BAREKENG: Journal of Mathematics and Its Applications
December 2024 Volume 18 Issue 4 Page 2685–2702
P-ISSN: 1978-7227 E-ISSN: 2615-3017
https://doi.org/10.30598/barekengvol18iss4pp2685-2702

DETERMINING THE OPTIMAL TEMPORARY WASTE DISPOSAL SITES IN THE ALANG-ALANG LEBAR SUB-DISTRICT PALEMBANG USING THE P-CENTRE LOCATION PROBLEM AND P-MEDIAN PROBLEM MODELS

Sisca Octarina[1*], Divasanda Armalia[2], Bambang Suprihatin[3], Putra BJ Bangun[4], Endro Setyo Cahyono[5], Fitri Maya Puspita[6], Evi Yuliza[7], Indrawati[8]

[1,2,3,4,5,6,7,8]*Department of Mathematics, Faculty of Mathematics and Natural Sciences, Universitas Sriwijaya*
Jln. Raya Palembang Prabumulih KM 32 Indralaya, South Sumatra, 30662, Indonesia

*Corresponding author's e-mail: * **sisca_octarina@unsri.ac.id***

Article History:

Received: 1st, June 2024
Revised: 3rd, August 2024
Accepted: 1st,September 2024
Published:14th, October 2024

Keywords:

p-Centre Location Problem; Location; p-Median Problem; Set Covering Problem; Temporary Waste Disposal Sites.

ABSTRACT

The rapid development of Palembang City comes with an increase in population and a proportionate increase in waste. Providing Temporary Waste Disposal Sites (TWDS) with ideal locations is one way to address the waste problem in Palembang City. The location of the existing TWDS could be more regular and optimal. The problem of determining the optimal TWDS location can be solved by optimization science, as classified in the Set Covering Problem (SCP) model. The SCP model is divided into the p-Center Location Problem and p-Median Problem models. This study aims to determine the optimal locations for TWDS in the Alang-Alang Lebar Sub-District, Palembang City, by comparing the results of the p-Center Location Problem and p-Median Problem models. Initially, the Alang-Alang Lebar Sub-District had 33 TWDS. After formulating the Set Covering Location Problem and Maximal Covering Location Problem models, we obtain the optimal solution, which we then solve using the p-Center Location Problem and p-Median Problem models. Based on the results and discussion, the optimal TWDS can meet the demand of each village in the Alang-Alang Lebar Sub-District. The p-Center Location Problem and p-Median Problem models produce the same optimal TWDS, namely TWDS Pramuka 2 Street and around, TWDS Colonel Sulaiman Amin Street, TWDS Talang Kelapa Ujung, and TWDS Beside Soekarno Hatta Street. This study recommends using both models to determine the optimal TWDS.

How to cite this article:

S. Octarina, D. Armalia, B. Suprihatin, P. B. Bangun, E. S. Cahyono, F. M. Puspita, E. Yuliza and Indrawati., "DETERMINING THE OPTIMAL TEMPORARY WASTE DISPOSAL SITES IN THE ALANG-ALANG LEBAR SUB-DISTRICT PALEMBANG USING THE P-CENTRE LOCATION PROBLEM AND P-MEDIAN PROBLEM MODELS," *BAREKENG: J. Math. & App.*, vol. 18, iss. 4, pp. 2685-2702, December, 2024.

Journal homepage: *https://ojs3.unpatti.ac.id/index.php/barekeng/*
Journal e-mail: *barekeng.math@yahoo.com; barekeng.journal@mail.unpatti.ac.id*

Research Article · Open Access

1. INTRODUCTION

The swift expansion of urban areas in Indonesia corresponds with the rise in population and is directly proportional to the amount of waste produced. However, the government must provide adequate facilities and infrastructure to address these issues, resulting in suboptimal services and a decline in environmental quality, particularly regarding waste management. The definition of waste can be found in Law No. 18 of 2012 [1]. The community refers to solid material from daily human activities or natural processes as waste [2]. The waste issue in Palembang City is a significant problem that must be addressed. According to the Head of the Palembang City Environment and Hygiene Office (EHO), the total daily waste production in Palembang City was 1,180 metric tons in 2022. Based on a population of 1.6 million people in Palembang City, it is assumed that 0.7 kilograms of waste are produced daily. Although this figure decreased by 1.67% from the previous year, it did not decrease significantly [3].

Alang-Alang Lebar Sub-District is one of Palembang City's sub-districts facing a waste problem. This new sub-district was established due to the expansion of the Palembang city area in 2007. According to the Palembang City Solid Waste Detail Engineering Design (DED) in 2013, the Alang-Alang Lebar Sub-District has numerous illegal waste disposal points. This problem may be due to its direct adjacency to Banyuasin Regency and its status as a new residential development area, which needs to be managed appropriately. In addition, the location could be better, and the waste collection system in the area needs to be improved, which causes garbage to accumulate [4]. One solution to the waste problem is using Temporary Waste Disposal Sites (TWDS). These waste storage areas are routinely transported to the Final Disposal Site (FDS) [5]. EHO Palembang City has handled waste problems by providing various locations with adequate waste stations. However, waste disposal sites must be optimally located to prevent excessive stockpiling.

Location optimization is more significant optimization problem [6]. Optimization involves maximizing or minimizing a function to obtain the best or maximum results [7]. The Set Covering Problem (SCP) is a widely used optimization problem in various industrial applications, such as scheduling, manufacturing, service planning, and location problems [8]-[9]. SCP comprises Covering-Based Problem (CBP) and Median-Based Problem models [10]. The SCP model comprises the Set Covering Location Problem (SCLP) model, Maximal Covering Location Problem (MCLP), p-Centre Location Problem, and p-Median Problem [11]. These models aim to minimize the number of facilities required to cover all clients or maximize the number of clients covered by a given number of facilities. The p-Centre Location Problem and p-Median Problem models can utilize the optimal solutions of SCLP and MCLP [12]. A comparison will be made between the optimal solutions of the two models.

SCLP aims to minimize the number of waste stations while ensuring users can access them within a specific distance or time [8]. However, the SCLP has a significant drawback as it requires the coverage of all customers, even if many waste sites need to be utilized more or less [13]. The MCLP is used to overcome these drawbacks. MCLP selects a subset of waste stations to be opened while maximizing the total demand of covered customers, with a constraint on the number of waste stations [14]. The p-Center Location problem aims to minimize the maximum distance between each customer and the assigned facility [15]. In contrast, the p-Median Problem seeks to determine the optimal location of facilities and assigned customers to minimize the total transportation cost and distance between customers and facilities [16]. This problem aims to reduce the distance between TWDS and villages in the Alang-Alang Lebar Sub-District using the p-Centre Location Problem. In contrast, the p-Median Problem minimizes the distance between urban villages in the Alang-Alang Lebar Sub-District and TWDS [17].

Previous research related to the problem of determining the location has been conducted [3], [14], [18]–[22]. [23] employed the SCP model to determine the optimal location and number of fire stations. [24] discussed optimizing the Hospital Emergency Room (HER) location in Palembang City using the SCLP, MCLP, and p-Median Problem models. Similarly, [8] explored the optimization of the location of TWDS in the Seberang Ulu I Sub-District of Palembang City, formulating the SCLP and p-Median Problem models. [3] We also considered the Covering-Based Problem model in determining the optimal location of TWDS in Sukarami Sub-District, Palembang City. In light of the background above, this research was conducted to compare the results of the p-Center Location Problem model with those of the p-Median Problem in determining the optimal location of TWDS in the Alang-Alang Lebar Sub-District of Palembang City.

2. RESEARCH METHODS

The steps taken in this research are

a. Data on the distance between TWDS in each village in the Alang-Alang Lebar Sub-District will be collected and presented in tables.
b. Measuring the distance traveled between TWDS in Alang-Alang Lebar Sub-District with the help of Google Maps.
c. Defining TWDS and village data variables in the Alang-Alang Lebar Sub-District.
d. Formulate the Covering Based Problem model as follows:
   1. The SCLP model uses **Equation (1)** as the objective function and **Constraints (2)-(3)**.
   2. The MCLP model uses **Equation (4)** as the objective function and **Constraints (5)-(8)**.
   3. The p-Centre Location Problem model uses **Equation (9)** as the objective function and **Constraints (10)-(16)**.
e. Formulate the Median Based Problem model using the p-Median Problem model using **Equation (17)** as the objective function and **Constraints (18)-(20)**.
f. Analyze the final results of the p-Center Location Problem and p-Median Problem models.
g. Mapping the optimal locations of TWDS in the Alang-Alang Lebar Sub-District using Google Earth.

Based on the data of TWDS in the Alang-Alang Lebar Sub-District obtained from DLHK Palembang City in 2022, there are eight additional TWDS after retracing, which are spread across four villages. The data can be seen in **Table 1**.

Table 1. List of the Names of TWDS in the Alang-Alang Lebar Sub-District

No	Name of Village	Name of TWDS
1	Srijaya	• TWDS Peristiwa Street and Surroundings • TWDS Srijaya Street around Bala Putra Dewa Museum • TWDS Pramuka 2 Street and Surroundings • TWDS Pulai Street • TWDS Mahmil Street • TWDS Kol. H. Burlian Street (Near JPO KM. 5 Bus Stop) • TWDS Taman Sari Street Near LRT RSUD Prov. Sumsel Station • TWDS Taman Sari Ujung Street • TWDS in front of Indomaret Kol. H. Burlian 1 • TWDS M. Husin Street • TWDS HBR Motik Street in front of Bougenville Complex • TWDS Raflesia Raya Street and Surroundings • TWDS Pancasila Street
2	Karya Baru	• TWDS Kolonel Sulaiman Amin Street • TWDS Pengadilan Tinggi Street • TWDS Minangkabau Street • TWDS Rama Raya Street
3	Talang Kelapa	• TWDS Beside Soekarno Hatta Street • TWDS Kolonel Sulaiman Amin Street around Pemda Jamik Al Muhajirin Complex • TWDS Bungur Raya Street (behind Maskarebet Hall) • TWDS Talang Kelapa Ujung • TWDS PMD Talang Kelapa Street Right and Left • TWDS Lebung Permai Street (Around Griya Interbiz Housing) • TWDS SMA Negeri 22 Palembang • TWDS Hasanudin Street (Near Griya Hero Housing and Surrounding)
4	Alang – Alang Lebar	• TWDS Hasanudin Street around Bumi Indah Sembaja Complex • TWDS Musholah Street • TWDS Jepang Street • TWDS Barokah VI Street • TWDS Bumi Mas Street • TWDS Lorong Alang-Alang Lebar Market • TWDS KM 12 Market • TWDS KM 12 Alang-Alang Lebar Bus Station

Based on Table 1, there are 13 TWDS in the Srijaya Village, 4 TWDS in the Karya Baru Village, 8 TWDS in the Talang Kelapa Village, and 8 TWDS in the Alang–Alang Lebar Village. The definition of village variables in the Alang-Alang Lebar Sub-District can be seen in Table 2. The notation used in defining the variable of villages in the Alang-Alang Lebar Sub-District is $I_{n,}$ where $n = 1, 2, 3, 4$.

Table 2. Definition of the Variable of Villages in the Alang-Alang Lebar Sub-District

Variable	Definition of Variable
I_1	Srijaya Village
I_2	Karya Baru Village
I_3	Talang Kelapa Village
I_4	Alang – Alang Lebar Village

Table 2 defines I_1 as Srijaya Village, I_2 as Karya Baru Village, I_3 as Talang Kelapa Village, and I_4 as Alang-Alang Lebar Village. Then, the definition of each TWDS can be seen in Table 3. The variable used to define each TWDS is K_n where $n = 1, 2, 3, \ldots, 33$.

Table 3. Definition of the Variable of TWDS in the Alang-Alang Lebar Sub-District

Variable	Definition of Variables
K_1	TWDS Peristiwa Street and Surroundings
K_2	TWDS Srijaya Street around Bala Putra Dewa Museum
K_3	TWDS Pramuka 2 Street and Surroundings
K_4	TWDS Pulai Street
K_5	TWDS Mahmil Street
K_6	TWDS Kol. H. Burlian Street (Near JPO KM.5 Bus Stop)
K_7	TWDS Taman Sari near LRT RSUD Prov. Sumsel Station
K_8	TWDS Taman Sari Ujung Street
K_9	TWDS in front of Indomaret Kol. H. Burlian 1
K_{10}	TWDS M. Husin Street
K_{11}	TWDS HBR Motik Street in front of Bougenville Complex
K_{12}	TWDS Raflesia Raya Street and Surroundings
K_{13}	TWDS Pancasila Street
K_{14}	TWDS Kolonel Sulaiman Amin Street
K_{15}	TWDS Pengadilan Tinggi Street
K_{16}	TWDS Minangkabau Street
K_{17}	TWDS Rama Raya Street
K_{18}	TWDS Beside Soekarno Hatta Street
K_{19}	TWDS Kolonel Sulaiman Amin around Pemda Jamik Al Muhajirin Complex
K_{20}	TWDS Bungur Raya Street (behind Maskarebet Hall)
K_{21}	TWDS Talang Kelapa Ujung
K_{22}	TWDS PMD Talang Kelapa Street Right and Left
K_{23}	TWDS Lebung Permai Street (Around Griya Interbiz Housing)
K_{24}	TWDS SMA Negeri 22 Palembang
K_{25}	TWDS Hasanudin (Near Griya Hero Housing and Surroundings)
K_{26}	TWDS Hasanudin Street around Bumi Indah Sembaja Complex
K_{27}	TWDS Musholah Street
K_{28}	TWDS Jepang Street
K_{29}	TWDS Barokah VI Street
K_{30}	TWDS Bumi Mas Street
K_{31}	TWDS Lorong Alang-Alang Lebar Market
K_{32}	TWDS KM 12 Market
K_{33}	TWDS KM 12 Alang-Alang Lebar Bus Station

From Table 3, K_1 defines TWDS Peristiwa Street and Surroundings, K_2 defines TWDS Srijaya Street around Bala Putra Dewa Museum, and so un unti K_{33} defines TWDS KM 12 Alang-Alang Lebar Bus Station.

2.1 Covering-Based Problem

The Covering-Based Problem (CBP) is a mathematical model that aims to fulfill service and satisfaction requirements. This model ensures that the demand location must cover the demand within a specific range or travel period from the facility that serves it [11]. The CBP consists of several models, including the following:

a. Set Covering Location Problem

SCLP aims to minimize the number of facilities constructed or the total location cost while ensuring that the resulting network can still meet the demand levels. This problem determines the number and location of facilities required to cover all demand points within a specified range or traveling period of open facilities serving demand **[11]**. The SCLP model can be mathematically expressed as follows.

$$\text{Minimize } Z_{SCLP} = \sum_{j\in Q} K_j \tag{1}$$

Subject to

$$\sum_{j\in Q} K_j \geq 1 \tag{2}$$

$$K_j \in \{0,1\}, \qquad j \in Q \tag{3}$$

Definition of notation:

Z_{SCLP} = Objective function value of SCLP model

Q = The index set of facility location

Decision Variable:

$$K_j = \begin{cases} 1; \text{ if the facility is located in the } j \text{ location} \\ \\ 0; \text{ if the facility is not located in the } j \text{ location} \end{cases}$$

Equation (1) minimizes the number of locations. **Constraint (2)** ensures that one facility is selected at each demand point. **Constraint (3)** states that all decision variables are binary numbers.

b. Maximal Covering Location Problem

MCLP aims to maximize the demand covered within a specific service distance by placing a specified number of facilities **[14]**. Mathematically, the MCLP model can be written as follows.

$$\text{Maximize } Z_{MCLP} = \sum_{i\in P} L_i \tag{4}$$

Subject to

$$\sum_{j\in Q} K_j = p \tag{5}$$

$$L_i \leq \sum_{j\in Q} K_j \tag{6}$$

$$L_i \in \{0,1\}, \qquad i \in P \tag{7}$$

$$K_j \in \{0,1\}, \qquad j \in Q \tag{8}$$

Definition of notation:

Z_{MCLP} = Objective function value of MCLP model

P = The index set of demand location

p = The number of facility locations which will be built

Decision Variable:

$$L_i = \begin{cases} 1; \text{ if the facility which located at } i \in P \text{ is covered} \\ \\ 0; \text{ if the facility which located at } i \in P \text{ is not covered} \end{cases}$$

The objective function is maximized at each demand location by **Equation (4)**. **Constraint (5)** stipulates that a total of p facilities are situated at each demand location. **Constraint (6)** indicates that open facilities are solely responsible for covering the demand location. **Constraints (7)** and **Constraints (8)** stipulate that the solution is binary.

c. p-Center Location Problem

p-Center Location Problem is the minimum solution consisting of a set of p points to minimize the maximum distance between the demand point and the nearest point of the set **[25]**. Mathematically, the p-Centre Location Problem model can be written as follows.

$$\text{Minimize } Z_{p-center} = N \tag{9}$$

Subject to

$$\sum_{j\in Q} I_{i,j} = 1, \quad i \in P \tag{10}$$

$$\sum_{j\in Q} K_j = p \tag{11}$$

$$\sum_{j\in Q} d_{i,j} I_{i,j} \leq N, \quad i \in P \tag{12}$$

$$I_{i,j} \leq K_j, \qquad i \in P, j \in Q \tag{13}$$

$$I_{i,j} \in \{0,1\}, \qquad i \in P, j \in Q \tag{14}$$

$$K_j \in \{0,1\}, \qquad j \in Q \tag{15}$$
$$N \geq 0 \tag{16}$$

Definition of notation:

$Z_{p-center}$ = Objective function value of p-Center Location Problem model

$d_{i,j}$ = The distance from the demand location i to facility location j (meter)

Decision variable:

$$K_j = \begin{cases} 1; \text{if the facility is located in the } j \text{ location} \\ 0; \text{if the facility is not located in the } j \text{ location} \end{cases}$$

$$I_{i,j} = \begin{cases} 1; \text{if the demand location } i \text{ is located at facility location } j \\ 0; \text{if the demand location } i \text{ is not located at facility location } j \end{cases}$$

Equation (9) is the objective function in minimizing the maximum distance the demand location will be placed to the nearest open facility. **Constraint (10)** ensures every demand location is fulfilled. **Constraint (11)** indicates the number of facilities to be placed put to p. **Constraint (12)** states that the distance from the demand point to the facility location must be less than the maximum distance. **Constraint (13)** indicates that each demand location can only be placed in an open facility. **Constraints (14)** and **(15)** are binary integer constraints, while **Constraint (16)** indicates that the solution is non-negative.

2.2 Median-Based Problem

A Median-Based Problem is an optimization problem related to distance-based allocation and location problems. In this problem, facilities must be located and assigned to demand points so that each is mapped to one facility, and the weighted distance between all demand points and related facilities is minimized. The model of the Median-Based Problem is the p-Median Problem.

The goal of the p-Median Problem is to find p locations (facilities) among a set of n potential locations, which is the distance from the demand point to the facility location [8]. In short, the p-Median Problem is a facility location problem that determines the optimal location of a fixed number of facilities by minimizing the total cost of serving demand. Mathematically, the p-Median Problem model is formulated as follows.

$$\text{Minimize } Z_{p-Median} = \sum_{i\in P} \sum_{j\in Q} d_{i,j} I_{i,j} \tag{17}$$

Subject to

$$\sum_{j\in Q} I_{i,j} = 1, \forall i \in P \tag{18}$$
$$\sum_{j\in Q} K_j = p \tag{19}$$
$$I_{i,j} \leq K_j, \forall i \in P, \forall j \in Q \tag{20}$$
$$I_{i,j} \in \{0,1\} \tag{21}$$
$$K_j \in \{0,1\}, \quad j \in Q \tag{22}$$

Definition of notation:

$Z_{p-Median}$ = The objective function value of p-Median Problem model

Decision variable:

$$K_j = \begin{cases} 1; \text{if the facility is located in the } j \text{ location} \\ 0; \text{if the facility is not located in the } j \text{ location} \end{cases}$$

$$I_{i,j} = \begin{cases} 1; \text{if the demand location } i \text{ is located at facility location } j \\ 0; \text{if the demand location } i \text{ is not located at facility location } j \end{cases}$$

Equation (17) is the objective function to minimize the distance between the demand point and the nearest allocated facility. **Constraint (18)** shows that each demand point has only one facility. **Constraint (19)** shows that p is the maximum number of facilities. **Constraint (20)** shows that the facility can cover the demand point. **Constraints (21)** and **(22)** are binary integer constraints.

3. RESULTS AND DISCUSSION

3.1 Formulation of the SCLP Model

Formulation of the SCLP model in the Alang-Alang Lebar Sub-District can be seen in **Equation (23)** with **Constraints (24)**-**(52)**.

Minimize $Z_{SCLP} = \sum_{n=1}^{33} K_n$ (23)

Subject to

$K_1 + K_5 + K_6 + K_7 \geq 1$ (24)

$K_2 \geq 1$ (25)

$K_3 + K_4 \geq 1$ (26)

$K_1 + K_5 + K_7 \geq 1$ (27)

$K_1 + K_6 \geq 1$ (28)

$K_1 + K_5 + K_7 + K_8 + K_9 \geq 1$ (29)

$K_7 + K_8 \geq 1$ (30)

$K_7 + K_9 \geq 1$ (31)

$K_{10} \geq 1$ (32)

$K_{11} + K_{12} \geq 1$ (33)

$K_{13} \geq 1$ (34)

$K_{14} \geq 1$ (35)

$K_{15} \geq 1$ (36)

$K_{16} + K_{18} \geq 1$ (37)

$K_{17} \geq 1$ (38)

$K_{19} \geq 1$ (39)

$K_{20} \geq 1$ (40)

$K_{21} \geq 1$ (41)

$K_{22} \geq 1$ (42)

$K_{23} \geq 1$ (43)

$K_{24} \geq 1$ (44)

$K_{25} \geq 1$ (45)

$K_{26} + K_{27} \geq 1$ (46)

$K_{26} + K_{27} + K_{29} \geq 1$ (47)

$K_{28} \geq 1$ (48)

$K_{27} + K_{29} \geq 1$ (49)

$K_{30} \geq 1$ (50)

$K_{31} + K_{32} + K_{33} \geq 1$ (51)

$K_n \in \{0,1\}$ where $n = 1, 2, 3, \ldots, 33$. (52)

Equation (23) states the minimum number of TWDS in the Alang-Alang Lebar Sub-District. **Constraints (24)-(51)** are the constraints for each demand points with distance ≤ 500 meter. **Constraint (52)** shows that each variable must be in 0 or 1 value. The value of 0 means that the TWDS will not be settled in location n where $n = 1, 2, 3, \ldots, 33$. The value of 1 means otherwise.

Table 4 presents the optimal solution of the SCLP model, obtained using the LINGO 13.0 application. The Solver Status, Model Class, indicates that the solution is Pure Integer Linear Programming (PILP), which signifies that the model is pure integer programming. The state field shows that the resulting solution is globally optimal, with the objective function value being 22. The infeasibility value is 0, indicating that the equation with multiple constraints has produced a feasible solution. The iteration value is 0, indicating that there have been no iterations. The extender solver status shows that the solver type is branch and bound, obtained from the optimal solution of 22 with an interval of 2, Generated Memory Unit (GMU) of 29K, and Elapsed Runtime (ER) of 0 seconds.

Based on **Table 4**, the optimal solutions are $K_1 = K_2 = K_4 = K_7 = K_{10} = K_{12} = K_{13} = K_{14} = K_{15} = K_{17} = K_{18} = K_{19} = K_{20} = K_{21} = K_{22} = K_{23} = K_{24} = K_{25} = K_{27} = K_{28} = K_{30} = K_{33}$, which means there are 22 candidate locations, which can be seen in **Table 5**.

Table 4. **Optimal Solution of the SCLP Model**

Solver Status	
Model Class	PILP
State	Global Optimal
Objective	22
Infeasibility	0
Iteration	0
Extended Solver Status	
Solver Type	Branch and Bound
Best Objective	22
Objective Bound	22
Steps	0
Active	0
Update Interval	2
GMU (K)	29
ER (sec)	0

Table 5. **Optimal TWDS Based on the SCLP Model**

No	Optimal TWDS
1	TWDS Peristiwa Street and Surroundings
2	TWDS Srijaya Street around Bala Putra Dewa Museum
3	TWDS Pulai Street
4	TWDS Taman Sari Street near LRT RSUD Prov. Sumsel Station
5	TWDS M. Husin Street
6	TWDS Raflesia Raya Street and Surroundings
7	TWDS Pancasila Street
8	TWDS Kolonel Sulaiman Amin Street
9	TWDS Pengadilan Tinggi Street
10	TWDS Rama Raya Street
11	TWDS Beside Soekarno Hatta Street
12	TWDS Kolonel Sulaiman Amin around Pemda Jamik Al Muhajirin Complex
13	TWDS Bungur Raya Street (behind Maskarebet Hall)
14	TWDS Talang Kelapa Ujung
15	TWDS PMD Talang Kelapa Street Right and Left
16	TWDS Lebung Permai Street (Around Griya Interbiz Housing)
17	TWDS SMA Negeri 22 Palembang
18	TWDS Hasanudin (Near Griya Hero Housing and Surroundings)
19	TWDS Musholah Street
20	TWDS Jepang Street
21	TWDS Bumi Mas Street
22	TWDS KM 12 Alang - Alang Lebar Bus Station

3.2 Formulation of the MCLP Model

This stage formulates the MCLP model using data on TWDS in the Alang-Alang Lebar Sub-District. This MCLP formulation maximizes the demand point with a specified coverage distance. Table 6 lists variable definitions and demand points in the Alang-Alang Lebar Sub-District.

Soekarno Hatta Street. The -Center Location Problem and -Median Problem models can determine the optimal TWDS to the nearest demand place. The mapping of the optimal location of TWDS for each village in the Alang-Alang Lebar Sub-District can be seen in **Figure 1**.

Figure 1. Optimal location of TWDS in the Alang-Alang Lebar Sub-District

Figure 1 shows the map of the optimal TWDS based on villages in the Alang-Alang Lebar Sub-District. The optimal TWDS in Srijaya Village is TWDS Pramuka 2 Street and Surroundings. The optimal TWDS in Karya Baru Village is TWDS Kolonel Sulaiman Amin Street. The Optimal TWDS in Talang Kelapa Village is TWDS Talang Kelapa Ujung, and the last TWDS beside Soekareno Hatta Street is the optimal TWDS in Alang-Alang Lebar Village.

4. CONCLUSIONS

The results and discussion of determining the optimal TWDS in the Alang-Alang Lebar Sub-District of Palembang City with the SCLP, MCLP, -Center Location Problem, and -Median Problem models have led to the following conclusions:

1. The SCLP model produces 22 optimal TWDS, as shown in **Table 5**.
2. The MCLP model produces 22 optimal TWDS, as shown in **Table 8**.
3. The -Center Location Problem and -Median Problem models produce the same 4 optimal TWDS: TWDS Pramuka 2 Street and Surroundings, TWDS Kolonel Sulaiman Amin Street, TWDS Talang Kelapa Ujung, and TWDS beside Soekarno Hatta Street. This research proposes the solution of the -Centre Location Problem and -Median Problem models.

The formulation of the -Centre Location Problem and -Median Problem models is highly dependent on the solutions of the SCLP and MCLP models. Therefore, for further research, it is necessary to develop a model that can provide solutions in the form of additional TWDS in each neighborhood to cover all demand areas.

REFERENCES

[1] *UU RI No 18 Tahun 2008 Tentang Pengelolaan Sampah*. 2008.

[2] S. Andaryani, I. Utami, and D. Rusdi, "Pelaksanaan pengolahan sampah pada Dinas Lingkungan Hidup dan Kebersihan Kota Palembang," *PUBLIKA J. lmu Adm. Publik*, vol. 9, no. 1, pp. 47–58, 2023, doi: 10.25299/jiap.2023.vol9(1).12551.

[3] S. Octarina, F. M. Puspita, S. S. Supadi, and N. A. Eliza, "Greedy reduction algorithm as the heuristic approach in determining the temporary waste disposal sites in Sukarami Sub-District, Palembang, Indonesia," *Sci. Technol. Indones.*, vol. 7, no. 4, pp. 469–480, 2022, doi: 10.26554/sti.2022.7.4.469-480.

[4] Ramadhani and I. Iskandar, "Waste management sites - Reduce, Reuse, and Recycle (TPS3R) construction study in Sekanak Area, Palembang City," *Int. J. Eng. Appl. Sci. Technol.*, vol. 7, no. 2, pp. 16–23, 2022, doi: 10.33564/ijeast.2022.v07i02.003.

[5] R. Nirmalasari, P. Syafitri, M. D. Irawan, N. Fajar, and R. Haryanto, "Pengadaan Tempat Pembuangan Sampah Sementara (TPS) Sebagai Upaya Mewujudkan Kampung Bersih," *Surya Abdimas*, vol. 6, no. 4, pp. 709–717, 2022.

[6] P. B. J. Bangun, S. Octarina, R. Aniza, L. Hanum, F. M. Puspita, and S. S. Supadi, "Set covering model using greedy heuristic algorithm to determine the temporary waste disposal sites in Palembang," *Sci. Technol. Indones.*, vol. 7, no. 1, pp. 98–105, 2022.

[7] N. Adelgren and A. Gupte, "Branch-and-bound for biobjective mixed integer programming," 2020. [Online]. Available: http://arxiv.org/abs/1709.03668.

[8] S. Octarina, F. M. Puspita, S. S. Supadi, R. Afrilia, and E. Yuliza, "Set covering location problem and p-median problem model in determining the optimal temporary waste disposal sites location in Seberang Ulu I sub-district Palembang," in *AIP Conference Proceedings*, 2022, pp. 1–10.

[9] G. Bergantiños, M. Gómez-Rúa, N. Llorca, M. Pulido, and J. Sánchez-Soriano, "Allocating costs in set covering problems," *Eur. J. Oper. Res.*, vol. 284, no. 3, pp. 1074–1087, 2020, doi: 10.1016/j.ejor.2020.01.031.

[10] A. Ahmadi-Javid, P. Seyedi, and S. S. Syam, "A survey of healthcare facility location," *Comput. Oper. Res.*, vol. 79, pp. 223–263, 2017, doi: 10.1016/j.cor.2016.05.018.

[11] S. Octarina, F. M. Puspita, and S. S. Supadi, "Models and heuristic algorithms for solving discrete location problems of temporary disposal places in Palembang City," *IAENG Int. J. Appl. Math.*, vol. 52, no. 2, pp. 1–11, 2022.

[12] C. Filippi, G. Guastaroba, D. L. Huerta-Muñoz, and M. G. Speranza, "A kernel search heuristic for a fair facility location problem," *Comput. Oper. Res.*, vol. 132, no. April, pp. 1–17, 2021, doi: 10.1016/j.cor.2021.105292.

[13] Y. S. Kwon, B. K. Lee, and S. Y. Sohn, "Optimal location-allocation model for the installation of rooftop sports facilities in metropolitan areas," *Eur. Sport Manag. Q.*, vol. 20, no. 2, pp. 189–204, 2020, doi: 10.1080/16184742.2019.1598454.

[14] A. Vaezihir, F. Safari, M. Tabarmayeh, and A. A. Khalafi, "Application of MCLP and LINGO methods to optimal design of groundwater monitoring network in an oil refinery site," *J. Hydroinformatics*, vol. 23, no. 4, pp. 813–830, 2021, doi: 10.2166/hydro.2021.172.

[15] X. Liu, Y. Fang, J. Chen, Z. Su, C. Li, and Z. Lu, "Effective approaches to solve p-center problem via set covering and SAT," *IEEE Access*, vol. 8, pp. 161232–161244, 2020, doi: 10.1109/ACCESS.2020.3018618.

[16] I. Espejo, R. Páez, J. Puerto, and A. M. Rodríguez-Chía, "Facility location problems on graphs with non-convex neighborhoods," *Comput. Oper. Res.*, vol. 159, no. June, pp. 1–14, 2023, doi: 10.1016/j.cor.2023.106356.

[17] R. Sitepu, F. M. Puspita, I. Lestari, E. Yuliza, and S. Octarina, "Facility location problem of dynamic optimal location of hospital emergency department in Palembang," *Sci. Technol. Indones.*, vol. 7, no. 2, pp. 251–256, 2022.

[18] J. F. Cordeau, F. Furini, and I. Ljubić, "Benders decomposition for very large scale partial set covering and maximal covering location problems," *Eur. J. Oper. Res.*, vol. 275, no. 3, pp. 882–896, 2019, doi: 10.1016/j.ejor.2018.12.021.

[19] H. Wibowo, M. Anggraini, and R. Y. Aldino, "Pemodelan set covering problem dalam penentuan lokasi halte bus rapid transit (BRT) pada koridor rajabasa-sukaraja di kota Bandar Lampung," *Spektrum Ind.*, vol. 16, pp. 1–8, 2018.

[20] B. S. Vieira *et al.*, "A progressive hybrid set covering based algorithm for the traffic counting location problem," *Expert Syst. Appl.*, vol. 160, pp. 1–10, 2020, doi: 10.1016/j.eswa.2020.113641.

[21] N. Kinsht and N. Petrunko, "Multiple partial discharge diagnostics as set covering problem," *Proc. - 2020 Int. Russ. Autom. Conf. RusAutoCon 2020*, pp. 777–781, 2020, doi: 10.1109/RusAutoCon49822.2020.9208219.

[22] Q. Xu and J. Li, "The relationship between the unicost set covering problem and the attribute reduction problem in rough set theory," *Math. Probl. Eng.*, vol. 2020, pp. 22–25, 2020, doi: 10.1155/2020/5359691.

[23] D. Idayani, Y. Puspitasari, and L. D. Ka. Sari, "Penggunaan model set covering problem dalam penentuan lokasi dan jumlah pos pemadam kebakaran," *J. Ilm. Edukasi Mat. SOULMATH*, vol. 8, no. 2, pp. 139–152, 2020.

[24] R. Sitepu, F. M. Puspita, I. S. Ariani, Indrawati, E. Yuliza, and S. Octarina, "Robust set cover problem in determining the optimal location of emergency units in Palembang city with unknown distance," in *AIP Conference Proceedings*, 2023, pp. 1–6.

[25] S. Octarina *et al.*, "Determining the best location for COVID-19 vaccine distribution in Palembang using the set covering problem model and greedy heuristic algorithm," *Int. J. Sci. Soc.*, vol. 6, no. 1, pp. 389–403, 2024.