Set Covering Method Determine the Capacity, Type and Covering Area of the Temporary Landfill Facility in Each Region

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Abstract

The decision to open or close the temporary waste disposal facility or change the size of the existing facility is a solution due to the imbalance between the volume of demand (amount of waste) and the facility's capacity. It is also a solution for some locations that are not desired by the community. Currently, the Environment Agency provides facilities with several types with different capacity sizes. The possibility of opening or enlarging the facility begins with screening of location points that meet the requirements as temporary waste disposal facilities. The decision model is a set covering problem model using a pure integer non-linear program (PINLP) by considering the capacity and type of the facilities, and volume of waste. The decision results were obtained from 78 facilities that have been operating so far; only 27 facilities will be retained, closing 51 facilities and opening three new facilities. Of the 27 facilities that have been maintained, 17 have been re-sized. This decision will provide a total facility capacity of 655 m^3/day, which is bigger than the initial condition of only 565.29 m^3/day. The proposed decision is expected to cover an average volume of waste of 629.18 m^3/day.

Keywords
Set covering model, Temporary waste facility, Capacity, Type of facility, Region area

1. Introduction
Human needs keep increasing from time to time. In line with that, the amount of waste is also increasing. It is stated in the law of Indonesia about the waste management UU No 18 the year 2008 (Goverment of Indonesia, 2008) that waste is the residue of the humans' everyday activities or a natural process in the form of solid or semi-solid, organic or inorganic, degradable and non-degradable waste which is considered as useless and valueless and is dumped into the environment.

Yogyakarta's waste management is the responsibility of both; the people living in Yogyakarta and the Yogyakarta environmental services (Dinas Lingkungan Hidup Yogyakarta - DLH). The programs created by the Yogyakarta Environmental services are waste handling programs and waste-reducing programs. The waste handling program starts with collecting waste from the temporary garbage dump then carried out into the big landfills. While the role of the people living in Yogyakarta here is to throwing their daily waste into the nearest garbage dump in their environment. The piles of waste that are not managed well could be the source of a new problem. It could be a social problem, a health problem, or even can cause a natural disaster. According to Marshall and Farahbakhsh (2013) had stated that people's health is very affected by the waste management program.

Waste handling means doing provided waste facility management. At least, there are 147 facilities or points of temporary local garbage dumps, or we can call it TPS (Tempat Pembuangan Sementara) with four type facilities sizes provided by the environmental services of Yogyakarta. Those four sizes are (1) Local temporary garbage dump in the form of a medium box to accommodate the waste (TPSS); (2) a local temporary garbage dump in the way of a large and wide box to accommodate the waste (Depo) ; (3) a moveable garbage dump in the form of a container made of steel 6 m^3 (container); (4) a mini movable local temporary garbage dump is about 0,66 m^3 (bin). The waste collecting method is done by using two kinds of vehicles with different capacities. Those two vehicles are dump trucks with 6 m3 and compactors whose capacity is 10 m^3.

Yogyakarta is a big city with 410.262 people living in it (Population and Civil Registry Office of Yogyakarta, 2017). The level of waste product in this city is considered high if everyone produces 0,47 kg of waste or 0,00188 m^3 per day. Moreover, the public facilities produce waste 0,3 kg/day every m^2 SNI-3242-2008 National Standardization Agency (2008). It means every kg is worth 0,0012 m^3. According to the head of the recycling Department of the Environmental Service of Yogyakarta, the amount of waste produced by Yogyakarta people reach about 200 tons per day. The waste management in Yogyakarta is divided into some sectors, such as Gunung Ketur sector, Krasak sector, Kotagede sector, Ngasem-Gading sector, dan Malioboro-Kranggan sector. The division of the landfills was done by Yogyakarta's government to optimize the accommodation of the waste of the people who live nearby before it is carried to the final disposal in Piyungan.

Yogyakarta's government is currently facing a problem of the imbalance between the capacity of the landfills and the volume of the waste produced by the people. This imbalance can create a pile of waste that can bother people's life as long as the waste has not been carried out by the vehicles from the environmental service. It can cause the waste scattered anywhere, produce a lousy smell, take a big portion of space on the road. Table 1. shows that the volume of the TPS (565.29 m^3) and the waste produced by the people (629.17 m^3) is imbalance. The difference of the waste volume that can not be accommodated by the TPS is 63.88 m^3.

The data of the waste source is the data of the people living in a region. The volume of the landfills is adapted to the location of the landfills in every region. In Table 1. can be seen that Kotagede and Danurejan region are unable to accommodate the waste source from those regions. The alternative ways that might be done are by opening a new TPS or doing an expansion. Those two alternative ways are hard to be done because Yogyakarta now has a very dense population.

Yogyakarta's government is also facing the problem that one of the temporary landfills will be closed Rusqiyati (2015). The closing of the South Alun-Alun TPS (Kraton Region) was due to the TPS location not feasible to use, which was caused by disturbing the traffic. Closing the TPS means reducing the capacity of the facility.

Table 1. Source of Waste and TPS Capacity

No.	**Region**	**Population**		**Market**		**TPS Capacity (m^3)**
		(people)	***(m^3)***	***(m^2)***	***(m^3)***	
1	Kotagede	33,535	78.81	4743	5.69	94
2	Umbulharjo	68,760	161.59	6847.45	8.22	159.4
3	Danurejan	21,121	49.63	2521	3.03	72.29
4	Pakualaman	10,716	25.18	2723	3.28	26.6
5	Mergangsan	31,986	75.17	3956	4.75	79
6	Kraton	21,939	51.56	6199	7.44	35
7	Mantrijeron	35,207	82.74	1140	1.37	71
8	Wirobrajan	27,746	65.20	4623	5.55	28
Total (m^3)		589.87		39.31		**565.29**
		629.18				

1.1 Objectives

The research focused on determining temporary waste disposal facilities provided to be opened or closed or expand to accommodate waste from community sources taking into account the capacity of different facilities and the capacity of different sources.

2. Literature Location and Allocation

The study of location and allocation was initiated in 1963 by (Cooper, 1963). Related to the problem of determining the location and allocation of the facility has been done by several researchers Susy Susanty and Yuni Triani (2012), Hasibuan et al. (2014), Zuhri (2017), Achmad et al. (2015), Chaerani et al. (2013), Nugrahadi (2017), Mardiana (2009).

The method used is set covering, p-median, max-covering. In general, set covering is to minimize the number of facilities that can accommodate demand, while the p-median finds a location to minimize the distance between facilities and demand, while max-covering aims to find a number of facilities to maximize demand. Problems in the city of Yogyakarta that face an imbalance capacity of facilities and sources of waste, apparently also faced in several other cities and have been studied Susanty and Triani (2012), Hasibuan et al. (2014), Zuhri (2017), Achmad et al. (2015), Nugrahadi (2017). Set covering is the method of choice for some studies, as it provides an efficient decision regarding the number of facilities. The model used is a discrete Current et al. (2001) approach and have not considered the distance of the customer to the facility. Zheng, et al. (2020) and Zhou, et al. (2016) research stated that the customer's distance to the facility is a sensitive matter that needs to be considered and significantly minimizes costs.

2.1 Waste Generation

According to SNI-3242-2008, waste generation is waste that is taken from the chosen location to be measured for the volume and the weight as well as the composition. Waste generation is needed to determine and design the tools that are used to mobilize the waste, recovery material facilities, and the location of final dump waste facilities National Standardization Agency (2008).

2.2 Set Covering Problem Method

The set covering problem is finding the minimum number of elements of a base set that intersect in any given family member of the base set (Mannino and Sassano, 1995). The basic set can be anything, including assignment and scheduling problems, location and allocation problems, facility layout problems, set partition and set cover problems, inventory control, and salesman travel problems or vehicle routes (Crawford et al., 2017). The set covering can solve several issues covering a fairly large set. Emerick et al. (2021) used a set covering model to determine the number of ingot molds in a metallurgical process in the steel industry.

Set covering aims to cover all locations with as few facilities as possible. The network is represented by the distance between locations (or the travel time between them). Location coverage depends on the distance (or travel time) to the nearest facility and depends on a given value called the coverage radius (Takači, et al., 2016). According to Daskin, (2008), set covering aims to minimize the minimum number of sites needed to meet all requests. This model is used to solve the optimum value to minimize the loss of ingot printing results. While the decision to open or close a set is NP-hard linear programming tends to have integer solutions (PINLP).

According to Current et al. (2001), Set Covering attempts to determine the lowest cost by placing the number of facilities where each requesting node can be reached by at least one facility. Set covering is part of the location-allocation problem. The location-allocation model aims to determine the location of facilities that can minimize the cost of service facilities to customers by limiting that each facility is used for several sets of customers. The facility can provide services if the customer as the point of request is at an accessible distance. The facility cannot serve if the distance is not reachable or exceeds the coverage area specified.

Several similar studies that also consider the location and type of facilities and the volume of waste sources and use set covering as a solution model are research of (Zuhri, 2017), (Susanty and Triani, 2012), and (Nugrahadi, 2017). However, the three studies only consider two types of facilities, while in Yogyakarta, there are four types of facilities. The source of waste in this study considers the population of an area and public facilities, such as markets. The maximum distance between the customer and the facility is an additional consideration so that the costs incurred are minimal. The parameters used are less than 2.5 km (Susanty and Triani, 2012) but more than 251-500 m (Achmad et al., 2015). Considering the maximum distance of this research is 1 km (Regulation of the Minister of Public Works of the Republic of Indonesia Number/3/PRT/M/2013) by anticipating leachate pollution, unpleasant odors, the spread of disease vectors, and social aspects.

3. Methods

The case of an imbalance between the source of waste and the capacity of temporary waste disposal facilities in Yogyakarta will be approached with a set covering model. The expected decision is to minimize the number of facilities that can accommodate waste sources. The study will be conducted in three sectors of the work area of the DLH, which covers eight sub-districts and consists of 75 facility locations. The study considers four types of facilities, (1) TPSS - medium size, (2) depot - large size, (3) steel container - small size, and (4) bins. The sources of waste in the three work areas of the environmental service come from urban villages and markets, consisting of 27 urban village points and 18 market points. The study also considers the maximum expected distance from the source point.

The study begins with resolving the imbalance in the capacity of waste sources and facilities by conducting location screening to find location points where the capacity is likely to be enlarged. The determination of the point and volume of the facility to be enlarged is discussed with the DLH. The next step is to build a model, which is done by identifying the structure of the model, designing the influence diagram, verification and validation, modeling, and analyzing the model.The basic model used is the set covering model developed by (Current et al., 2001). The covering set was chosen because it will be used to determine which facilities will be opened or closed. According to Current et al., (2001), set covering is a discrete model included in NP-hard that considers integer solutions to be a pure integer non-linear program. The basic model is added to the constraints of the maximum distance of the waste source to the facility point. The model was then processed using Lingo 11.0 software. Verification and validation were carried out for the hypothetical model.

3.1 Situation Analysis

This landfill research is located in Gunung Ketur, Kotagede and Ngasem-Gading sectors of Yogyakarta. Gunung Ketur, Kotagede dan Ngasem-Gading sectors are divided into eight regions which are Kotagede, Umbulharjo, Danurejan, Pakualaman, Mergangsan, Kraton, Mantrijeron dan Wirobrajan. The scope of the region in this research is set as the limitation of the area. There are four kinds of TPS facilities in the eight regions. They are local temporary landfills, depo, containers, and bins. The whole sectors and facilities are described in Figure 1. All facility points are depicted as blue dots.

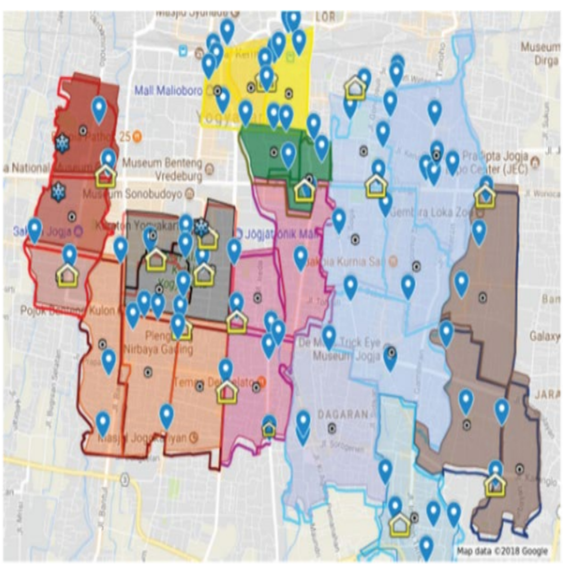

Figure 1. The map of region, marketplace, and TPS

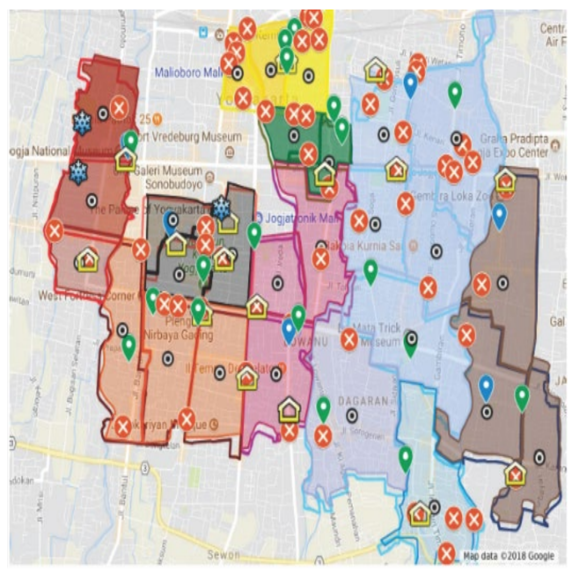

Figure 2**.** The map of Lingo result

Determination of the location is discrete using the Google Earth application in the form of a position based on the coordinate system without changing the regulations of the Yogyakarta City DLH regarding waste management. Figure 1. is an initial situation that shows the point of region, villages, market, and temporary landfill. In the picture, it is seen that eight regions have become research areas with 27 villages and 18 markets, 75 initial TPS facilities provided by the government as an existing location point, and new facility locations to meet capacity shortages.

3.2 Screening Location

Location screening is carried out to increase the capacity of available facilities. Screening location begins with determining the location of the 75 TPS points. Then observations are made at all points to find points that allow it to be enlarged and new location. Locations that can be enlarged and spawned into a new location, must meet the criteria to make it easier for trucks to load and enable DLH to use them. In accordance with (PUPR, 2013), the requirements related to the location are: (1) the minimum area for TPSS and depot types is 200m^2, (2) the type of development is not a permanent container, (3) the placement does not interfere with aesthetics and traffic, and (4) does not have the potential to pollute the environment.

4. Model

Optimization is done based on the model set covering problem which is used by Current et al. (2001) and Nugrahadi (2017). The mathematical model in this study aims to expand the facilities that have been determined and reduce the number of facilities that are considered to interfere with public facilities.

4.1 Model Formulation

The mathematical model in this study uses notations as follows:

- I = Set of demand point type I with the index i
- J = Set of demand point type J with the index j
- K = Set of alternative point of facility type TPSS with index k
- L = Set of alternative point of facility type Depo with index l
- M = Set of alternative point of facility type Container with index m
- N = Set of alternative point of facility type Bin with index n
- C_k = capacity of facilities type K with index k (m^3/day)
- C_l = capacity of facilities type L with index l (m^3/day)
- C_m = capacity of facilities type M with index m (m^3/day)
- C_n = capacity of facilities type N with index m (m^3/day)
- V_i = volume of demand points type I with the index i (m^3/day)
- V_j = volume of demand point type J with index j (m^3/day)
- d_{max} = maximum distance between demand point with facility
- d_{ik} = the distance between the demand points i and alternative facility k
- d_{il} = the distance between the demand points i and alternative facility l
- d_{im} = the distance between the demand points i and alternative facility m
- d_{in} = the distance between the demand points i and alternative facility n
- d_{jk} = the distance between the demand points j and alternative facility k
- d_{jl} = the distance between the demand points j and alternative facility l
- d_{jm} = the distance between demand points j and alternative facility m
- d_{jn} = the distance between demand points j and alternative facility m
- X_k = (1, if the facilities with index k becomes the location of the can covered demand and 0, if the opposited)
- X_l = (1, if the facilities with index l becomes the location of the can covered demand and 0, if the opposited)
- X_m = (1, if the facilities with index m becomes the location of the can covered demand and 0, if the opposited)
- X_n = (1, if the facilities with index n becomes the location of the can covered demand and 0, if the opposited)
- Y_{ik} = (1, if the demand points type I with index i can be met by alternative location k and 0, if the opposited)
- Y_{il} = (1, if the demand points type I with index i can be met by alternative location l and 0,if the opposited)
- Y_{im} = (1, if the demand points type I with index i can be met by alternative location m and 0, if the opposited)
- Y_{in} = (1, if the demand points type I with index i can be met by alternative location n and 0, if the opposited)
- Y_{jk} = (1, if the demand points type J with index j can be met by alternative location k and 0, if the opposited)
- Y_{jl} = (1, if the demand points type J with index j can be met by alternative location l and 0, if the opposited)
- Y_{jm} = (1, if the demand points type J with index j can be met by alternative location m and 0, if the opposited)
- Y_{jn} = (1, if the demand points type J with index j can be met by alternative location n and 0, if the opposited)

- Objective Function
  The objective function of this research is to minimize the numbers of facilities which consist of local temporary landfills, container, bin and depo. The minimization is considering the capacity of the facilities.

  $$\text{Minimize } \sum_{k\epsilon K} C_k X_k + \sum_{l\epsilon L} C_l X_l + \sum_{m\epsilon M} C_m X_m + \sum_{n\epsilon N} C_n X_n \quad (1)$$

- The capacity that can be accommodated
  Every waste source that consists of people living nearby and the nearest facility should at least can be accommodated by one facility

  $$\sum_{k,l,m,n} Y_{ik} + Y_{il} + Y_{im} + Y_{in} \geq 1 \quad \forall i \in I \quad (2)$$

$$\sum_{k,l,m,n} Y_{jk} + Y_{jl} + Y_{jm} + Y_{jn} \geq 1 \quad \forall j \in J \tag{3}$$

- Capacity of Facility
  Facilities have capacity in accommodating the waste from the waste source,

$$\sum_{i \epsilon I} V_i Y_{ik} + \sum_{j \epsilon J} V_j Y_{jk} \leq C_k X_k \quad \forall k \in K \tag{4}$$
$$\sum_{i \epsilon I} V_i Y_{il} + \sum_{j \epsilon J} V_j Y_{jl} \leq C_l X_l \quad \forall l \in L \tag{5}$$
$$\sum_{i \epsilon I} V_i Y_{im} + \sum_{j \epsilon J} V_j Y_{jm} \leq C_m X_m \quad \forall m \in M \tag{6}$$
$$\sum_{i \epsilon I} V_i Y_{in} + \sum_{j \epsilon J} V_j Y_{jn} \leq C_n X_n \quad \forall n \in N \tag{7}$$

- The Maximum Distance
  The maximum distance of disposing is measured by considering the farthest distance of a person walking and bringing loads so that the distance from the waste source to the facilities does not exceed the maximum distance

$$d_{max} X_k \geq max\left\{d_k^i\right\} \cdot Y_{ik} \quad \forall k \in K \tag{8}$$
$$d_{max} X_l \geq max\left\{d_l^i\right\} \cdot Y_{il} \quad \forall l \in L \tag{9}$$
$$d_{max} X_m \geq max\left\{d_m^i\right\} \cdot Y_{im} \quad \forall m \in M \tag{10}$$
$$d_{max} X_n \geq max\left\{d_n^i\right\} \cdot Y_{in} \quad \forall n \in N \tag{11}$$
$$d_{max} X_k \geq max\left\{d_k^j\right\} \cdot Y_{jk} \quad \forall k \in K \tag{12}$$
$$d_{max} X_l \geq max\left\{d_l^j\right\} \cdot Y_{jl} \quad \forall l \in L \tag{13}$$
$$d_{max} X_m \geq max\left\{d_m^j\right\} \cdot Y_{jm} \quad \forall m \in M \tag{14}$$
$$d_{max} X_n \geq max\left\{d_n^j\right\} \cdot Y_{jn} \quad \forall n \in N \tag{15}$$

- Decision Variable

$$X_k\{0,1\} \quad \forall k \in K \tag{16}$$
$$X_l\{0,1\} \quad \forall l \in L \tag{17}$$
$$X_m\{0,1\} \quad \forall m \in M \tag{18}$$
$$X_n\{0,1\} \quad \forall n \in N \tag{19}$$
$$Y_{ik}\{0,1\} \quad \forall k \in K \tag{20}$$
$$Y_{il}\{0,1\} \quad \forall l \in L \tag{21}$$
$$Y_{im}\{0,1\} \quad \forall m \in M \tag{22}$$
$$Y_{in}\{0,1\} \quad \forall n \in N \tag{23}$$
$$Y_{jk}\{0,1\} \quad \forall k \in K \tag{24}$$
$$Y_{jl}\{0,1\} \quad \forall l \in L \tag{25}$$
$$Y_{jm}\{0,1\} \quad \forall m \in M \tag{26}$$
$$Y_{jn}\{0,1\} \quad \forall n \in N \tag{27}$$

The minimum number of facilities will certainly minimize transportation costs from DLH. So the objective function of this model is the minimization of the facility points to be visited (Equation 1). However, the available facilities must be able to accommodate waste from waste sources while DLH provides four types of facilities with different capacities, which are then denoted as a set of K, L, M, and N. K for TPS, L for containers, M for bins and N for the depot. The decision uses binary numbers, one if a facility is selected and 0 if it is not selected. Equation 16 - 27. In this model, the source of waste or the community consists of the village community (I) and the market (J). Each source of waste, both from I and J, can only be disposed of at one of the closest types of facilities. Equations 2 and 3. The capacity of the source of waste that can be accommodated in each facility should not exceed the capacity of each type of facility. Equation 4 - 7. This model tries to accommodate the interests of waste sources, in this case, the community, where people will choose facilities that are not more than 1 km from their residence. Equation 8 - 15.

Table 2. Result from Lingo 11.0

Region	The temporary waste disposal	Capacity (m^3)	Waste source	Volume (m^3)
Kotagede	LK Gembiraloka	30	Rejowinangun	29.12
			Pasar Gedongkuning	0.70
	Depo Lapangan Karang	24	Purbayan	23.67
	Depo Kemasan	24 (32)	Prenggan	26.02
			Pasar Kotagede	4.99
Umbulharjo	TPS Cantel Baru	1	Pasar Sanggrahan	0.27
	TPS Pramuka	4 (29)	Pandeyan	28.37
	BIN Ipda Tut Harsono	2 (38)	Muja Muju	25.07
			Semaki	12.11
			Pasar Pace Semaki	0.08
	BIN Batikan II	2 (44)	Warungboto	21.21
			Tahunan	21.28
	Depo Sorosutan	25 (36)	Sorosutan	35.6
			P. Sepatu Tanjungsari	0.06
	Depo Nitikan	24 (26)	Giwangan	17.91
			Pasar Giwangan	7.81
Danurejan	Pasar Lempuyangan	2.25 (11)	Suryatmajan	10.97
	Mas Suharto	12 (22)	Bausasran	17.11
			Pasar Lempuyangan	3.03
	TPS Hayam Wuruk	11.34 (22)	Tegalpanggung	21.56
Pakualaman	TPS Mangunsarkoro	3.6 (15)	Gunungketur	10.56
			Pasar Sentul	3.27
	Pasar Sentul	4 (15)	Purwokinanti	14.62
Mergangsang	TPS Jembatan Tungkak	4 (28)	Brontokusuman	25.29
			Pasar Ciptomulyo	0.27
			Pasar Telo	1.65
	TPS Sisingamangaraja	4	Pasar Pujokusuman	0.42
			Pasar Prawirotaman	2.41
	Depo Pura Wisata	50	Wirongunan	26.49
			Keprakan	23.29
Kraton	TPS ALKID	4 (14)	Patehan	13.86
	Pasar Ngasem	24	Kadipaten	16.07
			Pasar Kluwih	0.07
			Pasar Ngasem	7.36
	DK 1	22	Panembahan	21.63
Mantrijeron	LK Pugeran	6 (36)	Suryodiningratan	26.09
			Pasar Gading	1.37
	BIN DI Panjaitan I	2 (24)	Mantrijeron	23.84
	Depo Dukuh	24 (33)	Gedongkiwo	32.8
Wirobrajan	Pasar Seranggan	3	Pasar Legi	2.06
	TPS Seranggan	16 (26)	Wirobrajan	21.29
			Pasar Serangan	2.34
	DW 1	26	Pakuncen	25.36
	DW 2	20	Patangpuluhan	17.86
			Pasar Klitikan	1.14
TOTAL		**655**		**629.18**

5. Results and Discussion

5.1 Result

Location screening is done to increase capacity so that the set covering model can work. Three alternative new locations and were obtained, which allowed for depots to be established with a size of 20 - 30 m^3. Two of the three locations are in the Wirobrajan region and one in the Kraton region. 17 locations that require additional capacity and are in almost all regions. The results of the addition and expansion location screening can be seen in Table 2. in blue ink. The total capacity that is possible with the addition of capacity from the new location and the enlarged location is 655 m^3 from the previous 565.29 m^3.

The basic set covering model has not considered the maximum distance between the waste source and the facility, in this study it was conducted . So it is hoped that the use of the nearest facility will be effective (Zheng, et al, 2020) (Zhou, et al., 2016). The researcher did the verification and model validation by checking the logic of the model which is programmed into Lingo 11.0 software and using the hypothetic data to test the model formulation logic. From the result of the validation, the model that has been made is valid based on the result (output) obtained and is considered as suitable with the result expected. After the model is verified and valid, it is then continued using real data in the three DLH sectors. The results can be seen in Table 2.

5.2 Model Analysis

Table 2. is the output of Lingo 11.0. which is an extension of the basic set covering model. Based on the table. it appears that 75 existing facilities. 17 enlarged and three new locations proposed. have a capacity of 655 m^3. However. not all facilities are used; 51 facilities are recommended to be closed by the set covering model (The 51 closed facilities can be seen in Figure 2. with a red cross). The processing results can accommodate the needs or sources of waste of 629.18 m^3. All waste sources from 27 urban village points and 18 market points can be accommodated at 17 points of expanded facilities and 3 points of new facilities. The allocation is limited to each region. cannot be shifted to another region even though it is closer. There are no sources of waste that are not accommodated at facility points in the same region. And the point of location facilities has followed the limit of less than 1 km.

In this study. the point of source of waste from the community represents the village point. Meanwhile. each urban village in eight regions consists of an average of 40 to 44 thousand families. So it is necessary to develop a model for household points. In addition. it is also required to consider other sources of waste besides households and markets. Still. it is also necessary to evaluate sources of waste from schools. offices. shopping centers. restaurants. and tourist attractions. Still. regarding the source of waste. the pattern of the amount of waste produced by each individual and each period is not always fixed and certain. Yogyakarta. as a tourist city and a student city. has its uniqueness. Sources of temporary waste contribute to adding to the waste at a certain period.

6. Conclusion

Based on the results of data processing and analysis of the discussion obtained the following conclusions. The average volume of waste sources generated by community activities and waste from public facilities (markets) in the Gunung Ketur. Kotagede. and Ngasem-Gading sectors is 629.18 m^3/day. which can be allocated to 17 waste disposal facilities. The results of the processing of Lingo 11.0. 17 facilities will be located with a capacity of 655 m^3. The future research is to develop a complete model that considers all sources of waste with a smaller source point than the urban village and accommodates the uncertainty of the source of the waste.

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