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Set covering models in optimizing the emergency unit location of health facility in Palembang

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Set covering models in optimizing the emergency unit location of health facility in Palembang

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Abstract. Palembang comprises 16 districts, but in this research, the focus area is limited to 8 districts namely Sukarami, Sako, Sematang Borang, Kalidoni, Kemuning, Ilir Timur II, Seberang Ulu II, and Plaju. There are currently only 7 districts that have emergency installations. This research is designed to optimize the number and location of emergency installation in Palembang. Optimization of emergency installation location is required to improve health services in Palembang. This optimization uses covering-based models that include location set covering problem and maximal covering location problem. The solutions are obtained by using branch and bound solver on Lingo 13.0. The results of the computation with the best time of 15 minutes are 6 locations of emergency installations in order to serve the existing 8 districts.

1. Introduction

Mathematically, optimization is a way of reaching prices of certain functions with limiting factors. If the decision will issue the maximum desired value, the result will be maximization. Optimization in solving problems is ways to produce optimal results [1].

Location facility issues such as emergency service facilities form an important class of location problems in optimization. These problems usually involve the optimal location of the facility[2]. For example ambulance vehicles, emergency care centers, fire stations, schools, libraries, and emergency equipment. The objective function of location problems usually involves costs, distance, and service utilization. Optimization problems relate to the need to fulfill a number of constraints that are specified. These constraints may be related to safety, available resources, service level, and time [3-5]. *Location Set Covering Problem* (LSCP) is a problem in a distribution system that aims to find the optimum number of facility location placements so that it can serve all points of demand [6]. Maximal Covering Location Problem (MCLP) aims to maximize the number of points of demand with the number of locations of facilities (Emergency Installation) whose limits are only available at a number of points of facility location so that they can cover all customer demand points. The median problem aims to minimize the average weighted distance between the location point of the service facility and the point of request [7].

Optimization is the search for variable values that are considered optimal, effective and efficient to achieve the desired goals. Optimization issues vary according to the conditions under which the system works. One of the most frequent optimization problems, especially in the field of transportation, is about finding the shortest path. Optimization in the shortest path can be based on the closest mileage to a facility or based on the fastest time to reach it. This settlement process still has to pay attention to the conditions that arise in it for a journey from the place of origin to the destination point such as congestion. The results of solving the shortest route problem can be called the optimal route. The optimal route is a route that has a minimum travel time and distance [8-9].

In integer programming problem, the variables are integer types. Integer programming is used to model problems whose variables cannot be non-integer numbers (which are real numbers), such as variables that represent the number of people, because the number of people is expressed in integers. Integer programming is usually chosen to model a problem because linear programs with real number variables are not good at modeling problems that require an integer number solution [10].

Lingo is software designed to solve general optimization models, including linear models, integer models, and nonlinear models. Using this software allows calculation of linear programming problems with *n* variables. Lingo's main working principle is entering data, completing, and estimating the truth and feasibility of the data based on its completion. To solve the problem of zero-one integer linear programming using the Lingo software branch and bound method. To determine the optimal value by using Lingo several steps are needed, namely determining mathematical models based on real data; determining the program formulation for Lingo and reading the report results produced by Lingo [11].

Basically, this paper contributes some ideas. First, the design of the optimization problem of ER location in Palembang and second, the design of optimal route from population covered by the nearest facility location.

2. Research Methodology

In this study, the data used will be described in the form of the number of sub-districts in the city of Palembang and travel time from one sub-district to another. The data obtained will then be defined variables and parameters for LSCP, MCLP, P-median problem, and P-center problem. The solution of the four covering based models is obtained by using Lingo 13.0 software.

3. Result and Discussion

In this study, the optimal number of emergency unit locations was determined using LSCP. The model is as follows.

Minimize :

$$Z_{LSCP} = x_1 + x_2 + x_3 + x_4 + x_5 + x_6 + x_7 + x_8 \tag{1}$$

Subject to:

$$x_1 \geq 1 \tag{2}$$

$$x_2 \geq 1 \tag{3}$$

$$x_2 + x_3 \geq 1 \tag{4}$$

$$x_4 + x_6 \geq 1 \tag{5}$$

$$x_5 \geq 1 \tag{6}$$

$$x_4 + x_6 \geq 1 \tag{7}$$

$$x_7 \geq 1 \tag{8}$$

$$x_8 \geq 1 \tag{9}$$

Solution obtained I presented in Table 1 :

Table 1. Optimal LSCP Solutions

Solver Status	
Model Class	PILP
State	Global Optimal
Objective	6
Infeasibility	0
Iterations	0

Extended Solver Status	
Solver Type	Branch and Bound
Best Objective	6
Objective bound	6
Steps	0
Active	0
Update Interval	2
GMU (K)	20
ER (sec)	0

The computation of the LSCP problem is resolved using Lingo 13.0 super edition with an optimal solution of 6. In a row the emergency unit should be in the following 6 locations, namely as follows.

a. Ilir Timur II
b. Kalidoni
c. Sako
d. Seberang Ulu II
e. Sematang Borang
f. Sukarami

Further analysis was carried out aimed at determining the location of the Emergency Unit selected when there were restrictions on the number of Emergency Units being built. The calculation results assuming the best time ≤ 15 minutes using the LSCP shows that the number of locations chosen to meet all points of demand is 6. The optimal Emergency Unit amounts to 6, in the sensitivity analysis try 3 other alternatives to see selected location. The alternatives are 4, 5, and 6. The selection of 3 alternatives is done to see how many sub-districts can be served if the number of facilities built is limited. How to determine the selected location on this problem is by using the Maximal Covering Location Problem (MCLP) which aims to maximize the total demand that can be met.

If the location of the facility is only built in 4 locations, then the locations of the proposed facilities can maximize the demand that is served. The model then is as follows.

Maximize :

$$Z=12y_1+5y_2+6y_3+7y_4+4y_5+7y_6+4y_7+7y_8 \quad (10)$$

Subject to:

$$x_1 \geq y_1 \quad (11)$$
$$x_2 \geq y_2 \quad (12)$$
$$x_2 + x_3 \geq y_3 \quad (13)$$
$$x_4 + x_6 \geq y_4 \quad (14)$$
$$x_5 \geq y_5 \quad (15)$$
$$x_4 + x_6 \geq y_6 \quad (16)$$
$$x_7 \geq y_7 \quad (17)$$
$$x_8 \geq y_8 \quad (18)$$
$$x_1+x_2+x_3+x_4+x_5+x_6+x_7+x_8 = 4 \quad (19)$$

Solution for this model is obtained in Table 2 as follows.

Table 2. Optimal Solution for p = 4 *MCLP*

Solver Status	
Model Class	PILP
State	*Global Optimal*
Objective	44
Infeasibility	0

Iterations	0
Extended Solver Status	
Solver Type	*Branch and Bound*
Best Objective	44
Objective bound	44
Steps	0
Active	0
Update Interval	2
GMU (K)	22
ER (sec)	0

The resolution of the MCLP problem was solved using Lingo 13.0 Super Edition with an alternative p = 4 which obtained the optimal solution of 4, but all of the existing demand points have not been fulfilled. In a row the Emergency Unit should be built in the following 4 locations, namely:

a. Ilir Timur II
b. Kalidoni
c. Seberang Ulu II
d. Sukarami

If the location of the facility is only built in 5 locations, then the location points of the proposed facility can maximize the demand that is served. The model is described as follows.

Maximize :

$$Z=12y_1+5y_2+6y_3+7y_4+4y_5+7y_6+4y_7+7y_8 \quad (20)$$

Subject to :

$$x_1 \geq y_1 \quad (21)$$
$$x_2 \geq y_2 \quad (22)$$
$$x_2 + x_3 \geq y_3 \quad (23)$$
$$x_4 + x_6 \geq y_4 \quad (24)$$
$$x_5 \geq y_5 \quad (25)$$
$$x_6 \geq y_6 \quad (26)$$
$$x_7 \geq y_7 \quad (27)$$
$$x_8 \geq y_8 \quad (28)$$
$$x_1+x_2+x_3+x_4+x_5+x_6+x_7+x_8 = 5 \quad (29)$$

Solution obtained is presented in Table 3.

Table 3. Optimal Solution for p = 5 *MCLP*

Solver Status	
Model Class	PILP
State	Global Optimal
Objective	48
Infeasibility	0
Iterations	0
Extended Solver Status	
Solver Type	Branch and Bound
Best Objective	48
Objective bound	48

Steps	0
Active	0
Update Interval	2
GMU (K)	22
ER (sec)	0

Completion of the MCLP problem was solved using Lingo 13.0 Super Edition with the alternative p = 5 the optimal solution was obtained by 5, but all existing demand points have not been fully fulfilled. In a row the Emergency Unit should be built in the following 5 locations, namely :

a. Ilir Timur II
b. Kalidoni
c. Sako
d. Seberang Ulu II
e. Sukarami

If the location of the facility is only built in 6 locations, then the location points of the proposed facility can maximize the demand that is served. Then the model is as follows.

Maximize :

$$Z = =12y_1+5y_2+6y_3+7y_4+4y_5+7y_6+4y_7+7y_8 \quad (30)$$

Subject to :

$$x_1 \geq y_1 \quad (31)$$

$$x_2 \geq y_2 \quad (32)$$

$$x_2 + x_3 \geq y_3 \quad (33)$$

$$x_4 + x_6 \geq y_4 \quad (34)$$

$$x_5 \geq y_5 \quad (35)$$

$$x_4 + x_6 \geq y_6 \quad (36)$$

$$x_7 \geq y_7 \quad (37)$$

$$x_8 \geq y_8 \quad (38)$$

$$x_1+x_2+x_3+x_4+x_5+x_6+x_7+x_8 = 6 \quad (39)$$

then the solution obtained is in Table 4.

Table 4. Optimal Solution for *p* = 6 *MCLP*

Solver Status	
Model Class	PILP
State	Global Optimal
Objective	52
Infeasibility	0
Iterations	0
Extended Solver Status	
Solver Type	Branch and Bound
Best Objective	52
Objective bound	52
Steps	0
Active	0
Update Interval	2
GMU (K)	22
ER (sec)	0

Completion of the *MCLP* problem was solved using Lingo 13.0 Super Edition with alternative p = 6 the optimal solution was obtained by 6 and all available request points could be fulfilled. In succession the Emergency Unit should be built in the following 6 locations, namely :

a. Ilir Timur II
b. Kalidoni
c. Sako
d. Seberang Ulu II
e. Sematang Borang
f. Sukarami

P-Median Problem and *P-Center Problem* use location data of Emergency Unit facilities and also location of request for emergency services. Location of facility uses location obtained from *LSCP*.To minimize the average distance between the point of request location and the location of the nearest facility is used in *p-median problem* with Lingo 13.0.the model is as follows.

Minimize :

$$Z = 0x_{1,1} + 38x_{1,2} + 17x_{1,3} + 37x_{1,4} + 19x_{1,5} + 33x_{1,6} + 29x_{1,7} + 43x_{1,8} + 40x_{2,1} + 0x_{2,2} + 26x_{2,3} + 49x_{2,4} + 29x_{2,5} + 45x_{2,6} + 22x_{2,7} + 48x_{2,8} + 16x_{3,1} + 13x_{3,2} + 0x_{3,3} + 40x_{3,4} + 21x_{3,5} + 36x_{3,6} + 36x_{3,7} + 27x_{3,8} + 41x_{4,1} + 49x_{4,2} + 40x_{4,3} + 0x_{4,4} + 40x_{4,5} + 12x_{4,6} + 68x_{4,7} + 67x_{4,8} + 20x_{5,1} + 20x_{5,2} + 27x_{5,3} + 40x_{5,4} + 0x_{5,5} + 50x_{5,6} + 33x_{5,7} + 25x_{5,8} + 37x_{6,1} + 44x_{6,2} + 35x_{6,3} + 12x_{6,4} + 52x_{6,5} + 0x_{6,6} + 64x_{6,7} + 62x_{6,8} + 30x_{7,1} + 24x_{7,2} + 40x_{7,3} + 62x_{7,4} + 34x_{7,5} + 58x_{7,6} + 0x_{7,7} + 54x_{7,8} + 41x_{8,1} + 38x_{8,2} + 30x_{8,3} + 65x_{8,4} + 24x_{8,5} + 60x_{8,6} + 53x_{8,7} + 0x_{8,8} \quad (40)$$

Subject to :

$$x_{1,1} + x_{1,2} + x_{1,3} + x_{1,4} + x_{1,5} + x_{1,6} + x_{1,7} + x_{1,8} = 1 \quad (41)$$

$$x_{2,1} + x_{2,2} + x_{2,3} + x_{2,4} + x_{2,5} + x_{2,6} + x_{2,7} + x_{2,8} = 1 \quad (42)$$

$$x_{3,1} + x_{3,2} + x_{3,3} + x_{3,4} + x_{3,5} + x_{3,6} + x_{3,7} + x_{3,8} = 1 \quad (43)$$

$$x_{4,1} + x_{4,2} + x_{4,3} + x_{4,4} + x_{4,5} + x_{4,6} + x_{4,7} + x_{4,8} = 1 \quad (44)$$

$$x_{5,1} + x_{5,2} + x_{5,3} + x_{5,4} + x_{5,5} + x_{5,6} + x_{5,7} + x_{5,8} = 1 \quad (45)$$

$$x_{6,1} + x_{6,2} + x_{6,3} + x_{6,4} + x_{6,5} + x_{6,6} + x_{6,7} + x_{6,8} = 1 \quad (46)$$

$$x_{7,1} + x_{7,2} + x_{7,3} + x_{7,4} + x_{7,5} + x_{7,6} + x_{7,7} + x_{7,8} = 1 \quad (47)$$

$$x_{8,1} + x_{8,2} + x_{8,3} + x_{8,4} + x_{8,5} + x_{8,6} + x_{8,7} + x_{8,8} = 1 \quad (48)$$

$$y_1 + y_2 + y_3 + y_4 + y_5 + y_6 + y_7 + y_8 = 6 \quad (49)$$

$$x_{1,1}, x_{2,1}, x_{3,1}, x_{4,1}, x_{5,1}, x_{6,1}, x_{7,1}, x_{8,1} \leq y_1$$
$$x_{1,2}, x_{2,2}, x_{3,2}, x_{4,2}, x_{5,2}, x_{6,2}, x_{7,2}, x_{8,2} \leq y_2$$
$$x_{1,3}, x_{2,3}, x_{3,3}, x_{4,3}, x_{5,3}, x_{6,3}, x_{7,3}, x_{8,3} \leq y_3$$
$$x_{1,4}, x_{2,4}, x_{3,4}, x_{4,4}, x_{5,4}, x_{6,4}, x_{7,4}, x_{8,4} \leq y_4$$
$$x_{1,5}, x_{2,5}, x_{3,5}, x_{4,5}, x_{5,5}, x_{6,5}, x_{7,5}, x_{8,5} \leq y_5$$
$$x_{1,6}, x_{2,6}, x_{3,6}, x_{4,6}, x_{5,6}, x_{6,6}, x_{7,6}, x_{8,6} \leq y_6$$
$$x_{1,7}, x_{2,7}, x_{3,7}, x_{4,7}, x_{5,7}, x_{6,7}, x_{7,7}, x_{8,7} \leq y_7$$
$$x_{1,8}, x_{2,8}, x_{3,8}, x_{4,8}, x_{5,8}, x_{6,8}, x_{7,8}, x_{8,8} \leq y_8 \quad (50)$$

Solution obtained is presented in Table 5.

Table 5. *P-Median Problem* Optimal Solution

Solver Status	
Model Class	PILP
State	Global Optimal
Objective	8512
Infeasibility	0
Iterations	0

Extended Solver Status	
Solver Type	Branch and Bound
Best Objective	8512
Objective bound	8512
Steps	0
Active	0
Update Interval	2
GMU (K)	48
ER (sec)	0

The calculation of the *P-Median Problem*shows that

a. Customers in Ilir Timur II District (x_1) were placed at the facility location in Ilir Timur II District(x_1)
b. Customers in Kalidoni District (x_2) are placed at the facility's location in Kalidoni District(x_2)
c. Customers in Kemuning District (x_3) are placed at the location of the facility in Kemuning District (x_3)
d. Customers in Plaju District (x_4) are placed at the facility location in Seberang Ulu II (x_6)
e. Customers in Sako District (x_5) are placed at the facility location in Sako District (x_5)
f. Customers in Seberang Ulu II District (x_6) are placed at the facility location in Seberang Ulu II(x_6)
g. Customers in Sematang Borang District (x_7) are placed at the facility location in Sukarami District(x_8)
h. Customers in Sukarami District (x_8) are placed at the facility location in Sukarami District(x_8)

Then again, the *P-Center Problem*was resolved using Lingo 13.0. Then the model is as follows.

Minimize:

$$Z = Z_{\text{p-center}} \quad (51)$$

Subject to

$$0x_{1,1} + 38x_{1,2} + 17x_{1,3} + 37x_{1,4} +19x_{1,5} + 33x_{1,6} + 29x_{1,7} + 43x_{1,8} + 40x_{2,1} + 0x_{2,2} + 26x_{2,3} + 49x_{2,4} + 29x_{2,5} + 45x_{2,6} + 22x_{2,7} + 48x_{2,8} + 16x_{3,1} + 13x_{3,2} + 0x_{3,3} + 40x_{3,4} + 21x_{3,5} + 36x_{3,6} + 36x_{3,7} + 27x_{3,8} + 41x_{4,1} + 49x_{4,2} + 40x_{4,3} + 0x_{4,4} + 40x_{4,5} + 12x_{4,6} + 68x_{4,7} + 67x_{4,8} + 20x_{5,1} + 20x_{5,2} + 27x_{5,3} + 40x_{5,4} + 0x_{5,5} + 50x_{5,6} + 33x_{5,7} + 25x_{5,8} + 37x_{6,1} + 44x_{6,2} + 35x_{6,3} + 12x_{6,4} + 52x_{6,5} + 0x_{6,6} + 64x_{6,7} + 62x_{6,8} + 30x_{7,1} + 24x_{7,2} + 40x_{7,3} + 62x_{7,4} + 34x_{7,5} + 58x_{7,6} + 0x_{7,7} + 54x_{7,8} + 41x_{8,1} + 38x_{8,2} + 30x_{8,3} + 65x_{8,4} + 24x_{8,5} + 60x_{8,6} + 53x_{8,7} + 0x_{8,8} \leq Z_{P\text{-}Center} \quad (52)$$

$$x_{1,1} + x_{1,2} + x_{1,3} + x_{1,4} + x_{1,5} + x_{1,6} + x_{1,7} + x_{1,8} = 1 \quad (53)$$

$$x_{2,1} + x_{2,2} + x_{2,3} + x_{2,4} + x_{2,5} + x_{2,6} + x_{2,7} + x_{2,8} = 1 \quad (54)$$

$$x_{3,1} + x_{3,2} + x_{3,3} + x_{3,4} + x_{3,5} + x_{3,6} + x_{3,7} + x_{3,8} = 1 \quad (55)$$

$$x_{4,1} + x_{4,2} + x_{4,3} + x_{4,4} + x_{4,5} + x_{4,6} + x_{4,7} + x_{4,8} = 1 \quad (56)$$

$$x_{5,1} + x_{5,2} + x_{5,3} + x_{5,4} + x_{5,5} + x_{5,6} + x_{5,7} + x_{5,8} = 1 \quad (57)$$

$$x_{6,1} + x_{6,2} + x_{6,3} + x_{6,4} + x_{6,5} + x_{6,6} + x_{6,7} + x_{6,8} = 1 \quad (58)$$

$$x_{7,1} + x_{7,2} + x_{7,3} + x_{7,4} + x_{7,5} + x_{7,6} + x_{7,7} + x_{7,8} = 1 \quad (59)$$

$$x_{8,1} + x_{8,2} + x_{8,3} + x_{8,4} + x_{8,5} + x_{8,6} + x_{8,7} + x_{8,8} = 1 \quad (60)$$

$$y_1 + y_2 + y_3 + y_4 + y_5 + y_6 + y_7 + y_8 \leq 6 \quad (61)$$

$$x_{1,1} , x_{2,1} , x_{3,1} , x_{4,1} , x_{5,1} , x_{6,1} , x_{7,1} , x_{8,1} \leq y_1$$

$$x_{1,2} , x_{2,2} , x_{3,2} , x_{4,2} , x_{5,2} , x_{6,2} , x_{7,2} , x_{8,2} \leq y_2$$

$$x_{1,3} , x_{2,3} , x_{3,3} , x_{4,3} , x_{5,3} , x_{6,3} , x_{7,3} , x_{8,3} \leq y_3$$

$x_{1,4}$, $x_{2,4}$, $x_{3,4}$, $x_{4,4}$, $x_{5,4}$, $x_{6,4}$, $x_{7,4}$, $x_{8,4} \leq y_4$
$x_{1,5}$, $x_{2,5}$, $x_{3,5}$, $x_{4,5}$, $x_{5,5}$, $x_{6,5}$, $x_{7,5}$, $x_{8,5} \leq y_5$
$x_{1,6}$, $x_{2,6}$, $x_{3,6}$, $x_{4,6}$, $x_{5,6}$, $x_{6,6}$, $x_{7,6}$, $x_{8,6} \leq y_6$
$x_{1,7}$, $x_{2,7}$, $x_{3,7}$, $x_{4,7}$, $x_{5,7}$, $x_{6,7}$, $x_{7,7}$, $x_{8,7} \leq y_7$
$x_{1,8}$, $x_{2,8}$, $x_{3,8}$, $x_{4,8}$, $x_{5,8}$, $x_{6,8}$, $x_{7,8}$, $x_{8,8} \leq y_8$ (62)

Solution obtained is in Table 6

Table 6. *P-Center Problem* Optimal Solution

Solver Status	
Model Class	MILP
State	Global Optimal
Objective	8512
Infeasibility	0
Iterations	0
Extended Solver Status	
Solver Type	Branch and Bound
Best Objective	8512
Objective bound	8512
Steps	0
Active	0
Update Interval	2
GMU (K)	48
ER (sec)	0

Completion of the *P-Median Problem* is obtained :

a. Customers in Ilir Timur II District (x_1) were placed at the facility location in Ilir Timur II District (x_1)
b. Customers in Kalidoni District (x_2) are placed at the facility's location in Kalidoni District (x_2)
c. Customers in Kemuning District (x_3) are placed at the location of the facility in Kemuning District (x_3)
d. Customers in Plaju District (x_4) are placed at the facility location in Seberang Ulu II (x_6)
e. Customers in Sako District (x_5) are placed at the facility location in Sako District (x_5)
f. Customers in Seberang Ulu II District (x_6) are placed at the facility location in Seberang Ulu II (x_6)
g. Customers in Sematang Borang District (x_7) are placed at the facility location in Sukarami District (x_8)
h. Customers in Sukarami District (x_8) are placed at the facility location in Sukarami District (x_8)

4. Conclusion

Based on the discussion, it can be concluded that the number of Emergency Unit locations in order to serve 8 sub-districts in Palembang City is 6 locations. The location of the Emergency Unit can be built in the following 6 locations: Ilir Timur II Subdistrict, Kalidoni Subdistrict, Sako Subdistrict, Seberang Ulu II Subdistrict, Sematang Borang Subdistrict, and Sukarami Subdistrict.

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References

[1] Dzator M 2006 *The optimal location of emergency units within* cities *Thesis* Curtin University of Technology, Perth
[2] Segall M, Lumb R, Lall V, & Moreno, A 2017 Healthcare Facility Location: A DEA Approach *American Journal of Management* **17**(6), 54-65
[3] Dzator M and Dzator J 2015 *An Efficient Modified Greedy Algorithm for the P-Median Problem* Paper presented at the 21st *International Congress on Modelling and Simulation*
[4] Dzator M and Dzator J 2017 The p-Median Problem and Health Facilities: Cost Saving and Improvement in Healthcare Delivery Through Facility Location. In R. Sarker, H. Abbass, S. Dunstall, P. Kilby, R. Davis & L. Young (Eds.), *Data and Decision Sciences in Action, Lecture Notes in Management and Industrial Engineering*: Springer International Publishing AG 2018
[5] Neebe A W 1988 A Procedure for Locating Emergency-Service Facilities for All Possible Response Distances *J. Opt Res. Soc.* **39**(8) 743-748
[6] Rahmawati M 2009 *Penentuan Jumlah dan Lokasi Halte Rute I Bus Rapid Transit* (*BRT*) *di Surakarta dengan Model Set Covering* Problem (Surakarta : Universitas Sebelas Maret)
[7] Daskin M S and Maass K L 2015 *The P-Median Problem* (USA : University of Michigan)
[8] Hannawati A, Thiang and Eleazer 2002 Pencarian Rute Optimum Menggunakan Algoritma Genetika Universitas Kristen Petra
[9] Puspita, F. M., Hartono, Y., Syaputri, N. Z., & Pratiwi, W. D. (2018). Robust Counterpart Open Capacitation Vehicle Routing (RCOCVRP) Model in Optimization of Garbage Transportation in Sako District and Sukarami District, Palembang City. *International Journal of Electrical and Computer Engineering (IJECE),* **8**(6)
[10] Hayati E N 2010 *Aplikasi Algoritma Branch and Bound Untuk Menyelesaikan Integer Programming* Universitas Stikubank Semarang
[11] Anonim 2011 *Tutorial Penggunaan Lingo. https://ko2smath06.wordpress.com.* (Accessed on February 6, 2018, pukul 09.18 WIB)

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