RESEARCH ARTICLE | JULY 13 2022

Preface: The 6th National Conference on Mathematics and Mathematics Education (SENATIK)

AIP Conference Proceedings 2577, 010001 (2022)
https://doi.org/10.1063/12.0010270

Preface: The 6th National Conference on Mathematics and Mathematics Education (SENATIK)

The 6th National Conference on Mathematics and Mathematics Education (SENATIK) was held by Mathematics Education Study Program, Universitas PGRI Semarang, Indonesia, in 11 August 2021. The seminar theme is Numerize and Digitaze of Mathematics Toward Freedom of Learning. According to the theme, this seminar aims to improve mathematics teaching, solve mathematics problems, and expand mathematics contribution to society.

Freedom of learning is a policy implemented by the Indonesian Ministry of Education and Culture. Freedom learning encourages students to master literacy, numeracy, and character. Numeration is one of the ways to make mathematics easy. At the same time, it provides opportunities for students to collaborate, has critical thinking, creative thinking, communication, good character, and face the challenges of an increasingly global world with advances in science and technology. Having numeracy skills will impact good thinking patterns and habits associated with numbers or calculations with existing problems.

Along with the freedom learning program development during the COVID-19 pandemic, it is very clear that technological developments have a high impact on the education world. This impact also occurs in the learning process, especially in accessing information as a learning resource, both online and offline learning. The availability of abundant information and easily accessible also causes learning to experience a digitization process. The era of digitalization brings challenges as well as opportunities in the world of education. There is an opportunity to integrate technology into the learning process so that learning outcomes are more effective. The integration of technology in the learning process results in digitization in the education world, especially in the learning process. The findings that were discussed in the seminar: In mathematics learning and problem-solving, teachers and students need technology. Integration of mathematics and technology is a crucial process.

There are 151 manuscripts through the peer-review and end up with 76 papers which are published in this AIP Conference Proceeding. Together with the keynote speakers and the presenters, they shared their research results on different fields in the plenary and parallel sessions attended by more than 300 participants.

We want to thank the keynote speakers; 1) Prof. Helia Jacinto, Ph. D. (University of Lisbon, Portugal); 2) Dr. Rully Charitas Indra Prahmana, S.Si., M.Pd. (Universitas Ahmad Dahlan, Indonesia), and; 3) Dr. Muhtarom, M.Pd. (Universitas PGRI Semarang, Indonesia). Many thanks go as well to the speakers in the workshop session that are Sutrisno, S.Pd., M.Pd. (Universitas PGRI Semarang, Indonesia) and Dr. Muhtarom, M.Pd (Universitas PGRI Semarang, Indonesia). We also would like to thank all the committee for arranging this conference.

The conference's success is achieved due to the support and commitment of many people, and we acknowledge their contribution, especially all the participants and presenters. For all participants and presenters, we hope they enjoy the seminar, so they are valuable, rewarding and improving their knowledge and experiences.

Thank you,

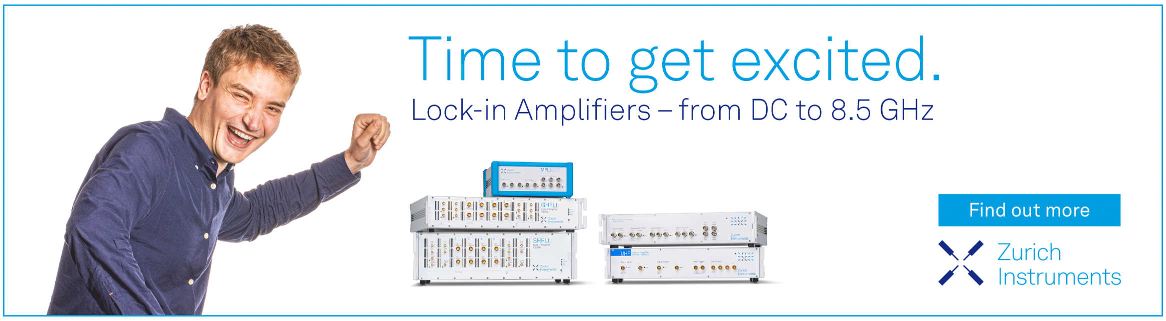
Dr. Widya Kusumaningsih, M. Pd.
Chairman The 6th National Conference on Mathematics and Mathematics Education
SENATIK
2021

Proceedings of the 6th National Conference on Mathematics and Mathematics Education
AIP Conf. Proc. 2577, 010001-1–010001-1; https://doi.org/10.1063/12.0010270
Published by AIP Publishing. 978-0-7354-4360-0/$30.00

RESEARCH ARTICLE | JULY 13 2022

Committee: The 6th National Conference on Mathematics and Mathematics Education (SENATIK)

AIP Conference Proceedings 2577, 010002 (2022)
https://doi.org/10.1063/12.0012581



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Proceedings of the 6th National Conference on Mathematics and Mathematics Education
AIP Conf. Proc. 2577, 010002-1–010002-1; https://doi.org/10.1063/12.0012581
Published by AIP Publishing. 978-0-7354-4360-0/$30.00

pubs.aip.org/aip/acp/issue/2577/1

Abstract View article PDF

Volume 2577, Issue 1

13 July 2022
All Issues

In this Issue

PRELIMINARY

MATHEMATICS

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

Cite as: AIP Conference Proceedings **2577**, 020046 (2022); https://doi.org/10.1063/5.0096034
Published Online: 13 July 2022

Sisca Octarina, Fitri Maya Puspita, Siti Suzlin Supadi, et al.

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

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Abstract. The growing population also increases the amount of waste. The temporary waste disposal site (TWDS) location in Palembang is irregular, so it is necessary to optimize the TWDS location. The number of existing TWDS does not match the population's needs. Seberang Ulu I sub-district is one of the sub-districts with the most populous population in Palembang. This study formulates the Set Covering Location Problem model and the p-median problem model to determine the TWDS locations in Seberang Ulu I sub-district. The formulated model is then solved using Lingo 18.0 software and a Genetic Algorithm. We analyze the optimal solutions of the two applications. Seberang Ulu I sub-district consists of 16 TWDS. Based on the result and discussion, there are 12 optimal TWDS in Seberang Ulu I sub-district. This study recommends adding TWDS in Seberang Ulu I sub-district, including 1 TWDS in 7 Ulu village, 2 TWDS in 5 Ulu village, 2 TWDS in 2 Ulu village, and 3 TWDS in 1 Ulu village.

INTRODUCTION

Set Covering Problem (SCP) is a part of an optimization problem modeled in Integer Linear Programming. In general, SCP is used to determine how many facilities and locations cover a particular area [1]. SCP aims to minimize the number of service facility locations but can serve all demand points [2]. SCP can be found in everyday life, for example, determining the bus stop location, the number, and location of fire stations, the hospitals or clinics location, etc. SCP consists of several types, including Set Covering Location Problem (SCLP), Maximum Covering Location Problem (MCLP), p-Center Location Problem, and p-Median Problem [3]. SCLP aims to minimize the number of facilities established to serve all demand points [4]. In contrast, the p-Median problem minimizes the average distance between service facility location and demand points [5]. SCLP can be solved by using an interconnected model or a suitable method.

Several previous studies regarding location determination using the SCP model have been carried out. Šarac *et al*. [6] used an approach based on population criteria and the SCLP model in determining the minimum number of

AIP Conf. Proc. 2577, 020046-1–020046-10; https://doi.org/10.1063/5.0096034
Published by AIP Publishing. 978-0-7354-4360-0/$30.00

post offices in Serbian cities. Sitepu *et al*. [2] formulated a covered-based model in optimizing the Hospital Emergency Unit in Palembang. The study found five emergency locations that can serve eight sub-districts in Palembang. Idayani *et al.* [7] used the SCP model in determining the fire station's location in the Sidoarjo Regency. They succeeded in determining six locations of fire stations to be built in Sidoarjo Regency with 17 potential sites. Puspita *et al.* [8] optimized TWDS in the Kemuning sub-district using the Greedy Reduction Algorithm (GRA) and allocated three locations to serve six villages in the Kemuning sub-district. Furthermore, Wibowo *et al.* [9] used SCP modeling to determine the Bus Rapid Transit (BRT) stops on the Rajabasa-Sukaraja corridor in Bandar Lampung and decided 19 bus stops locations along the Rajabasa-Sukaraja route with 53 potential sites.

There are several heuristic methods to solve SCP [10][11][12][13][14]. The Genetic Algorithm is known as an evaluation algorithm. Based on Darwin's evaluation, good traits will survive and form new traits [15]. The Genetic Algorithm is implemented in a computer simulation where a new population is generated by optimizing the problem from the initial population. Genetic algorithms can be applied in everyday life, such as determining airline tickets, choosing to lodge, choosing a car when you want to go on vacation, or optimizing population services [16]. According to [17], Genetic algorithms can optimize complex problems and vast search space.

Previous research on genetic algorithms has been carried out by Krisnandi and Agung [18], who implemented the Genetic algorithm and succeeded in determining the cost and time predictions of the project with a 98.72% accuracy percentage. Pane *et al.* [19] implemented a Genetic algorithm for optimizing population services and determined scheduling with a structured room time faster and more accurately than the manual scheduling process, thus creating a more structured schedule. Paranduk *et al.* [17] discussed the course scheduling information system using a web-based genetic algorithm. They produced 35 optimal solutions from 100 chromosomes with a mutation rate of 0.75, a probability mutation of 0.40, and 10,000 generations. Another research was done by Guo [20], who discussed the network location model distribution with linear constraints based on genetic algorithms. This research results can reduce 37.6% of an average daily fuel cost and optimize transportation distances and fuel costs. Mettawa *et al.* [21] used Genetic algorithms to optimize bank loan decisions by successfully reducing loan inspection times in the range of 12% to 50% and increasing bank profits by 3.9% to 8.1%.

There have been limited studies concerned with the application of Genetic algorithms in solving the SCP model. Therefore, this study formulated the SCLP model, p-Median problem, and applied the Genetic algorithm to determine the optimal TWDS locations in Seberang Ulu I sub-district. The solution obtained is expected to optimize TWDS locations to serve all Seberang Ulu I sub-district demand locations.

METHOD

The first step taken in this research was describing the number of TWDS and villages in the Seberang Ulu I sub-district. We also measured the distance between the TWDS in Seberang Ulu I sub-district. Then, define the variables and parameters for the SCLP model and the p-Median Problem in Seberang Ulu I sub-district. All variables and parameters are used to formulate the SCP model, namely, SCLP and p-Median Problem. SCP model was solved by using the Lingo 18.0 software and the Genetic algorithms. At the final step, we analyze the final results obtained and make the conclusions.

RESULT AND DISCUSSION

This section explains the Genetic algorithm, the SCLP model, the p-Median problem, and the implementation of the Genetic algorithm in solving the p-Median Problem model.

The Genetic Algorithm

The first stage in the Genetic algorithm is to evaluate the fitness value of each individual based on the given objective function. The crossover process is a crossbreeding or gene exchange between two individuals to produce new individuals. The next stage of the process is a mutation, which changes the value of genes in an individual. The Genetic algorithm process continues to determine the new generation according to the objective function.

This study states that one individual consists of one chromosome, namely the TWDS in Seberang Ulu I sub-district, Palembang. Chromosomes in each individual are composed of several value genes. Genes can be integer, float, binary, character, or combinatorial values. Values contained in one gene are called alleles. The population starts by initializing some individuals. Each individual is a collection of genes called chromosomes. The Genetic algorithm is arranged with columns and rows to form a matrix containing binary numbers. Matrix rows in the Genetic algorithm are known as chromosomes, while the number of columns is known as the number of genes. The number of genes is the multiplication of the Nvar value (the number of variables) with the N-bit value (the number of bits). In contrast, the number of rows in a matrix is referred to as UkPop (population size) [22].

The fitness value measures whether or not a solution is expressed as an individual on an existing problem. The fitness value can be used as a reference in achieving the optimal solution [23]. The Genetic algorithm aims to find individuals with the highest (for the maximization case) or the lowest (for the minimization case) fitness value. The better the fitness value of an individual, the more likely that individual will survive and continue to the next generation. In this study, the Genetic algorithm aims to find individuals or chromosomes with the minimum fitness value. The fitness value of each chromosome can be calculated based on Equation (1).

$$\text{fitness value} = \sum_{j=1}^{n} s_{ij} c_j \tag{1}$$

where

s_{ij} = the binary value of the j^{th} column in the i^{th} chromosome

c_j = the distance value of the j^{th} column 081369099088

Selection is used to select individuals to be used in the interbreeding and mutation. The higher the fitness value of an individual (maximum case), the more likely it is to be selected, or the smaller the fitness value of an individual (minimum case), the more likely it is to be chosen. The first step in the selection is finding the fitness value, which will be used in the following stages.

In this study, the selection method used is roulette wheel selection, where the individual or parent is selected based on their fitness value. The steps for the roulette wheel selection process are as follows:

a. Calculate the relative fitness value p_i with Equation (2).

$$p_i = \frac{\text{fitness value (i)}}{\text{total of fitness value}} \tag{2}$$

b. Calculate the cumulative fitness value p_i with Equation (3)

$$q_i = q_{(i-1)} + p_i \tag{3}$$

c. Generate random numbers in [0, 1] as much as the population size in the problem. Then select the i^{th} chromosome as the surviving chromosome using the rule in Inequalities (4).

$$q_{(i-1)} \leq r_i \leq p_i \tag{4}$$

The better the quality of a chromosome, the greater the chance of being selected as parents in the following process, namely crossover.

Crossover aims to find new values, combining two or more chromosomes to become a new chromosome. We exchange genetic information on the parent chromosome to replace some traits or characteristics on the resulting new chromosome [24]. In this study, the method used for the crossbreeding process is the one-point crossover method. This method uses the crossover probability (PC). This study uses 0.25, then generates a random number (r) at [0, 1] and compares it with the PC value. If the r on the chromosome is less than the PC value, then the chromosome will be crossed. Then, to select the position to be crossed, the process of crossing is done by generating random numbers from 1 to n (chromosome length).

Mutations aim to get a new chromosome with the best fitness value by replacing one or several genes from the selected parent or parent chromosome. Mutation probability is used to determine the rate of mutation that occurs. A high mutation rate will cause the offspring to be more similar to the parent. A good mutation probability is in the range 0.01 – 0.3 [25]. The first step is to count the number of genes by multiplying the population size by the length of the chromosome. The mutation probability (PM) in this study uses 0.01, then generates at [0,1] as many as the number of genes. Genes with a random number value (r) smaller than the predetermined PM value will undergo a mutation process.

The Set Covering Location Problem Model

Data of TWDS in Seberang Ulu I sub-district was obtained from the Palembang City Environment and Hygiene Service (DLHK). The definition of the variables can be seen in Table 1.

TABLE 1. Definition of each variable of TWDS.

Variable	Name of TWDS
s_1	TWDS 10 Ulu Market
s_2	TWDS Inside Al-Faktur Akbar Mosque
s_3	TWDS Beside DPRD City Building
s_4	TWDS Before Jakabaring Flyover
s_5	TWDS Opposite Bungaran Fuel Station
s_6	TWDS Infront of Alfamart (Before Tugu KB)
s_7	TWDS Infront of Panca Usaha
s_8	TWDS Opposite Panca Usaha Street (Infront of Panglong)
s_9	TWDS In front of Camat SU. I Office
s_{10}	TWDS Beside PBK 3/4 Ulu Office
s_{11}	TWDS 3/4 Ulu Market
s_{12}	TWDS 2 Ulu Market
s_{13}	TWDS Infront of Muhajirin 2 Ulu Mosque
s_{14}	TWDS 1 Ulu Laut Street
s_{15}	TWDS KH. Wahid Hasyim (PT. ALI) Street
s_{16}	TWDS Beside Sekta SU. I

Each variable states the name of TWDS and is denoted by $x_j, j = 1,2,3,...,16$. Seberang Ulu I sub-district consists of 5 villages, which are shown in Table 2. According to the DLHK of Palembang and the Regulation of the Minister of Public Works of the Republic of Indonesia Number 03/PRT/M/2013, Article 32 states the optimal distance required between one TWDS to another TPS is 500 m. Table 3 shows the distance (in meters) between each TWDS.

TABLE 2. Definition of each variable of village.

Variable	Name of Village
t_1	7 Ulu
t_2	5 Ulu
t_3	3/4 Ulu
t_4	2 Ulu
t_5	1 Ulu

TABLE 3. The distance between each TWDS.

d_{ij}	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	0	950	1200	1300	1350	1450	2000	2100	2300	2350	2000	2000	2750	3300	3050	2350
2	950	0	350	950	750	700	2200	1200	2500	2500	2700	3100	3100	3000	2650	2250
3	1200	350	0	800	950	900	2400	1400	2300	2300	2500	3300	2900	2800	2450	2050
4	1300	950	800	0	1700	1700	3100	2200	2100	2100	2300	3100	2700	2600	2250	1850
5	1350	750	950	1700	0	50	600	1600	1500	1700	1700	2400	2300	2000	1700	1250
6	1450	700	900	1700	50	0	550	1500	1500	1400	1700	2400	2200	1900	1650	1250
7	2000	2200	2400	3100	600	550	0	960	950	900	1100	1900	1700	1400	1050	700
8	2100	1200	1400	2200	1600	1500	960	0	2000	2000	2200	2600	2800	2500	2150	1750
9	2300	2500	2300	2100	1500	1500	950	2000	0	60	210	950	1100	3900	850	2050
10	2350	2500	2300	2100	1700	1400	900	2000	60	0	240	1000	1200	3900	800	2050
11	2000	2700	2500	2300	1700	1700	1100	2200	210	240	0	750	1400	2300	2650	2250
12	2000	3100	3300	3100	2400	2400	1900	2600	950	1000	750	0	700	1500	1950	2650
13	2750	3100	2900	2700	2300	2200	1700	2800	1100	1200	1400	700	0	3800	850	1050
14	3300	3000	2800	2600	2000	1900	1400	2500	3900	3900	2300	1500	3800	0	1550	3650
15	3050	2650	2450	2250	1700	1650	1050	2150	850	800	2650	1950	850	1550	0	600
16	2350	2250	2050	1850	1250	1250	700	1750	2050	2050	2250	2650	1050	3650	600	0

The SCLP model is used to optimize the number of TWDS in Seberang Ulu I sub-district but can serve all demand points. The SCLP model is shown in Equation (5) and Constraints (6) to (18).

Minimize

$$Z_{SLCP} = s_1 + s_2 + s_3 + s_4 + s_5 + s_6 + s_7 + s_8 + s_9 + s_{10} + s_{11} + s_{12} + s_{13} + s_{14} + s_{15} + s_{16} \tag{5}$$

Subject to

$$s_1 \geq 1 \tag{6}$$

$$s_2 + s_3 \geq 1 \tag{7}$$

$$s_4 \geq 1 \tag{8}$$

$$s_5 + s_6 \geq 1 \tag{9}$$

$$s_7 \geq 1 \tag{10}$$

$$s_8 \geq 1 \tag{11}$$

$$s_9 + s_{10} + s_{11} \geq 1 \tag{12}$$

$$s_{12} \geq 1 \tag{13}$$

$$s_{13} \geq 1 \tag{14}$$

$$s_{14} \geq 1 \tag{15}$$

$$s_{15} \geq 1 \tag{16}$$

$$s_{16} \geq 1 \tag{17}$$

$$s_1, s_2, s_3, s_4, s_5, s_6, s_7, s_8, s_9, s_{10}, s_{11}, s_{12}, s_{13}, s_{14}, s_{15}, s_{16} \geq 0 \text{ and integer} \tag{18}$$

The objective function (5) aims to minimize the location of the required facilities to cover all demand points. Constraints (6) to (17) ensure that at least one facility can cover each demand point. Constraint (18) states that each variable must be non-negative and integer. The solution of model (5) with Constraints (6) to (18) is $Z_{SLCP} = 12$ with the optimal solutions $s_1 = s_2 = s_3 = s_4 = s_5 = s_6 = s_7 = s_8 = s_9 = s_{10} = s_{11} = s_{12} = s_{13} = s_{14} = s_{15} = s_{16} = 1$, which means that the candidate of TWDS is TWDS 10 Ulu Market, TWDS Beside DPRD City Building, TWDS Before Jakabaring Flyover, TWDS Infront of Alfamart (Before Tugu KB), TWDS Infront of Panca Usaha, TWDS Opposite Panca Usaha

Street (Infront of Panglong), TWDS 3/4 Ulu Market, TWDS 2 Ulu Market, TWDS Infront of Muhajirin 2 Ulu Mosque, TWDS 1 Ulu Laut Street, TWDS KH. Wahid Hasyim (PT. ALI) Street, and TWDS Beside Sekta SU. I.

The p-Median Problem Model

The p-Median Problem model uses data on the optimal TWDS location from the SCLP model and the demand location of village services in Seberang Ulu I District. The optimal TWDS is denoted by j, and the request location is denoted by i. Based on the results obtained from the SCLP model, the optimal TPS locations are as shown in Table 4. The demand point uses the village locations in Table 2. The p-Median Problem model is formulated to minimize the average distance between the demand location point and the closest facility location point. The model is as shown in Equation (19) to Equation (39). The distance data from the facility point to the demand point is shown in Table 5.

TABLE 4. The optimal TWDS from the SCLP model.

Variable	Name of TWDS
s_1	TWDS 10 Ulu Market
s_3	TWDS Beside DPRD City Building
s_4	TWDS Before Jakabaring Flyover
s_6	TWDS Infront of Alfamart (Before Tugu KB)
s_7	TWDS Infront of Panca Usaha
s_8	TWDS Opposite Panca Usaha Street (Infront of Panglong)
s_9	TWDS Beside PBK 3/4 Ulu Office
s_{10}	TWDS 2 Ulu Market
s_{11}	TWDS Infront of Muhajirin 2 Ulu Mosque
s_{12}	TWDS 1 Ulu Laut Street
s_{13}	TWDS KH. Wahid Hasyim (PT.ALI) Street
s_{14}	TWDS Beside Sekta SU. I

TABLE 5. The distance between the village and the optimal TWDS from the SCLP model.

d_{ij}	1	3	4	6	7	8	11	12	13	14	15	16
1	500	1200	1100	1400	1500	1900	1800	1800	2500	3200	2800	2150
2	2100	1500	1100	700	500	1200	1600	2400	2200	2500	2100	1300
3	2200	2800	3300	2600	2100	1500	950	210	1300	1600	2000	1300
4	3600	2900	2800	2100	1600	1500	1600	2400	650	750	600	1250
5	3000	2300	3100	2600	2000	950	1100	1800	750	350	50	750

Minimize

$$Z_{P\text{-}Median} = 500t_{1,1} + 1200t_{1,3} + 1100t_{1,4} + 1400t_{1,6} + 1500t_{1,7} + 1900t1_{,8} + 1800t_{1,11} + 1800t_{1,12} + 2500t_{1,13} + 3200t_{1,14} + 2800t_{1,15} + 2150t_{1,16} + 2100t_{2,1} + 1500t_{2,3} + 1100t_{2,4} + 700t_{2,6} + 500t_{2,7} + 1200t_{2,8} + 1600t_{2,11} + 2400t_{2,12} + 2200t_{2,13} + 2500t_{2,14} + 2100t_{2,15} + 1300t_{2,16} + 2200t_{3,1} + 2800t_{3,3} + 3300t_{3,4} + 2600t_{3,6} + 2100t_{3,7} + 1500t_{3,8} + 950t_{3,11} + 210t_{3,12} + 1300t_{3,13} + 1600t_{3,14} + 2000t_{3,15} + 1300t_{3,16} + 3600t_{4,1} + 2900t_{4,3} + 2800t_{4,4} + 2100t_{4,6} + 1600t_{4,7} + 1500t_{4,8} + 1600t_{4,11} + 2400t_{4,12} + 650t_{4,13} + 750t_{4,14} + 600t_{4,15} + 1250t_{4,16} + 3000t_{5,1} + 2300t_{5,3} + 3100t_{5,4} + 2600t_{5,6} + 2000t_{5,7} + 950t_{5,8} + 1100t_{5,11} + 1800t_{5,12} + 750t_{5,13} + 350t_{5,14} + 50t_{5,15} + 750t_{5,16} \quad (19)$$

Subject to

$$t_{1,1} + t_{1,3} + t_{1,4} + t_{1,6} + t_{1,7} + t_{1,8} + t_{1,11} + t_{1,12} + t_{1,13} + t_{1,14} + t_{1,15} + t_{1,16} = 1 \quad (20)$$

$$t_{2,1} + t_{2,3} + t_{2,4} + t_{2,6} + t_{2,7} + t_{2,8} + t_{2,11} + t_{2,12} + t_{2,13} + t_{2,14} + t_{2,15} + t_{2,16} = 1 \quad (21)$$

$$t_{3,1}+t_{3,3}+t_{3,4}+t_{3,6}+t_{3,7}+t_{3,8}+t_{3,11}+t_{3,12}+t_{3,13}+t_{3,14}+t_{3,15}+t_{3,16}=1 \quad (22)$$

$$t_{4,1}+t_{4,3}+t_{4,4}+t_{4,6}+t_{4,7}+t_{4,8}+t_{4,11}+t_{4,12}+t_{4,13}+t_{4,14}+t_{4,15}+t_{4,16}=1 \quad (23)$$

$$t_{5,1}+t_{5,3}+t_{5,4}+t_{5,6}+t_{5,7}+t_{5,8}+t_{5,11}+t_{5,12}+t_{5,13}+t_{5,14}+t_{5,15}+t_{5,16}=1 \quad (24)$$

$$s_1+s_3+s_4+s_6+s_7+s_8+s_{11}+s_{12}+s_{13}+s_{14}+s_{15}+s_{16}=12 \quad (25)$$

$$t_{1,1},t_{2,1},t_{3,1},t_{4,1},t_{5,1}\le s_1 \quad (26)$$

$$t_{1,3},t_{2,3},t_{3,3},t_{4,3},t_{5,3}\le s_3 \quad (27)$$

$$t_{1,4},t_{2,4},t_{3,4},t_{4,4},t_{5,4}\le s_4 \quad (28)$$

$$t_{1,6},t_{2,6},t_{3,6},t_{4,6},t_{5,6}\le s_6 \quad (29)$$

$$t_{1,7},t_{2,7},t_{3,7},t_{4,7},t_{5,7}\le s_7 \quad (30)$$

$$t_{1,8},t_{2,8},t_{3,8},t_{4,8},t_{5,8}\le s_8 \quad (31)$$

$$t_{1,11},t_{2,11},t_{3,11},t_{4,11},t_{5,11}\le s_{11} \quad (32)$$

$$t_{1,12},t_{2,12},t_{3,12},t_{4,12},t_{5,12}\le s_{12} \quad (33)$$

$$t_{1,13},t_{2,13},t_{3,13},t_{4,13},t_{5,13}\le s_{13} \quad (34)$$

$$t_{1,14},t_{2,14},t_{3,14},t_{4,14},t_{5,14}\le s_{14} \quad (35)$$

$$t_{1,15},t_{2,15},t_{3,15},t_{4,15},t_{5,15}\le s_{15} \quad (36)$$

$$t_{1,16},t_{2,16},t_{3,16},t_{4,16},t_{5,16}\le s_{16} \quad (37)$$

$$t_{1,1},t_{2,1},t_{3,1},t_{4,1},t_{5,1},t_{1,3},t_{2,3},t_{3,3},t_{4,3},t_{5,3},t_{1,4},t_{2,4},t_{3,4},t_{4,4},t_{5,4},t_{1,6},t_{2,6},t_{3,6},t_{4,6},t_{5,6},t_{1,7},t_{2,7},t_{3,7},t_{4,7},t_{5,7},t_{1,8},t_{2,8},t_{3,8},t_{4,8},t_{5,8},t_{1,11},$$
$$t_{2,11},t_{3,11},t_{4,11},t_{5,11},t_{1,12},t_{2,12},t_{3,12},t_{4,12},t_{5,12},t_{1,13},t_{2,13},t_{3,13},t_{4,13},t_{5,13},t_{1,14},t_{2,14},t_{3,14},t_{4,14},t_{5,14},t_{1,15},t_{2,15},t_{3,15},t_{4,15},t_{5,15},t_{1,16},t_{2,16},t_{3,16},$$
$$t_{4,16},t_{5,16}\ge 0 \text{ and integer} \quad (38)$$

$$s_1,s_3,s_4,s_6,s_7,s_8,s_{11},s_{12},s_{13},s_{14},s_{15},s_{16}\ge 0 \text{ and integer} \quad (39)$$

The objective function (19) is the minimum number of mileage. Constraints (20)-(24) are the constraints model for each demand $t_i, i=1,2,3,4,5.$ Constraint (25) is the number of placement of facility locations. Constraints (26)-(37) show the boundary of demand location $t_{i,j}\le s_j=1,2,3,4,5$ and j = 1, 3, 4, 6, 7, 8, 11, 12, 13, 14, 15, 16. Constraints (38) dan (39) are non-negative and integer constraints. Each demand location is grouped with the nearest facility location to minimize the average distance traveled. Based on Lingo 18.0, the value 1 of the variable means that the demand location is allocated in the facility location, and the value of 0 is otherwise. The objective value is 1860, with optimal solutions are $t_{1,1}=t_{2,7}=t_{3,12}=t_{4,15}=t_{5,15}=1$. It means:

1. The demand in 7 Ulu village (t_1) (t_1) is located at TWDS 10 Ulu market (s_1).
2. The demand in 5 Ulu village (t_2) is located at TWDS Infront of Panca Usaha (s_7).
3. The demand in 3/4 Ulu village (t_3) is located at TWDS 2 Ulu Market (s_{12}).
4. The demand in 2 Ulu village (t_4) is located at TWDS KH. Wahid Hasyim (PT.ALI) Street (s_{15}).
5. The demand in 1 Ulu village (t_5) is located at TWDS KH. Wahid Hasyim (PT.ALI) Street (s_{15}).

The Implementation of The Genetic Algorithm

In this case, the initial population data generated is the distance data between each TWDS, as shown in Table 3. The mileage data contained in the row entries are chromosomes, and those contained in the column entries are the number of genes. In this study, the initial population was formed from 16 chromosomes and 16 genes. The value for each gene in the population will be initialized into a series of binary numbers (0 and 1). Gene is worth 0 if the distance traveled is >500 meters and is worth 1 if the distance traveled is 500 meters. Table 6 is the initial population from the initialization of mileage data in Table 3. This initial population will be used for subsequent genetic operators.

TABLE 6. Initial population.

s_{ij}	s_1	s_2	s_3	s_4	s_5	s_6	s_7	s_8	s_9	s_{10}	s_{11}	s_{12}	s_{13}	s_{14}	s_{15}	s_{16}
s_1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
s_2	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0
s_3	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0
s_4	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
s_5	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0
s_6	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0
s_7	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
s_8	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
s_9	0	0	0	0	0	0	0	0	1	1	1	0	0	0	0	0
s_{10}	0	0	0	0	0	0	0	0	1	1	1	0	0	0	0	0
s_{11}	0	0	0	0	0	0	0	0	1	1	1	0	0	0	0	0
s_{12}	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
s_{13}	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0
s_{14}	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0
s_{15}	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
s_{16}	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1

After the initial population is formed, the next step is to evaluate the fitness value in that population. In this study, the selection process used the roulette wheel selection method. The roulette wheel selection method selects certain population members to become parents with a probability equal to the fitness value divided by the total fitness. The process continues with crossover and mutation. From the results of the Genetic algorithm process obtained in the first generation, second generation, and third generation, it can be seen that the fitness value of the selected chromosome as the optimal solution for each generation is shown in Table 7.

TABLE 7. The fitness value of TWDS in each generation.

First Generation		Second Generation		Third Generation	
Chromosome	**Fitness Value**	**Chromosome**	**Fitness Value**	**Chromosome**	**Fitness Value**
s_1	2800	s_3	7100	s_1	9900
s_3	350	s_4	6500	s_2	7700
s_4	1750	s_5	6600	s_4	6500
s_5	1750	s_6	4600	s_5	8900
s_6	4900	s_7	3250	s_6	6050
s_7	4600	s_8	6200	s_7	8650
s_9	4400	s_9	1120	s_9	4520
s_{10}	2300	s_{10}	1700	s_{10}	1100
s_{11}	450	s_{11}	450	s_{11}	5350
s_{13}	3700	s_{13}	3700	s_{12}	4700
s_{14}	3700	s_{15}	4300	s_{13}	4550
s_{15}	2650	s_{16}	2500	s_{15}	6550

In Table 7, it can be seen that the fitness value of the chromosome which is chosen as the optimal solution in each generation is getting bigger. Therefore, the genetic algorithm process on this problem stops in the third generation. The Genetic algorithm aims to find the minimum fitness value, so the optimal solution is the solution contained in the first generation, as shown in Table 8.

TABLE 8. The optimal TWDS from the genetic algorithm.

Chromosome	Name of TWDS
s_1	TWDS 10 Ulu Market
s_3	TWDS Beside DPRD City Building
s_4	TWDS Before Jakabaring Flyover
s_5	TWDS Opposite Bungaran Fuel Station
s_6	TWDS Infront of Alfamart (Before Tugu KB)
s_7	TWDS Infront of Panca Usaha
s_9	TWDS In front of Camat SU. I Office
s_{10}	TWDS Beside PBK 3/4 Ulu Office
s_{11}	TWDS 3/4 Ulu Market
s_{13}	TWDS Infront of Muhajirin 2 Ulu Mosque
s_{14}	TWDS 1 Ulu Laut Street
s_{15}	TWDS KH. Wahid Hasyim (PT.ALI) Street

Based on the results of the SCLP model, p-Median Problem model, and the application of the Genetic algorithm, there are 12 optimal TWDS, as shown in Table 9. We group the location of TWDS according to the village in Seberang Ulu I sub-district.

TABLE 9. The optimal TWDS in Seberang Ulu I Sub-District.

No	Village	Name of TWDS
1.	7 Ulu	TWDS 10 Ulu Market
		TWDS Beside DPRD City Building
		TWDS Before Jakabaring Flyover
2.	5 Ulu	TWDS Opposite Bungaran Fuel Station
		TWDS Infront of Alfamart (Before Tugu KB)
3.	3/4 Ulu	TWDS Infront of Panca Usaha
		TWDS In front of Camat SU. I Office
		TWDS Beside PBK 3/4 Ulu Office
		TWDS 3/4 Ulu Market
4.	2 Ulu	TWDS Infront of Muhajirin 2 Ulu Mosque
		TWDS KH. Wahid Hasyim (PT.ALI) Street
5.	1 Ulu	TWDS 1 Ulu Laut Street

Table 9 describes the grouping of TWDS by villages and each village does not have the same number of TWDS. The 3/4 Ulu village has the most number of TWDS. Based on the application of the Genetic Algorithm solution, we recommend that 1 TWDS in 7 Ulu village, 2 TWDS in 5 Ulu village, 2 TWDS in 2 Ulu village, and 3 TWDS in 1 Ulu village must be built to cover all the demand point in the Seberang Ulu I sub-district.

CONCLUSION

From the formulation of the Set Covering model and the application of the Genetic Algorithm for the Seberang Ulu I sub-district, we obtained 12 optimal TWDS locations. The optimal TWDS from the solution of the Set Covering model and the application of the Genetic algorithm has not been maximized, so it is necessary to build extra TWDS. This research recommends building 1 TWDS in 7 Ulu village, 2 TWDS in 5 Ulu village, 2 TWDS in 2 Ulu Village, and 3 TWDS in 1 Ulu village.

ACKNOWLEDGMENT

This paper is preliminary research of the doctoral degree dissertation in the Graduate School of Science, Faculty of Mathematics and Natural Sciences, Sriwijaya University. We want to thank Sriwijaya University, supervisors, and colleagues who have supported, motivated and helped this study.

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FAKULTAS PENDIDIKAN MIPA DAN TEKNOLOGI INFORMASI
UNIVERSITAS PGRI SEMARANG

Sertifikat

Nomor: 215/3.2/FPMIPATI/UPGRIS/VIII/2021

diberikan kepada

Sisca Octarina, S.Si, M.Sc

Atas partisipasinya sebagai **PEMAKALAH** dalam acara

" Seminar Nasional Matematika dan Pendidikan Matematika (SENATIK) VI Tahun 2021"

yang diselenggarakan oleh

Program Studi Pendidikan Matematika Universitas PGRI Semarang

pada 11 Agustus 2021

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