 \geq 1 \quad (23)$$
$$A_3 + A_4 + A_7 + A_8 + A_9 + A_{10} \geq 1 \quad (24)$$
$$A_3 + A_4 + A_7 + A_8 + A_9 \geq 1 \quad (25)$$
$$A_5 + A_6 + A_{11} + A_{12} \geq 1 \quad (26)$$
$$A_3 + A_4 + A_7 + A_8 \geq 1 \quad (27)$$
$$A_3 + A_4 + A_9 + A_{10} \geq 1 \quad (28)$$
$$A_3 + A_9 + A_{10} \geq 1 \quad (29)$$
$$A_5 + A_6 + A_{11} + A_{12} \geq 1 \quad (30)$$
$$A_1, A_2, A_3, A_4, A_5, A_6, A_7, A_8, A_9, A_{10}, A_{11}, A_{12} \geq 0 \text{ and integers} \quad (31)$$

Table 8. LSCP Calculation Results with a Minimum Distance of 1000 m

No	TDS Candidate Names
1	TDS B Hamlet A
2	TDS A Hamlet B
3	TDS B Hamlet F

Calculations with the p-Median Problem Model

Completion of the p-Median Problem model uses data on the location of requests for each hamlet in Pulau Semambu Village and the location of the TDS facilities selected from the completion of the LSCP model. This calculation was carried out using LINGO 13.0 software and the RH method.

1. Calculation the p-Median Problem using LINGO 13.0 and RH method for a Minimum Distance of 500 m, as stated in Table 9.

Table 9. Calculation Results of the p-Median Problem with a Minimum Distance of 500 m with LINGO 13.0 Software and RH

Hamlet	LINGO 13.0 Results	RH Results
1	TDS B	-
2	TDS A	TDS A
3	TDS B	-
4	TDS A	TDS B
5	TDS B	TDS B
6	TDS B	-

2. Calculation p-Median Problem using LINGO 13.0 and RH method with a Minimum Distance of 850 m, as stated in Table 10.

Table 10. Calculation Results of the p-Median Problem with a Minimum Distance of 850 m using LINGO 13.0 Software and RH

Hamlet	LINGO 13.0 Results	RH Results
1	TDS B	-
2	TDS A	-
3	TDS B	-
4	TDS A	TDS A
5	TDS B	TDS A
6	TDS A	-

3. Calculation P-Median Problem using LINGO 13.0 and RH method with a Minimum Distance of 1000 m, as stated in Table 11.

Table 11. Calculation Results of the P-Median Problem with a Minimum Distance of 1000 m with LINGO 13.0 Software and RH

Hamlet	LINGO 13.0 Results	RH Results
1	TDS B	-
2	TDS A	TDS A
3	TDS B	-
4	TDS A	-
5	TDS B	-
6	TDS A	TDS B

Comparison of Overall Calculation Results

Based on the results that have been obtained, it can be compared with the calculation results of the LSCP model with LINGO 13.0 software, the p-Median Problem with LINGO 13.0, and p-Median Problem with the RH method are as follows.

1. Comparison of calculation results of p-median Problem with a Minimum Distance of 500m, as displayed in Table 12.

Table 12. Comparison of Overall Calculation Results with a Minimum Distance of 500 m

Hamlet	LSCP Result by LINGO 13.0	p-Median Problem by LINGO 13.0 Results	p-Median Problem by RH Results
1	TDS B	TDS B	-
2	TDS A	TDS A	TDS A
3	TDS B	TDS B	-
4	TDS B	TDS A	TDS B
5	TDS B	TDS B	TDS B
6	-	TDS B	-

2. Comparison of Calculation Results of p-median Problem Results with a Minimum Distance of 850 m, as displayed in Table 13.

Table 13. Comparison of Overall Calculation Results with a Minimum Distance of 850 m

Hamlet	LSCP Result by LINGO 13.0	p-Median Problem by LINGO 13.0 Results	p-Median Problem by RH Results
1	TDS B	TDS B	-
2	-	TDS A	-
3	-	TDS B	-
4	TDS A	TDS A	TDS A
5	TDS A	TDS A	TDS A
6	TDS B	TDS B	-

3. Comparison of Calculation Results of p-median Problem Results with a Minimum Distance of 1000 m as displayed in Table 14.

Table 14. Comparison of Overall Calculation Results with a Minimum Distance of 1000 m

Hamlet	LSCP Result by LINGO 13.0	p-Median Problem by LINGO 13.0 Results	p-Median Problem by RH Results
1	TDS B	TDS B	-
2	TDS A	TDS A	TDS A
3	-	TDS B	-
4	-	TDS A	-
5	-	TDS A	-
6	TDS B	TDS B	TDS B

Comparison of calculation results with previous research methods

Based on the results obtained with the P-Median Problem model using the RH method, it can be compared with the results of research by using GRA and using the Myopic Algorithm [28]. The results to be compared are the results using a distance of 500 meters and 1000 meters.

1. Comparison of Calculation Results of p-median Problem Results with a Distance of 500 m as displayed in Table 15.

Table 15. Comparison Results with Previous Research Using a Minimum Distance of 500 m

Hamlet	GRA	Myopic Algorithm	RH
1	TDS B	TDS B	-
2	TDS A	TDS A	TDS A
3	TDS B	TDS B	-
4	TDS B	TDS A	TDS B
5	TDS B	TDS B	TDS B
6	-	TDS B	-

2. Comparison of Calculation Results of p-median Problem Results with a Distance of 500 m as displayed in Table 16.

Table 16. Comparison Results with Previous Research Using a Minimum Distance of 1000 m

Hamlet	GRA	Myopic Algorithm	Reduction Heuristics
1	TDS B	TDS B	-
2	TDS A	TDS A	TDS A
3	TDS B	TDS B	-
4	-	TDS A	-
5	-	TDS A	-
6	-	TDS B	TDS B

4 Discussion

Calculations with the LSCP model

Based on Table 6, a solution is obtained that the location of the facilities is located in 5 TDS, namely TDS B Hamlet A, TDS A Hamlet B, TDS B Hamlet C, TDS B Hamlet D, and TDS B Hamlet E. These results are the result of calculations using LINGO 13.0 software which obtains the optimum solution which means that the TDS candidate locations are in these 5 locations.

$$Z_{LSCP} = 5$$
$$A_2 = A_3 = A_6 = A_8 = A_{10} = 1$$

Based on Table 7, a solution is obtained that the location of the facility is located in 4 TDS, namely TDS B Hamlet A, TDS A Hamlet D, TDS A Hamlet E, and TDS B Hamlet F. These results are the result of calculations using LINGO 13.0 software which obtains the optimum solution which means that the TDS candidate locations are in the 4 locations.

$$Z_{LSCP} = 4$$
$$A_2 = A_7 = A_9 = A_{12} = 1$$

Based on Table 8, a solution is obtained that the location of the facility is located in 3 TDS, namely TDS B Hamlet A, TDS A Hamlet B, and TDS B Hamlet F. These results are the results of calculations using LINGO 13.0 software which obtains the optimum solution which means that the candidate TDS locations are at these 3 locations.

$$Z_{LSCP} = 3$$
$$A_2 = A_3 = A_{12} = 1$$

Calculations with the p-median problem model

Based on Table 9, the results of calculations with LINGO 13.0 Software and RH with a distance of 500 meters there is a discrepancy between requests in each hamlet and the specified TDS for garbage, so this study suggests that the location of TDS for garbage in Hamlet A is placed in TDS B, Hamlet B is placed in TDS A, Hamlet C TDS B was placed, Hamlet D was placed in TDS b, Hamlet e was placed in TDS b, and Hamlet F was placed in TDS B.

Based on Table 10, the results of calculations with LINGO 13.0 Software and RH with a distance of 850 meters there is a discrepancy between requests in each hamlet and the specified TDS for garbage, so this study suggests that the location of TDS for garbage in Hamlet A is placed in TDS B, Hamlet B is placed in TDS A, Hamlet C TDS B was placed, Hamlet D was placed in TDS A, Hamlet E was placed in TDS A, and Hamlet F was placed in TDS B.
Based on Table 11 the results of calculations with LINGO 13.0 Software and RH with a distance of 1000 meters there is a discrepancy between requests in each hamlet and the specified TDS for garbage, so this study suggests that the location of TDS for garbage in Hamlet A is placed in TDS B, Hamlet B is placed in TDS A, Hamlet C3 TDS B was placed, Hamlet D was placed in TDS A, Hamlet E was placed in TDS A, and Hamlet F was placed in TDS B.

Comparison of calculation results with previous research methods

Based on Table 12, a comparison of the results of the overall calculation with a distance of 500 meters there is a discrepancy between the demand in each hamlet and the specified waste TDS, so this study suggests that Hamlet A should be placed in TDS B, Hamlet B be placed in TDS A, Hamlet C be placed in TDS B, Hamlet D was placed at TDS B, Hamlet E was placed at TDS B, and Hamlet F was placed at TDS B.

Based on Table 13, a comparison of the results of the overall calculation with a distance of 850 meters there is a discrepancy between requests in each hamlet and the specified TDS for waste, so this study suggests that Hamlet A should be placed in TDS B, Hamlet B be placed in TDS A, Hamlet C be placed in TDS B, Hamlet D was allocated TDS A, Hamlet E was assigned TDS A, and Hamlet F was assigned TDS B.

Based on Table 14, a comparison of the overall calculation results with a distance of 1000 meters there is a discrepancy between the demand in each hamlet and the specified TDS for waste, so this study suggests that Hamlet A should be placed in TDS B, Hamlet B be placed in TDS A, Hamlet C be placed in TDS B, Hamlet D was allocated TDS A, Hamlet E was assigned TDS A, and Hamlet F was assigned TDS B.

Comparison of Calculation Results with Previous Research Methods

Based on the comparison results in Table 15 and Table 16, using the RH method with the results of previous studies using the GRA and Myopic Algorithm for determining the optimum waste TDS, the RH method is not good and accurate to use because the results obtained are only 2 locations. The Myopic Algorithm method is better to use than the 3 methods because the results obtained are 6 locations.

5 Conclusion

Based on the results of the calculations and discussions that have been carried out, it can be concluded that:

1. Based on a comparison of the calculation results of the LSCP model with LINGO 13.0 software, model p-Median Problem with Software LINGO 13.0, and models of p-Median Problem using the RH method obtained for a minimum distance of 500m there are 6 locations, namely TDS B Hamlet A, TDS A Hamlet B, TDS B Hamlet C, TDS B Hamlet D, TDS B Hamlet E, and TDS B Hamlet F. For a minimum distance of 850m there are 6 locations, namely TDS B Hamlet A, TDS A Hamlet B, TDS B Hamlet C, TDS A Hamlet D, TDS A Hamlet E, and TDS B Hamlet F. For a minimum distance of 1000m there are 6 locations, namely TDS B Hamlet A, TDS A Hamlet B, TDS B Hamlet C, TDS A Hamlet D, TDS A Hamlet E, and TDS B Hamlet F.
2. Based on the comparison of the overall calculation results, it can be concluded that the calculation results of p-Median Problem using LINGO 13.0 software more accurate.

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