November-December 2019
ISSN: 0193-4120 Page No. 2176 - 2190

A Bi-Perspective Positioning of Household Waste Transfer Points for Boyolali Regency, Central Java, Indonesia

Eko Setiawan *
Industrial Engineering Department, Engineering Faculty, Universitas Muhammadiyah Surakarta, Indonesia
*Corresponding email: Eko.Setiawan@ums.ac.id
Nuruddin Zuhri
PT. Kayu Lapis Indonesia, Kendal, Indonesia
Yoga Ardi Nugroho
Industrial Engineering Department, Engineering Faculty, Universitas Muhammadiyah Surakarta, Indonesia
Much Djunaidi
Industrial Engineering Department, Engineering Faculty, Universitas Muhammadiyah Surakarta, Indonesia
Suranto
Industrial Engineering Department, Engineering Faculty, Universitas Muhammadiyah Surakarta, Indonesia
Septin Puji Astuti
Center for Science and Technology, IAIN Surakarta, Indonesia

Article Info
Volume 81
Page Number:2176 - 2190
Publication Issue:
November-December 2019

Article History
Article Received: *5 March 2019*
Revised: *18 May 2019*
Accepted: *24 September 2019*
Publication: *12 December 2019*

Abstract:
This article deals with the positioning of household waste transfer points from the perspective of minimising total number of transfer points and covering all the waste generators, respectively, as a response to growing importance of household waste management issue. By taking Boyolali Regency, Central Java, Indonesia, as an example, the problem is formulated as an MILP, is approached with a modified set covering method, and finally is solved by using software LINGO 11. The article concludes that the 13 selected transfer points are able to serve the 35units of waste generators in the year of 2016. In case of 50% increase of waste volume, the conclusion remains the same, given 50% increase of the 13 transfer points' capacity.

Keywords: *Household Waste, Location-Allocation, Modified SetCovering, Waste Transfer Point*

I. Introduction

Importance and emergence of waste grows over time(Mccunney, 1986; Kennes and Thalasso, 1998; Yuan and Shen, 2011; Krook, Svensson and Eklund, 2012; Zaman, 2015; Wang et al., 2016; Yu and Solvang, 2017). Lack of good waste management results in serious problems such as landslide(Lavigne et al., 2014; Ouyang et al., 2016; Gao et al., 2017; Liang et al., 2017);decreasing water quality (Earman and Hershey, 2004; Vasanthi, Kaliappan and Srinivasaraghavan, 2008); negative impacts to society (Taylor et al., 1991; Martin, Williams and Clark, 2006; Owusu, 2010; Scott et al.,

November-December 2019
ISSN: 0193-4120 Page No. 2176 - 2190

2012);economical effects (Kohlhase, 1991; Maheshi, Steven and Karel, 2015); health effects(Finkelman, 2004; Ayomoh et al., 2008; Yang, Huo and Yekeen, 2013; Ozabor and Obaro, 2016; Woon and Lo, 2016; Ziraba, Haregu and Mberu, 2016)and negative impacts to environment(El-fadel, Findikakis and Leckie, 1997; Earman and Hershey, 2004; Quinn et al., 2005; Hischier, Wäger and Gauglhofer, 2005; Kirkeby et al., 2007; Ayomoh et al., 2008; Barba-Gutierrez, Adenso-Diaz and Hopp, 2008; Rabl, Spadaro and Zoughaib, 2008; Wang et al., 2008; Morselli et al., 2008; Robinson, 2009; Manfredi, Tonini and Christensen, 2010; Osinibi and Law, 2014; Maheshi, Steven and Karel, 2015), to name a few. More specifically, poor management of household waste leads to a variety of misfortunes(Giusti, 2009; Tai et al., 2011; Laurent et al., 2014). The misfortunes are even critical in developing countries(Henry, Yongsheng and Jun, 2006; Al-khatib et al., 2007; Pasang, Moore and Sitorus, 2007; Ayomoh et al., 2008; Troschinetz and Mihelcic, 2009; Owusu, 2010; Oteng-ababio, Ernesto and Arguello, 2013; Ozabor and Obaro, 2016; Ziraba, Haregu and Mberu, 2016).

Nowadays, household waste in regencies and municipalities in Indonesia is generally organised as it is presented in Figure 1(Djunaidi, Angga and Setiawan, 2018).From the figure, it is obvious that the household waste from waste generators (WGs) is transported to transfer points from which the waste is subsequently sent to disposal sites. In voluminous areas in the country, third parties salaried by a set of waste generators conduct the first step of the conveyanceprocesses. The transportation processes from transfer points to disposal sites, on the other hand, are mostly handled by government agencies responsible for them using transportation devices with larger capacities. In this circumstance, the transfer points are made available by the government agencies based on requests from the society.

Boyolali Regency is located in Central Java, Indonesia. In the year of 2016, its 1,015.10 km2 area is populated by 963,690 persons spreading over 19 sub-regencies (BPS, 2017). In the same year, the regency has 261 villages(BPS, 2017). In terms of household waste management, 57 legal transfer points (TPs) are available in Boyolali Regency in the year of 2016(Zuhri, 2017). Household waste, on the other hand, is produced over all areas in the regency(Zuhri, 2017).

This leads to an important issue: where the collection points should be built in such a way that their number is as minimum as possible due to financial reasons and, at the same time, all the waste generated is coverable.

Figure 1: Recent Household Waste management Systems in Indonesia. The waste comes from households or industries (1), In numerous areas of the country, sanitary workers pick up the waste (2), The waste is placed at transfer points (3), The waste is transported to waste disposal sites by trucks, and (4) Landfilling at disposal sites (5).

In the paper, the issue under concern is expressed as a mixed integer linear programming (MILP) and is dealt with a modified set covering model. Using data acquired from the field, the model is resolved by applying software LINGO 11.

The progress of set covering models, tothe best of our knowledge, can be outlined back to the year of 1971(Bellmore and Ratfliff, 1971). Since

TEST Engineering & Management
November-December 2019
ISSN: 0193-4120 Page No. 2176 - 2190

then, the academic societieswitness an ever-increasing number of research and publications on the implementation of set covering models(Farahani et al., 2012)(Farahani et al., 2012). This contains those to the management of waste (Ye, Ye and Chuang, 2011; Li et al., 2014; Eiselt and Marianov, 2015; Purkayastha, Majumder and Chakrabarti, 2015).

The article is ordered as follows. Available at the end of the paper is conclusions, and is preceded by results and discussion. Method of research is presented prior to the results and discussion.

II. Research Method

The research is conducted by firstly observing the circumstance around household waste in Boyolali Regency. From the observation, it is found that Agency of Environment in the regency assumes responsibility of managing household waste in the regency. It is also revealed that the TPs in the regency vary in terms of their capacity. Considering this fact, the TPs were assessed based on the criteria of capacity. Among 57 TPs, 37 TPs (see Table 1) were subsequently selected as alternative TPs. Villages in the center of each sub-district and several community centers, on the other hand, are used as units of WGs. This leads to a total number of 35 WGs in the research paper (see Table 2).Between points of WGs and TPs are linked by travelling times. The travelling times are set not to be greater than 8 hours, that is, the sanitary workers' maximum working hour in one day. Google map was used to gain data on travelling times between nodes of alternative sites.

Table 1:Transfer Points (TPs) and their Location

Alternative TP	*Location*	*Capacity (m3)*	*Coordinates on the map*
Alternative 1	Pandean Selatan, Kiringan Village	6.00	(-7.511628,110.597771)
Alternative 2	Dukuh Ngambuh, Kebonbimo Village	16.00	(-7.506375,110.600479)
Alternative 3	To the east of Boyolali Traffic Unit, Karanggeneng Village	6.00	(-7.517221,110.595741)
Alternative 4	Umi Barokah Hospital, Karanggeneng Village	2.25	(-7.515225,110.595238)
Alternative 5	Behind Junior High School 3 Karanggeneng, Karanggeneng Village	4.50	(-7.519263,110.601486)
Alternative 6	Pusung depo transfer, Banaran Village	10.00	(-7.529235,110.601776)
Alternative 7	Kemuning 1 Road, Banaran Village	6.00	(-7.527197,110.599014)
Alternative 8	Kemuning 2 Road, Banaran Village	6.00	(-7.525705,110.598412)
Alternative 9	Behind Primary School No. 9 Boyolali, Siswodipuran Village	6.00	(-7.530211,110.594162)
Alternative 10	In front of Bank Guna Daya office, Siswodipuran Village	7.50	(-7.533048,110.599892)
Alternative 11	In front of Marhaen House, Siswodipuran Village	7.00	(-7.538671,110.606079)
Alternative 12	Kauman Baru, Siswodipuran Village	2.00	(-7.540548,110.593147)
Alternative 13	In front of Junior High School No. 1 Boyolali, Siswodipuran Village	4.50	(-7.533038,110.599892)
Alternative 14	Merapi Road, Dukuh Dawung, Siswodipuran Village	4.50	(-7.533190,110.597672)
Alternative 15	To the south of Sor Nongko Chicken Noodle Restaurant, Siswodipuran Village	4.50	(-7.536175,110.591614)
Alternative 16	To the west of Sumur Umum, Jl. Anggrek, Siswodipuran Village	6.00	(-7.538970,110.593048)
Alternative 17	The bridge behind Central Farma Pharmacy,	5.60	(-7.534970,110.593124)

	Siswodipuran Village		
Alternative 18	To the west of Pulisen cow statue, Pulisen Village	10.50	(-7.539928,110.589111)
Alternative 19	Pahlawan Road to the north of traffic light, Pulisen Village	7.50	(-7.539972,110.603615)
Alternative 20	Behind Luwes Department Store, Pulisen Village	16.20	(-7.537035,110.607318)
Alternative 21	Pisang Road at city border, Pulisen Village	16.00	(-7.537982,110.610193)
Alternative 22	To the north of Karisma Radio, Pulisen Village	4.50	(-7.541217,110.608642)
Alternative 23	In front of BK Senior High School, Pulisen Village	18.00	(-7.546027,110.605550)
Alternative 24	Madu Mulyo Regency, Pulisen Village	5.25	(-7.542728,110.595432)
Alternative 25	Behind Boyolali sports building, Pulisen Village	5.25	(-7.541162,110.596080)
Alternative 26	Behind Vocational Senior High School No. 1 Boyolali, Pulisen Village	9.90	(-7.543248,110.592753)
Alternative 27	Inside Vocational Senior High School No. 1 Boyolali, Pulisen Village	16.20	(-7.543398,110.593025)
Alternative 28	Griya Pulisen Regency, Pulisen Village	8.00	(-7.540722, 110.5908)
Alternative 29	Islamic Senior High School Boyolali, Pulisen Village	16.20	(-7.539397,110.600090)
Alternative 30	In front of the office of Boyolali Leadership Board of Golkar, Pulisen Village	6.00	(-7.537842,110.589523)
Alternative 31	Cendana 1 Road, Winong Village	10.50	(-7.529955,110.590668)
Alternative 32	Cendana 2 Road, Winong Village	6.00	(-7.527006,110.590725)
Alternative 33	Cendana 3 Road, Winong Village	6.00	(-7.524617,110.591671)
Alternative 34	KlatakBridge, Winong Village	6.00	(-7.528158,110.594207)
Alternative 35	Bayem Poncodoyo Bridge, Winong Village	6.00	(-7.523788,110.594475)
Alternative 36	CepekDukuh, Winong Village	6.00	(-7.512486,110.595873)
Alternative 37	In front of Boyolali Military Office, Winong Village	4.50	(-7.518044,110.593094)

Table 2:Waste Generators (WGs) and their Location

WG	*Location*	*WG*	*Location*
WG 1	Bumi Singkil Indah Residence	WG 19	Srimulya Village
WG 2	Bumi Singkil Permai Residence	WG 20	Pusung Village
WG 3	Recosari Village	WG 21	Banaran Village
WG 4	Kaligentong Village	WG 22	Srawedanan Village
WG 5	Banyudono Village	WG 23	Siswodipuran Village
WG 6	Cepogo Village	WG 24	Pulisen Village
WG 7	Mojosongo Village	WG 25	Griya Pulisen Residence
WG 8	Musuk Village	WG 26	Gatak Village
WG 9	Sambi Village	WG 27	Susiloharjo Village
WG 10	Sawit Village	WG 28	Bakungan Village
WG 11	Selo Village	WG 29	Ndriyan Village
WG 12	Simo Village	WG 30	Madu Mulya Village
WG 13	Teras Village	WG 31	Bangunharjo Village
WG 14	Gambiran Square Residence	WG 32	Dukuhan Village
WG 15	Kiringan Village	WG 33	Cepek Village
WG 16	Kebonbimo Village	WG 34	Winong Village
WG 17	Banjarsari Village	WG 35	Penggung Village
WG 18	Griya Permai Residence		

TEST Engineering & Management
November-December 2019
ISSN: 0193-4120 Page No. 2176 - 2190

The modifiedset covering model of the MILP under concern is as follows:

$$\text{Minimize } \sum_{j\in J} x_j \tag{1}$$

Subject to:

$$\sum_{j\in N_i} y_{ij} = 1 \ \forall i \in I \tag{2}$$

$$\sum_{i\in I} v_i y_{ij} - c_j x_j \le 0 \forall j \in J \tag{3}$$

$$x_j \in \{0, 1\} \forall j \in J \tag{4}$$

$$y_{ij} \in \{0, 1\} \forall i \in I, j \in J \tag{5}$$

where:

I = set of WGs, I = {1, 2, ..., 270}

J = set of TPs, J = {1, 2, ..., 37}

c_j = capacity of alternative TPs of j, $j \in J$

v_i = waste volume produced by WGs of i in m^3/day, $i \in I$

T_{ij} = traveling time between WGs of $i \in I$ and alternative TPs of $j \in J$, in minutes

T_c = maximum tolerance of traveling time for transporting waste, 8 hours

N_i = $\{j|T_{ij} \le T_c\}$

x_j = decision variable associated with alternative TPs of j

$$= \begin{cases} 1, if\ alternative\ TPs\ of\ j\ is\ selected\ as\ a\ TP \\ 0, otherwise \end{cases}$$

y_{ij} = whether or not WGs of i is served by alternative TPs of j

$$= \begin{cases} 1, if\ the\ answer\ is\ yes \\ 0,\ if\ otherwise \end{cases}$$

The model minimizes the total number of TPs, as can be inferred from Constraint (1). Constraints (2) set a guarantee that each WG is served by exactly one TP. The requirement that every TP can only serve WGs of which total waste volume are not greater than the TP's capacity is reflected by Constraints (3). Constraints (4) and (5), in the meantime, are binary variables.

The model is subsequently tested by using data on the aforementioned travelling times between WGs and TPs with the aid of LINGO version 11.0. In addition to the year of 2016situation of waste production (and is called 2016 scenario from now on), another scenario of waste production are considered: increasing production of waste by 50% (and is henceforth referred to as 50%_up scenario).The screenshot of the formulation is provided in Figure 1 and Figure 2.

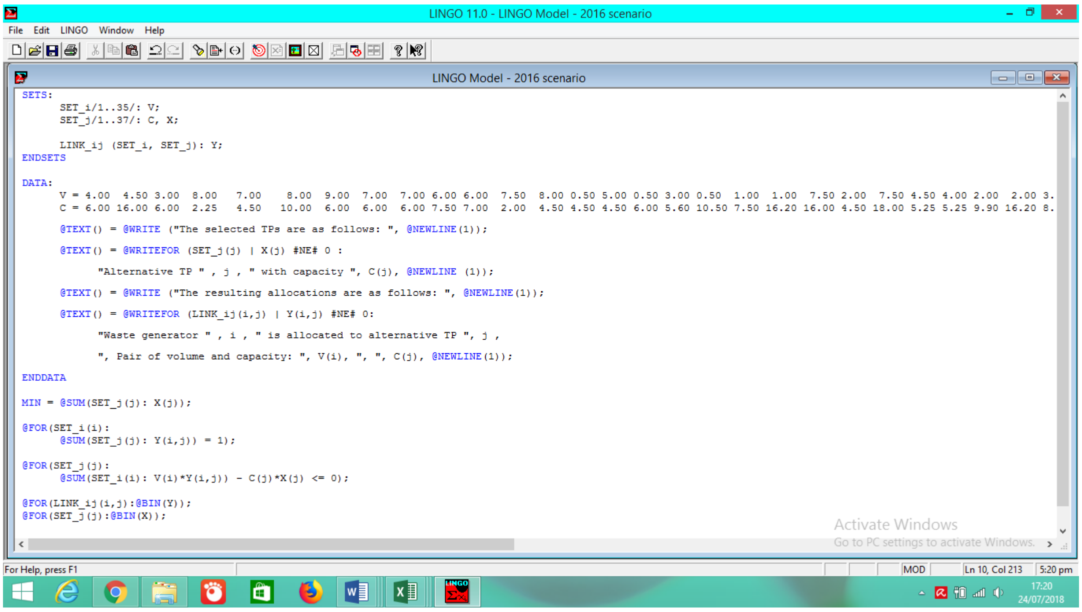

Figure 1: Formulation of 2016 Scenario

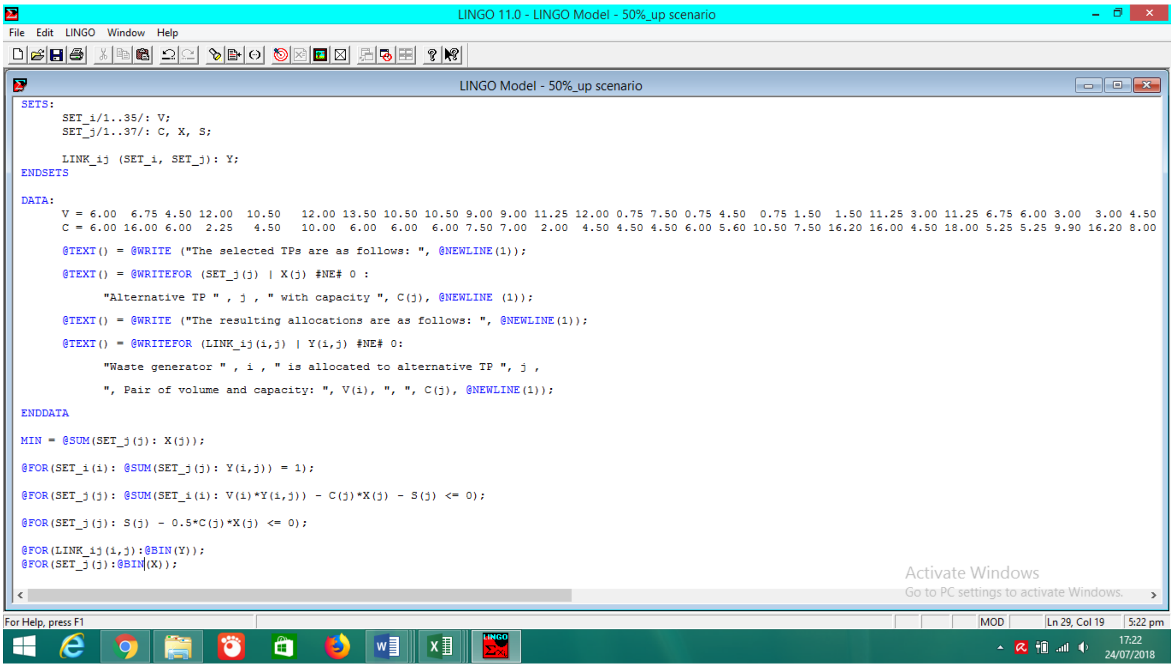

Figure 2: Formulation of 50%_up Scenario

The formulations are subsequently executed. The screenshot of the result are available in Figure 3a and Figure 3bfor the 2016 scenario. The final result of the 50%_up scenario, in the meantime, is presented in Figure 4a, Figure 4b, and Figure 4c.

November-December 2019
ISSN: 0193-4120 Page No. 2176 - 2190

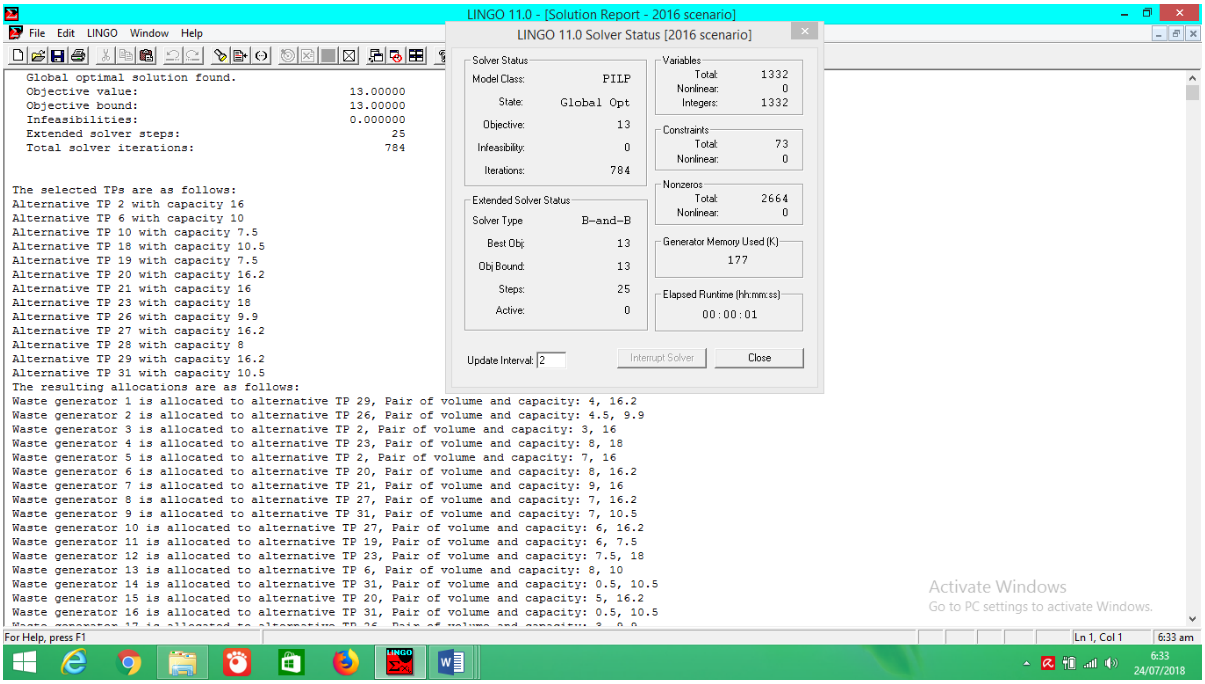

Figure 3a:Screenshot of the Global Optimal Solution for the 2016 Scenario

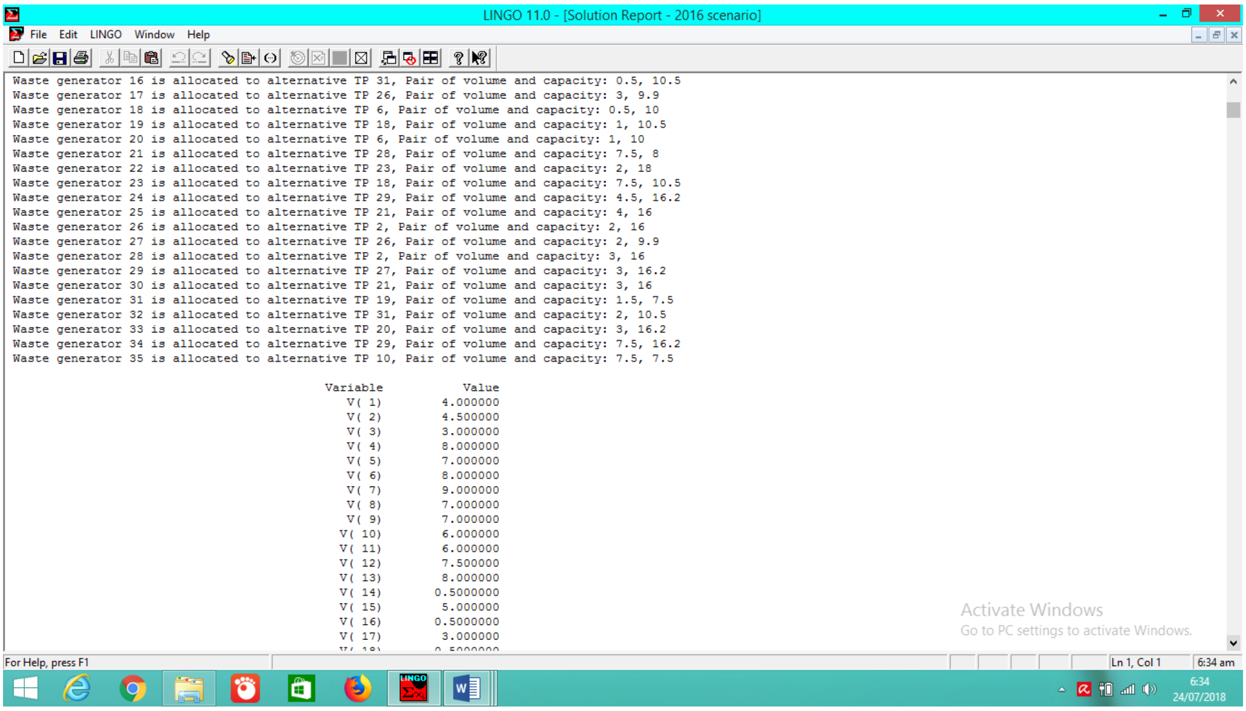

Figure 3b:Screenshot of the allocation for the 2016 scenario

Published by: The Mattingley Publishing Co., Inc.

November-December 2019
ISSN: 0193-4120 Page No. 2176 - 2190

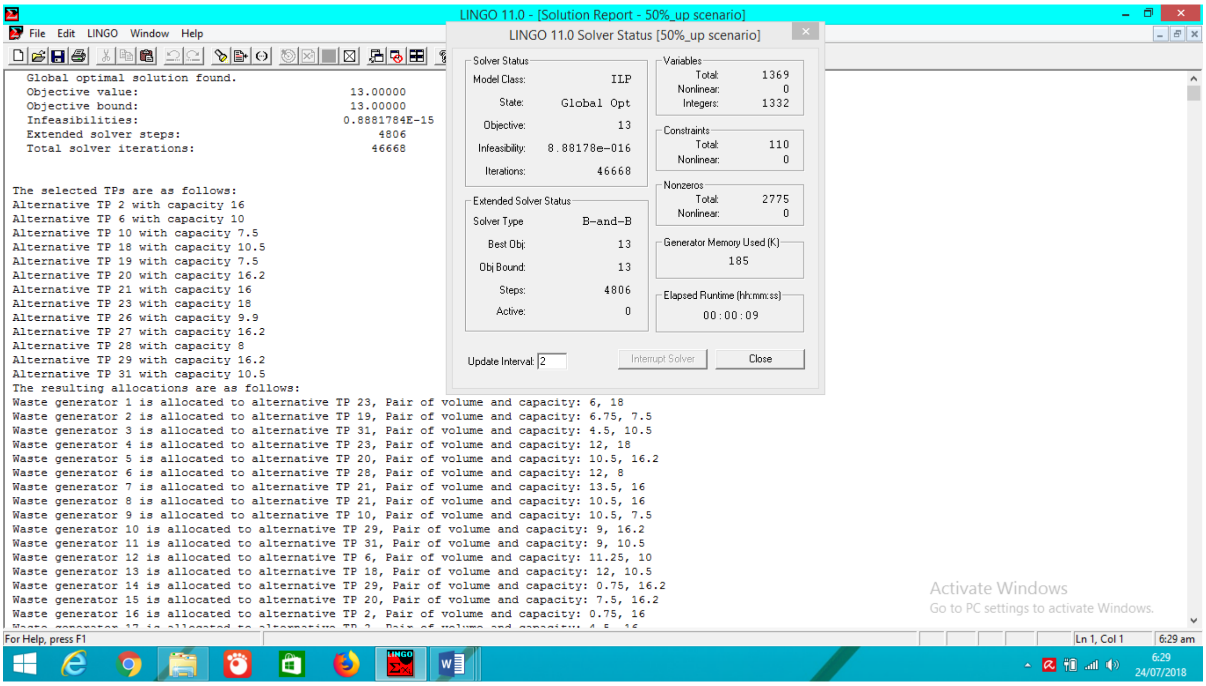

Figure 4a:Screenshot of the Global Optimal Solution for the 50%_up Scenario

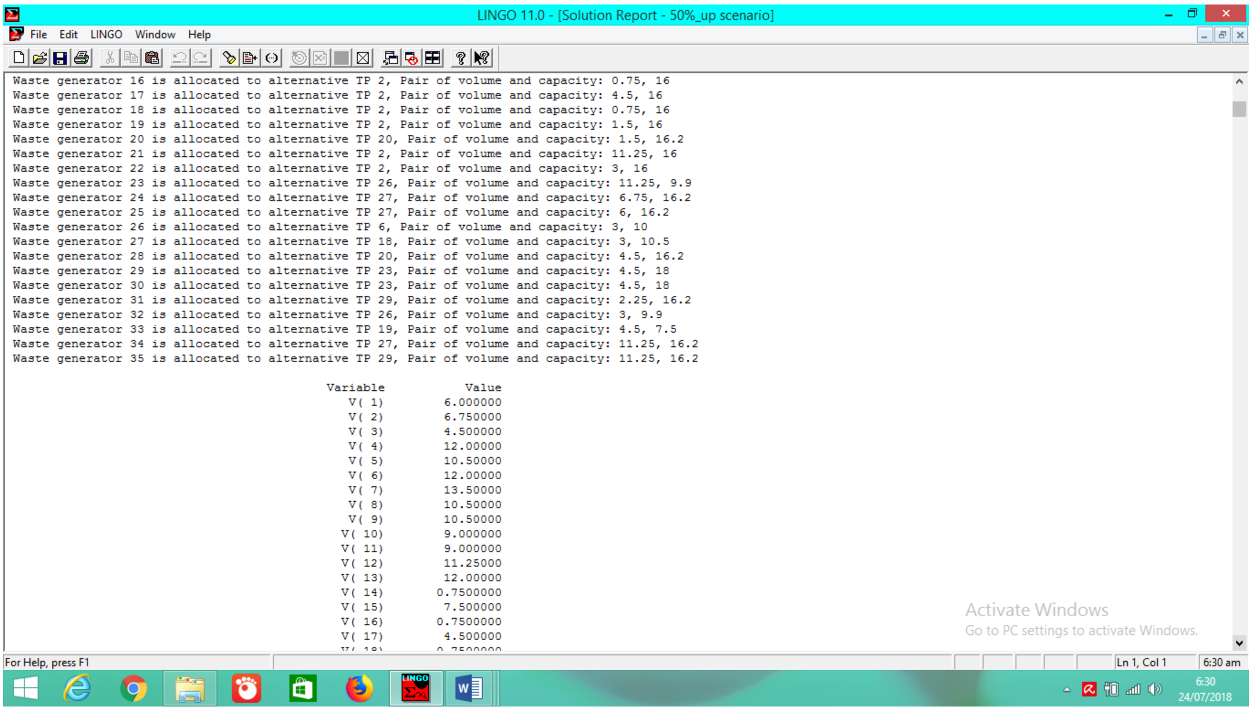

Figure 4b:Screenshot of the Allocation for the 50%_up Scenario

Published by: The Mattingley Publishing Co., Inc.

November-December 2019
ISSN: 0193-4120 Page No. 2176 - 2190

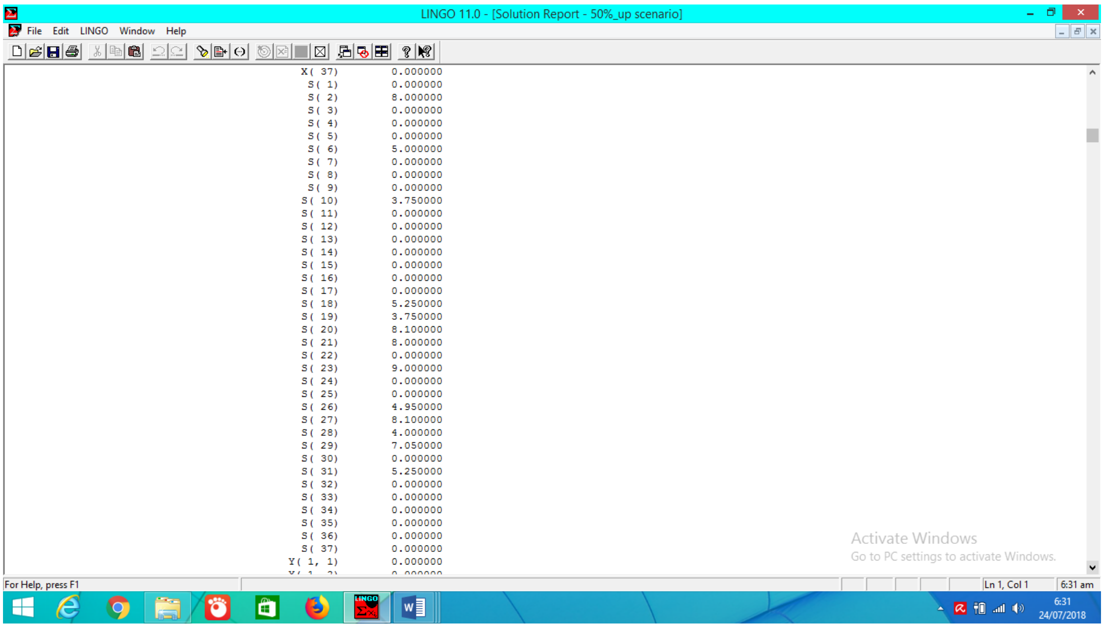

Figure 4c:Screenshot of the Slack Values for the 50%_up Scenario

III. Results and Discussion

Table 3 gives the summary on alternative TPs selected as results of the computational experiments for the 2016 scenarios.The final results of the implementation of the 50%_up scenario is available in Table 4.

Table 3:Result for the 2016 Scenario

Selected TP				
No.	*TP*	*Capacity (m3)*	*Total waste volume allocated to the TP*	*Unused capacity (m3)*
1	Alternative 2	16.00	15.00	1.00
2	Alternative 6	10.00	9.50	0.50
3	Alternative 10	7.50	7.50	0.00
4	Alternative 18	10.50	8.50	2.00
5	Alternative 19	7.50	7.50	0.00
6	Alternative 20	16.20	16.00	0.20
7	Alternative 21	16.00	16.00	0.00
8	Alternative 23	18.00	17.50	0.50
9	Alternative 26	9.90	9.50	0.40
10	Alternative 27	16.20	16.00	0.20
11	Alternative 28	8.00	7.50	0.50
12	Alternative 29	16.20	16.00	0.20
13	Alternative 31	10.50	10.00	0.50
Total		162.50	156.50	6.00

November-December 2019
ISSN: 0193-4120 Page No. 2176 - 2190

Based on information available in Table 3, 13 alternatives of TPs are selected to serve the 35 WGs. With a total capacity of 162.50 m3, the selected TPs are available to handle the total waste volume of 156.50 m3. Among the 13 TPs selected, 10 ones still have unused capacity with a total of 6.00 m3.

Using the same mathematical formulation, data with 50% increase in terms of waste volume was computationally tested. The result shows no feasible solution. The problem is slightly modified by increasing each of the alternatives' capacity by 50%, considering the fact that, for the next 10 years from 2016, the total population from which the waste is produced will be increased by slightly below 50%. The mathematical formulation is subsequently adjusted by replacing Constraint (3) with a new one and by adding one more constraint wherein slack variables are included. In full, the adjusted mathematical formulation is as follows, where Constraints (3') alongside with Constraints (6) allow each alternative TP to have 1.5 times capacity than the original one.

$$\text{Minimize } \sum_{j\in J} x_j \qquad \text{.............................. (1)}$$

Subject to:

$$\sum_{j\in N_i} y_{ij} = 1\ \forall i \in I \qquad \text{.............................. (2)}$$

$$\sum_{i\in I} v_i y_{ij} - c_j x_j - s_j \leq 0 \forall j \in J \qquad \text{.............................. (3)}$$

$$x_j \in \{0,\ 1\} \forall j \in J \qquad \text{.............................. (4)}$$

$$y_{ij} \in \{0, 1\} \forall i \in I, j \in J \qquad \text{.............................. (5)}$$

$$s_j - 0.5 c_j x_j \leq 0 \forall j \in J \qquad \text{.............................. (6)}$$

Table 4 provides the final result of the implemention of the 50%_up scenario in this way. It can be seen from Table 4 that the selected TPs in the 50%_up scenario is exactly those resulted from the implementation of the 2016 scenario. It is also availaible from Table 4 that a total 7.95 m3 of the increasing capacity is left unused. Interestingly, different from the result of the 2016 scenario, 5 out of 13 selected TPs in the 50%_up scenario operate at full capacity.

Table 4: Final Result for the 50%_up Scenario

SelectedTP					
No.	*TP*	*Original capacity (m3)*	*"Added" capacity (m3)*	*Total capacity (m3)*	*Unused capacity (m3)*
1	Alternative 2	16.00	8.00	24.00	2.25
2	Alternative 6	10.00	5.00	15.00	0.75
3	Alternative 10	7.50	3.75	11.25	0.75
4	Alternative 18	10.50	5.25	15.75	0.75
5	Alternative 19	7.50	3.75	11.25	0.00
6	Alternative 20	16.20	8.10	24.30	0.30
7	Alternative 21	16.00	8.00	24.00	0.00
8	Alternative 23	18.00	9.00	27.00	0.00
9	Alternative 26	9.90	4.95	14.85	0.60

November-December 2019
ISSN: 0193-4120 Page No. 2176 - 2190

10	Alternative 27	16.20	8.10	24.30	0.30
11	Alternative 28	8.00	4.00	12.00	0.00
12	Alternative 29	16.20	7.05	23.25	0.00
13	Alternative 31	10.50	5.25	15.75	2.25
Total		162.50	80.2	242.7	7.95

Another interesting finding relates to which WGs are served by each of the selected TPs in each of the scenario. Table 5 is associated with this issue. From Table 5, despite the same chosen TPs in both scenarios, it is clear that the increasing volume of waste leads to different configuration of service given to the WGs. This in turn leads to different average traveling times. Alternative 10, for instance, has to travel 4.60 minutes on average in the 2016 scenario and 18.40 minutes on average in the 50%_up scenario. Alternative 28, in the meantime, has to travel 2.40 minutes on average in the 2016 scenario and 9.90 minutes on average in the 50%_up scenario.

Table 5: Service Given to WGs in the Scenarios

No.	*Selected TP*	*WGs served by the selected TP*	
		2016 scenario	*50%_up scenario*
1	Alternative 2	3, 5, 26, 28	16, 17, 18, 19, 21, 22
2	Alternative 6	13, 18, 20	12, 26
3	Alternative 10	35	9
4	Alternative 18	19, 23	13, 27
5	Alternative 19	11, 3	2, 33
6	Alternative 20	6, 15, 33	5, 15, 20, 28
7	Alternative 21	7, 25, 30	7, 8
8	Alternative 23	4, 12, 22	1, 4, 29, 30
9	Alternative 26	2, 17, 27	23, 32
10	Alternative 27	8, 10, 29	24, 25, 34
11	Alternative 28	21	6
12	Alternative 29	1, 24, 34	10, 14, 31, 35
13	Alternative 31	9, 14, 16, 32	3, 11

IV. Conclusions

This article examines the positioning of household waste transfer points and household waste generators' allocation to the points from two contradictory perspectives: how to minimise the total number of the transfer points provided for all the waste generators within the context of Boyolali Regency, Central Java, Indonesia. It can be concluded that the selected 13 out of 37 alternatives of transfer points are sufficient for serving the waste generators in the year of 2016. Anticipating 50% increase of total volume of waste produced, the research argues that the 13 selected alternatives are still able to serve all the waste generators, given that the capacity of the selected alternatives is increased by 50%.

V. Acknowledgments

This project is financially supported by the Applied Research Program (No. 211.25/ A.3-III/ LPPM/ V/ 2017)from Directorate General of Research and Development Strengthening,MinistryofResearch,Technology andHigherEducation, Republic of Indonesia.

REFERENCES

[1] Al-khatib, I. A. et al. (2007) 'Trends and problems of solid waste management in developing countries : A case study in seven Palestinian districts', 27, pp. 1910–1919. doi: 10.1016/j.wasman.2006.11.006.

[2] Ayomoh, M. K. O. et al. (2008) 'An approach to tackling the environmental and health impacts of municipal solid waste disposal in developing countries', Journal of Environmental Management, 88(1), pp. 108–114. doi: 10.1016/j.jenvman.2007.01.040.

[3] Barba-Gutierrez, Y., Adenso-Diaz, B. and Hopp, M. (2008) 'An analysis of some environmental consequences of European electrical and electronic waste regulation', Resources, Conservation and Recycling, 52, pp. 481–495. doi: 10.1016/j.resconrec.2007.06.002.

[4] Bellmore, M. and Ratfliff, H. D. (1971) 'Set covering and involutory bases', Management Science, 18(3), pp. 194–206. doi: 10.1287/mnsc.1040.0262.

[5] BPS (2017) Kabupaten Boyolali Dalam Angka 2017. Boyolali.

[6] Djunaidi, M., Angga and Setiawan, E. (2018) 'Disposal site selection using TOPSIS in Wonogiri District Central Java', Jurnal Ilmiah Teknik Industri, 17(1), pp. 62–70. doi: 10.23917/jiti.v17i1.5389.

[7] Earman, S. and Hershey, R. L. (2004) 'Water quality impacts from waste rock at a Carlin-type gold mine, Elko County, Nevada', Environmental Geology, 45(8), pp. 1043–1053. doi: 10.1007/s00254-004-0982-7.

[8] Eiselt, H. A. and Marianov, V. (2015) 'Location modeling for municipal solid waste facilities', Computers and Operations Research. Elsevier, 62, pp. 305–315. doi: 10.1016/j.cor.2014.05.003.

[9] El-fadel, M., Findikakis, A. N. and Leckie, J. O. (1997) 'Environmental Impacts of Solid Waste Landfilling', (November 1995), pp. 1–25.

[10] Farahani, R. Z. et al. (2012) 'Covering problems in facility location: A review', Computers and Industrial Engineering. Elsevier Ltd, 62(1), pp. 368–407. doi: 10.1016/j.cie.2011.08.020.

[11] Finkelman, R. B. (2004) 'Potential health impacts of burning coal beds and waste banks', International Journal of Coal Geology, 59(1–2), pp. 19–24. doi: 10.1016/j.coal.2003.11.002.

[12] Gao, Y. et al. (2017) 'Investigation and dynamic analysis of the long runout catastrophic landslide at the Shenzhen landfill on December 20, 2015, in Guangdong, China', Environmental Earth Sciences. Springer Berlin Heidelberg, 76(1). doi: 10.1007/s12665-016-6332-8.

[13] Giusti, L. (2009) 'A review of waste management practices and their impact on human health', Waste Management. Elsevier Ltd, 29(8), pp. 2227–2239. doi: 10.1016/j.wasman.2009.03.028.

[14] Henry, R. K., Yongsheng, Z. and Jun, D. (2006) 'Municipal solid waste management challenges in developing countries – Kenyan case study', 26, pp. 92–100. doi: 10.1016/j.wasman.2005.03.007.

[15] Hischier, R., Wäger, P. and Gauglhofer, J. (2005) 'Does WEEE recycling make sense from an environmental perspective? The environmental impacts of the Swiss take-back and recycling systems for waste electrical and electronic equipment (WEEE)', Environmental Impact Assessment Review,

25(5 SPEC. ISS.), pp. 525–539. doi: 10.1016/j.eiar.2005.04.003.
[16] Kennes, C. and Thalasso, F. (1998) 'Waste gas biotreatment technology', J. Chem. Technol. Biotechnol., 72, pp. 303–319.
[17] Kirkeby, J. T. et al. (2007) 'Modelling of environmental impacts of solid waste landfilling within the life-cycle analysis program EASEWASTE', 27, pp. 961–970. doi: 10.1016/j.wasman.2006.06.017.
[18] Kohlhase, J. E. (1991) 'The impact of toxic waste sites on housing values', Journal of Urban Economics, 30, pp. 1–26.
[19] Krook, J., Svensson, N. and Eklund, M. (2012) 'Landfill mining: a critical review of two decades of research', Waste Management. Elsevier Ltd, 32(3), pp. 513–520. doi: 10.1016/j.wasman.2011.10.015.
[20] Laurent, A. et al. (2014) 'Review of LCA studies of solid waste management systems – Part I : Lessons learned and perspectives', Waste Management. Elsevier Ltd, 34(3), pp. 573–588. doi: 10.1016/j.wasman.2013.10.045.
[21] Lavigne, F. et al. (2014) 'The 21 February 2005, catastrophic waste avalanche at Leuwigajah dumpsite, Bandung, Indonesia', Geoenvironmental Disasters, 1(1), p. 10. doi: 10.1186/s40677-014-0010-5.
[22] Li, L. et al. (2014) 'A covering model application on Chinese industrial hazardous waste management based on integer program method', Ecological Indicators. Elsevier Ltd, pp. 1–7. doi: 10.1016/j.ecolind.2014.05.001.
[23] Liang, H. et al. (2017) 'Dynamic process simulation of construction solid waste (CSW) landfill landslide based on SPH considering dilatancy effects', Bulletin of Engineering Geology and the Environment. Springer Berlin Heidelberg, pp. 1–15. doi: 10.1007/s10064-017-1129-x.
[24] Maheshi, D., Steven, V. P. and Karel, V. A. (2015) 'Resources, conservation and recycling environmental and economic assessment of "open waste dump" mining in Sri Lanka', 'Resources, Conservation & Recycling'. Elsevier B.V., 102, pp. 67–79. doi: 10.1016/j.resconrec.2015.07.004.
[25] Manfredi, S., Tonini, D. and Christensen, T. H. (2010) 'Contribution of individual waste fractions to the environmental impacts from landfilling of municipal solid waste', Waste Management. Elsevier Ltd, 30(3), pp. 433–440. doi: 10.1016/j.wasman.2009.09.017.
[26] Martin, M., Williams, I. D. and Clark, M. (2006) 'Social, cultural and structural influences on household waste recycling: A case study', Resources, Conservation and Recycling, 48, pp. 357–395. doi: 10.1016/j.resconrec.2005.09.005.
[27] Mccunney, R. J. (1986) 'Health effects of work at waste water treatment plants: a review of the literature with guidelines for medical surveillance', American Journal of Industrial Medicine, 279, pp. 271–279.
[28] Morselli, L. et al. (2008) 'Environmental impacts of waste incineration in a regional system (Emilia Romagna, Italy) evaluated from a life cycle perspective', Journal of Hazardous Materials, 159(2–3), pp. 505–511. doi: 10.1016/j.jhazmat.2008.02.047.
[29] Osinibi, O. M. and Law, P. (2014) 'Evaluating the impact of poor waste disposal management on environmental sustainability and human rights in Nigeria', 15(June 2012).
[30] Oteng-ababio, M., Ernesto, J. and Arguello, M. (2013) 'Solid waste management in African cities : Sorting the facts from the fads in Accra , Ghana', 39, pp. 96–104. doi: 10.1016/j.habitatint.2012.10.010.
[31] Ouyang, C. et al. (2016) 'Dynamic analysis and numerical modeling of the 2015 catastrophic landslide of the construction waste landfill at Guangming, Shenzhen, China', Landslides. Landslides, 14(2), pp. 705–718. doi: 10.1007/s10346-016-0764-9.
[32] Owusu, G. (2010) 'Social effects of poor sanitation and waste management on poor urban communities: A neighborhood-specific study of Sabon Zongo, Accra', Journal of Urbanism, 3(2), pp. 145–160. doi: 10.1080/17549175.2010.502001.

[33] Ozabor, F. and Obaro, H. N. (2016) 'Health effects of poor waste management in Nigeria: a case study of Abraka in Delta State', Waste Management, 18(3), pp. 195–204.
[34] Pasang, H., Moore, G. A. and Sitorus, G. (2007) 'Neighbourhood-based waste management: A solution for solid waste problems in Jakarta, Indonesia', Waste Management, 27(12), pp. 1924–1938. doi: 10.1016/j.wasman.2006.09.010.
[35] Purkayastha, D., Majumder, M. and Chakrabarti, S. (2015) 'Collection and recycle bin location-allocation problem in solid waste management : A review', Pollution, 1(2), pp. 175–191. Available at: https://jpoll.ut.ac.ir/article_52927_7f3c6c2744324db252eaead57db03019.pdf.
[36] Quinn, B. et al. (2005) 'Ecotoxicological effects of a semi-submerged municipal dump (Castle harbour, Bermuda) on the Calico scallop Argopecten gibbus', Marine Pollution Bulletin, 51(5–7), pp. 534–544. doi: 10.1016/j.marpolbul.2005.07.019.
[37] Rabl, A., Spadaro, J. V and Zoughaib, A. (2008) 'Environmental impacts and costs of solid waste : a comparison of landfill and incineration', (March 2007), pp. 147–162. doi: 10.1177/0734242X07080755.
[38] Robinson, B. H. (2009) 'Science of the Total Environment E-waste : An assessment of global production and environmental impacts', Science of the Total Environment, The. Elsevier B.V., 408(2), pp. 183–191. doi: 10.1016/j.scitotenv.2009.09.044.
[39] Scott, S. L. et al. (2012) 'The long-term effects of a coal waste disaster on social trust in Appalachian Kentucky', Organization and Environment, 25(4), pp. 402–418. doi: 10.1177/1086026612467983.
[40] Tai, J. et al. (2011) 'Municipal solid waste source-separated collection in China : A comparative analysis', Waste Management. Elsevier Ltd, 31(8), pp. 1673–1682. doi: 10.1016/j.wasman.2011.03.014.
[41] Taylor, S. M. et al. (1991) 'Psychosocial impacts in populations exposed to solid-waste facilities', Social Science & Medicine, 33(4), pp. 441–447.
[42] Troschinetz, A. M. and Mihelcic, J. R. (2009) 'Sustainable recycling of municipal solid waste in developing countries', Waste Management. Elsevier Ltd, 29(2), pp. 915–923. doi: 10.1016/j.wasman.2008.04.016.
[43] Vasanthi, P., Kaliappan, S. and Srinivasaraghavan, R. (2008) 'Impact of poor solid waste management on ground water', Environmental Monitoring and Assessment, 143(1–3), pp. 227–238. doi: 10.1007/s10661-007-9971-0.
[44] Wang, J. B. et al. (2008) 'Approaches adopted to assess environmental impacts of PCDD/F emissions from a municipal solid waste incinerator', Journal of Hazardous Materials, 152(3), pp. 968–975. doi: 10.1016/j.jhazmat.2007.07.090.
[45] Wang, Y. et al. (2016) 'Characteristics and trends of research on waste-to-energy incineration : A bibliometric analysis , 1999 – 2015', Renewable and Sustainable Energy Reviews. Elsevier, 66, pp. 95–104. doi: 10.1016/j.rser.2016.07.006.
[46] Woon, K. S. and Lo, I. M. C. (2016) 'An integrated life cycle costing and human health impact analysis of municipal solid waste management options in Hong Kong using modified eco-efficiency indicator', Resources, Conservation and Recycling. Elsevier B.V., 107, pp. 104–114. doi: 10.1016/j.resconrec.2015.11.020.
[47] Yang, H., Huo, X. and Yekeen, T. A. (2013) 'Effects of lead and cadmium exposure from electronic waste on child physical growth', pp. 4441–4447. doi: 10.1007/s11356-012-1366-2.
[48] Ye, L., Ye, C. and Chuang, Y. (2011) 'Location set covering for waste resource recycling centers in Taiwan', 'Resources, Conservation & Recycling'. Elsevier B.V., 55(11), pp. 979–985. doi: 10.1016/j.resconrec.2011.05.007.
[49] Yu, H. and Solvang, W. D. (2017) 'A multi-objective location-allocation optimization for sustainable management of municipal solid

waste', Environment Systems and Decisions. Springer US, 37(3), pp. 289–308. doi: 10.1007/s10669-017-9632-y.

[50] Yuan, H. and Shen, L. (2011) 'Trend of the research on construction and demolition waste management', Waste Management. Elsevier Ltd, 31(4), pp. 670–679. doi: 10.1016/j.wasman.2010.10.030.

[51] Zaman, A. U. (2015) 'A comprehensive review of the development of zero waste management: lessons learned and guidelines', Journal of Cleaner Production. Elsevier Ltd, 91, pp. 12–25. doi: 10.1016/j.jclepro.2014.12.013.

[52] Ziraba, A. K., Haregu, T. N. and Mberu, B. (2016) 'A review and framework for understanding the potential impact of poor solid waste management on health in developing countries', Archives of Public Health. Archives of Public Health, 74(1), pp. 1–11. doi: 10.1186/s13690-016-0166-4.

[53] Zuhri, N. (2017) Analisis Lokasi dan Alokasi Tempat Penampungan Sementara (TPS) Sampah Menggunakan Metode Set Covering Problem (SCP) di Wilayah Kabupaten Boyolali. Universitas Muhammadiyah Surakarta.