Mapping of solid waste generation and collection by using GIS: A case study in Depok City

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Abstract. Waste treatment facility, known as UPS, in Depok City is one of component in waste treatment for handling organic waste. However, carrying capacity of UPS and its ability to process of organic waste from citywide were low although 30 unit of UPS has been built over the years. The objective of this research was to map current practices and projections on waste and organic waste generation, and current organic waste collection services coverage area as well as to assess the service level of UPS at each sub-district. The amount of waste generation in 2018 is approximately 594,450 tonnes/year and projected will increase up to 886,589 tonnes/year. The organic waste fraction was projected 44% and will grow at a rate 3.9%/year in the period of 2018-2028. The amount of organic waste in 2018 is approximately 272,850 tonnes/year and increased up to 390,098 tonnes/year in 2028. Each resident projected will generate organic waste at about 118 kg/capita/year. The results showed that Cimanggis and Sukmajaya were sub-districts with the highest amount of waste and organic waste generation. Nonetheless both were having only one UPS and smallest collection services coverage area as well as high number of populations to be served for each UPS. Organic waste collection service coverage area can be distinguished by 2 schemes which were local and municipal services. It is found out that 22 UPS served for local services and 8 UPS served for municipal services. Each UPS covered averagely 16% of each total area.

1. Introduction

Solid waste is of all types of waste generated by human and animal activities in the form of solids and is considered useless or unwanted material [22]. It is important for waste to be managed properly to avoid negative impacts on humans and the environment. The amount of waste generation is influenced by factors such as population, level of economic growth, geographical location, culture, seasons, etc. [13]. With so many influencing factors, the amount of waste generation is not an easy parameter to predict. Many waste generation projection models have been developed, but these models are not necessarily suitable for use in other cities, or different countries. This is troublesome since the projection of waste generation is important for planning waste management in an area, where many current projection models take into account the demographic factors of the population and the socio-economic conditions of the community to produce an accurate amount of waste generation [2].

Solid waste management is selecting and applying appropriate techniques, technologies, and management programs to achieve specific waste management objectives [22]. Referring to the National Standard of Indonesia (SNI) No. 19-2454-2002 concerning the Operational Engineering Procedure for Urban Waste Management, the basis for planning waste management includes service areas, service
levels and operational techniques [3]. Meanwhile, waste management operational techniques include the containment, collection, transfer, transportation, sorting and processing, and final disposal of waste [3][18]. Waste management system must be well planned so that all waste generation can be handled in an appropriate manner.

The city of Depok is one of the cities in Indonesia which part of West Java Province. Based on its population, Depok can be classified as a metropolitan city with a population in 2017 reaching more than 2,25 million people and an average increase of 74,207 people/year [11]. Population that continue to increase will certainly affect the amount of waste generation in Depok City. Based on information from the National Waste Management Information System (SIPSN), the amount of waste generated by Depok reached 1,320 tonnes/day within the period of 2017-2018 [18]. The composition of waste from Depok consisted of food waste (40%), wood, twigs and leaves (15%), paper (5%), plastic (10%), metal (2%), textile (8%), rubber and leather (2%), glass (3%) and other waste (15%) [18]. Depok City has an area of 200.3 km² and consists of 11 sub-districts. In 2017, solid waste management system was able to manage only 59.83% of waste generation [18]. It means only 790 tons/day of waste can be handled and the rest, 530 tonnes/day, cannot be managed.

Solid waste management system in Depok City is carried out by employing 6 elements, which are waste generation, waste handling at source, collection, transfer and transportation, processing, and final disposal systems [15]. Waste handling at the source is the key element to obtain an efficient waste management system [22]. Activities that can be performed at source such as sorting and composting. Composting can help to reduce the amount of waste that need to be handled and sorting can help further handling more efficiently. These activities have been implemented in City Depok since couple years ago. Composting at household scale has been conducted but some of composting currently performed at communal scale in waste treatment facility (UPS). Organic waste from households are collected by motorized cart and brought to UPS. At the UPS, collected organic waste are given pre-treatment such as sorting and shredding before composted. However, households which can get collection service on their organic waste are still small numbers. Furthermore, the ability of UPS to process of organic waste is still small. Based on previous research in 2018, carrying capacity of UPS is approximately 0.26 and UPS is able to process only 3.26% of organic waste from citywide [21]. Although 30 unit of UPS has been built over the years, the utilization of UPS' are still low [15].

The objective of this research was to map current practices and projections regarding on waste generation, organic waste generation, and current organic waste collection services coverage area at each sub-district in the Depok City. The mapping of the amount of waste generation in Depok has been previously conducted, but only to the extent of mapping waste generation in the period of 2016 which carried out by Paramita et al. which conducted in 2018 [21]. However, the mapping of the projected waste generation for Depok's city has no development yet. Moreover, there has been no research conducted for mapping organic waste generation, its collection and transportation service areas within City of Depok. There was only mapping on location of waste treatment facility (UPS) and landfill belong to City of Depok that carried out by Environmental and Sanitation Office of Depok City as well as waste bank facilities conducted by Nursetyowati et al. in 2018 [20]. Mapping of waste generation and solid waste management service areas is important for the planning process. Knowing the amount of waste generation in each sub-district can help determine priorities for the provision of waste containment, collection, and transportation facilities so that the planning and procurement processes become more efficiently. Mapping of waste collection service coverage areas can also assist in determining container and conveyance requirements. By using this knowledge acquired, the additional objective was to assess the service level of UPS at each sub-district. This is emerged as a concern over the low utilization rate of UPS in Depok City. This research can be supplemental for the municipal of Depok City in making a good planning on waste management system and expanding the coverage area of solid waste services as well as improving the utilization of UPS in the future. An integrated and comprehensive organic waste management system is needed to ensure that every element in solid waste management system are carried out properly. Knowledge and understanding of information regarding the implementation of each elements can be developed as a work reference design for the present and for the future.
2. Method

The research method used in this paper was a quantitative approach. While the type of research used was a comparative causal study, this study investigates the causal relationship between the projection of waste generations and the UPS coverage area, based on observations on existing effects and looks for factors that may cause a phenomenon through certain data. This study used some primary and secondary data, which the primary data used for the mapping of UPS’ service area. The secondary data was used to project the waste generation in Depok for the period of 2018-2028.

2.1. Projecting and mapping the waste generation and composition in the period of 2018-2028

The projection of waste generation in Depok was carried out based on the Indonesia National Standard (SNI) No. 3242:2008 concerning of the Waste Management in Settlements which stated that the amount of waste generated in an urban area can be determined by multiplying the number of residents in the city with the standard unit of waste generation (L/cap/d or units/day). In SNI No. 3242:2008, the standard unit for waste generation is differentiated based on the type or size of a city. Since Depok considered as a metropolitan city, the standard unit for waste generation which appropriate was 3.0 L/cap/d.

The projection of waste generation was calculated based on the population projection. Population projection was carried out by using geometric methods referring to the population projection method that used by the Environment and Sanitation Office of Depok City and the Bureau of Statistic. The population database that employed for the projections was based on the total population in the period of 2010-2018.

| No. | Parameter | Source | Value | Unit |
|-----|-----------|--------|-------|------|
| 1   | Population of Depok | Depok in Figures, 2019 [11] | 2,330,333 | People |
| 2   | Quantity and Composition of Waste in Depok | SIPSN, 2018 [18] | Can be seen in Table 3 | - |
| 3   | The Amount of the Population that are on Age 15-59 Years Old | Depok in Figures, 2019 [11] | 68,686 | % |
| 4   | Infant Mortality Rate of Depok | The Health Profile of Depok, 2018 [15] | 1.55 | % |
| 5   | Life Expectancy in Depok | The Health Profile of Depok, 2018 [15] | 74.17 | Years |
| 6   | Average Household Size | Statistics of Indonesia in 2019, 2019 [12] | 3.8 | People/Household |
| 7   | National Infant Mortality Rate | Indonesia Demographic – Knoema.com [16] | 18.61 | % |
| 8   | GDP by USD GPP | World Bank [22] | 4,552.3 | USD PPP |
| 9   | Labour in Agriculture | World Bank [22] | 29.6 | % |

The projection of waste composition was carried out by using the TU Darmstadt LCA-IWM Prognosis Tools software. Despite the fact that waste composition is important parameter in planning solid waste management system, there is no modelling methods or software that can be used to project waste composition except this Prognosis Tools [2][14]. In this research, the year of 2018 was used as reference year. The outcomes of projection by using this software were amount of waste generation based on each type of waste, as well as percentage waste generation growth rate yearly. Using these outcomes, it is possible to ascertain the percentage of waste composition and growth rate each composition. These percentage values will then be used as the basis for projections of generation for
each type of waste. The projection of waste generation with this software based on the relationship between the socio-economic conditions and the amount of existing waste generation [14]. The socio-economic indicators that required in this prognosis tool were indicators at city level as well as national level. All the indicators that employed for these calculations can be seen in Table 1.

The mapping of waste and organic waste generation carried out by using ArcMap 10.6 with the base map data in the form of Depok City SHP file. Data of waste generation based on each type of waste were filled in the Attribute Table in that software. Colour coding was added to distinguished the amount of waste and organic generation by using symbology and categories.

2.2. Mapping of the UPS Service Area in Depok
The mapping of collection services coverage area was conducted by using Geospatial Information System (GIS). There were two types of coordinate data that gathered through field survey. These are including organic waste collection routes as UPS services coverage area and organic waste collection point. Then, these data are plotted into by using ArcMap10.6 software.

3. Results and discussion

3.1. Projection of Waste Generation and Composition in the Period of 2018-2028
The projection of waste generation for the period of 2018-2028 was calculated referred to SNI No. 3242:2008 concerning the Waste Management in Settlements. The projection of waste generation by using the assumption that the amount of waste generation per capita during certain planning period was constant at 3.0 L/person/day. It was implied that changes in waste generation at the city only affected by the addition of the number of waste sources, which equivalent with an increasing in population [19]. If the population increase, the amount of waste generation will also increase regardless of the type of activity carried out by each resident and the factors that support their activities, such as the background of social and economic conditions. Population projection in the period of 2018-2028 must be calculated as a first step.

Table 2. Projection of waste generation in 2018-2028 period based on SNI No. 3242:2008

| Year | Population Projection (People) | Projection of Waste Generation (tonnes/day) |
|------|--------------------------------|---------------------------------------------|
| 2018 | 2,311,485                      | 1,698.94                                    |
| 2019 | 2,395,610                      | 1,760.77                                    |
| 2020 | 2,482,797                      | 1,824.86                                    |
| 2021 | 2,573,156                      | 1,891.27                                    |
| 2022 | 2,666,804                      | 1,960.10                                    |
| 2023 | 2,763,861                      | 2,031.44                                    |
| 2024 | 2,864,450                      | 2,105.37                                    |
| 2025 | 2,968,699                      | 2,181.99                                    |
| 2026 | 3,076,743                      | 2,261.41                                    |
| 2027 | 3,188,719                      | 2,343.71                                    |
| 2028 | 3,304,770                      | 2,429.01                                    |

Then, waste generation can be calculated by using method in this SNI No. 3242:2008. The projection of the population of Depok was carried out by using the geometric method, which assumed that the
population growth ratio was constant, or in other words, the population will decrease or increase at a constant rate. In the period of 2010-2018, the population of Depok growth with an average increase of 3.639% [10][11]. This percentage was also used as the basis calculation on population growth for population projections in the period of 2018-2028.

The projection results on waste generation was obtained in the form of volume values. Further on to convert these volume values into mass values, waste density must be acquired. Based on this fact, waste density that applied in this calculation was coming from Solid Waste Management Masterplan for Depok City. In that masterplan, waste density was approximately 0.245 tonnes/m$^3$[15]. This value was acquired based on sampling and measurement in 2016. An assumption was applied that this waste density did not change during this research. The population projection results presented in Table 2. As seen in Table 2, number of populations in Depok City will increase from 2.3 million in 2018 to more than 3.3 million in 2028. Meanwhile, the amount of waste generated will increase at about 41% from 1,700 tonnes/day in 2018 to more than 2,400 tonnes/day in 2028.

Projection of waste composition was carried out by using the TU Darmstadt Prognosis Tools. Using this software, waste generation and composition was projected for Depok City in the period of 2018-2028. Data regarding the trend of waste generated (in percentage) each year then applied as a reference in calculating the composition of the organic waste generation. To run this software, the required data were related to waste generation and its composition as well as socio-economic indicators. The year of 2018 was used as reference year for this calculation. As mention earlier, all socio-economic indicators that used in this projection were presented in Table 1. Meanwhile, waste generation and composition at Depok City that applied can be seen in Table 3.

Table 3. The projection of waste generation and composition at Depok City in 2018.

| No. | Type of Waste    | %  | Waste Generation (tonnes/year) |
|-----|----------------|----|--------------------------------|
| 1   | Food Waste      | 40 | 192,720                        |
| 2   | Twigs and Leaves| 15 | 72,270                         |
| 3   | Paper           | 5  | 24,090                         |
| 4   | Plastic         | 10 | 48,180                         |
| 5   | Metal           | 2  | 9,636                          |
| 6   | Glass           | 3  | 14,454                         |
| 7   | Others/Residue  | 25 | 233,100                        |
|     | Total           | 100| 594,450                        |

(Source: Adapted from Ministry of Environmental & Forestry [15])

Based on the projection results by using the TU Darmstadt LCA-IWM Prognosis Tools, it was found out that the organic fraction of waste is approximately 44%. Meanwhile, paper, plastics, metal, glass and residual fractions are 4%, 8%, 2%, 2% and 39%, respectively. This residual fraction that obtained from this modelling with this software was quite high due to incomplete database on waste generation. Since waste management system was only able to handle 59.83% of waste in Depok City, an assumption was applied that all waste that cannot be handled categorized as residual along with textile, rubber and others fraction of waste.

By using the outcomes from TU Darmstadt LCA-IWM Prognosis Tools, the projection of organic waste generation can be calculated. The amount of organic waste continues to increase with a trend of 3.9% in the period of 2018-2028. The projection results presented in Table 4, Figure 1 to Figure 5. The amount of organic waste generated in 2018 is approximately 272,850 tonnes/year as stated in Table 4. This amount will increase by 43% in 10 years to become 390,098 tonnes/year. The amount of organic waste generation for each resident of the Depok City is calculated and the amount is averagely 118 kg/capita/year. This amount will stay constant, consistent with the assumption that earlier explained.
In 2018, it can be seen from Figure 1 that Cimanggis (39,000 tonnes/year) and Sukmajaya sub-districts (37,400 tonnes/year) were the area with the highest amount of organic waste generation compared to the other sub-districts. Meanwhile, Limo (14,800 tonnes/year) and Cinere sub-district (17,970 tonnes/year) were the sub-districts with the least amount of organic waste generation. Within 10 years, Cimanggis (increase to 57,200 tonnes/year) and Sukmajaya (increase to 54,870 tonnes/year) will remain as the area that generate waste the most compare with other sub-districts. Limo (increase to 20,900 tonnes/year) and Cinere sub-districts (increase to 25,400 tonnes/year) will also remain as the area that produce the least organic waste in 2028.

Table 4. Projection of organic waste generation in the period of 2018-2028.

| Year | Population Projection (People) | Projection of Organic Waste Generation (tonnes/year) |
|------|--------------------------------|------------------------------------------------------|
| 2018 | 2,311,485                      | 272,850.03                                           |
| 2019 | 2,395,610                      | 282,780.21                                           |
| 2020 | 2,482,796                      | 293,071.79                                           |
| 2021 | 2,573,156                      | 303,737.93                                           |
| 2022 | 2,666,804                      | 314,792.25                                           |
| 2023 | 2,763,860                      | 326,248.89                                           |
| 2024 | 2,864,449                      | 338,122.49                                           |
| 2025 | 2,968,699                      | 350,428.21                                           |
| 2026 | 3,076,742                      | 363,181.80                                           |
| 2027 | 3,188,718                      | 376,399.54                                           |
| 2028 | 3,304,769                      | 390,098.33                                           |
|      | Average Value                  | 328,337.41 ± 26,117.05                                |

Figure 1. Projection results of organic waste generation for each sub-district at Depok City in the period of 2018-2028 based on the projection results by Using SNI 3242:2008.
As seen in Figure 1, all sub-districts showed an increasing of organic waste generation continually. If the availability of data were more complete, especially data regarding of waste generation and composition, the projections might be made more accurate. Unfortunately, in this research, some assumptions have been forced to employed in completing data.

![Figure 2. Map of the waste generation and composition of Depok in 2018.](image)

### 3.2. Mapping of UPS Service Coverage Area

Mapping of local and communal service coverage area was conducted through field survey which following the trip of each waste collector. Each location coordinates were recorded by using GPS. Based on this field survey, waste collection scheme can be distinguished.

Waste collection is third element in the solid waste management system. Based on its scheme, collection that has implemented in the citywide of Depok consists of 2 schemes. They are indirect individual and communal scheme. The indirect individual collection scheme means that organic waste from each household or source is collected directly and brought to UPS. Meanwhile, the communal collection scheme means organic waste is collected from big communal containers. These containers placed in locations that were easy to reach by transportation fleet provided by Environmental and Sanitation Office. Thus, each household should bring their organic waste to those communal containers by themselves or hiring waste collectors in their neighbourhood. This scheme is carried out in collaboration with local community and municipal.

UPS service coverage areas can be distinguished into two types, which are local and municipal service coverage areas. Local service coverage area means UPS serves and receives organic waste from...
the surrounding neighbourhood. Each household stores their organic waste into small container that placed in front of their home and then pick up by waste collector. Each container can serve several household and waste collector pick up the organic waste by using motorized carts. This waste collector is a part of operator of UPS and usually local residents. There are 22 UPS that provided for these local services. Municipal service coverage area means UPS serve and receives organic waste from far away. Each household or organic waste source stores their organic waste into small container that place in front of their home and the pick up by waste collectors. These waste collectors were provided by Environmental and Sanitation Office and they are not part of the UPS operators. Organic waste collected by using pick-up car with capacity approximately 5 m$^3$. There were 8 UPS to serve this municipal service coverage area.

![Figure 3. Map of the organic waste generation of Depok in 2018.](image)

The map of UPS coverage area for collection on local service can be seen in Figure 7. Based on this Figure, UPS Cilangkap 10 that has the most extensive service coverage area compared than others UPS’. Its service coverage area was about 2.9 km$^2$ (1.4% of Depok City total area). UPS Cilangkap 10 is located within the administrative area of Tapos Sub-district. As we can see from Table 5, Tapos has the largest area compare other sub-districts within Depok City. As a result of field survey, there are 3 UPS that have been worked in Tapos, which are UPS Cilangkap 10, UPS Cilangkap 17 and UPS Sukatani. Of the three UPS, UPS Cilangkap 10 had the most broaden service coverage area that was approximately 8.7% of Tapos total area. The smallest service coverage area was UPS Cilangkap 17 (0.001 km$^2$) which also located in Tapos and served only 0.003% of its total area.

Other than UPS Cilangkap 17, UPS Cipayung Jaya which located in Cipayung sub-district was also having small service coverage area at about 0.015 km$^2$ (0.008% of Depok City total area). Cipayung
sub-district had 4 UPS for collection on local service which are UPS Cipayung Jaya, UPS Ratujaya 1, UPS Pondok Jaya and UPS Permata Regency. Among these 4 UPS, UPS Permata Regency was having the most extensive coverage area which approximately 0.3 km$^2$ (0.15% of Depok City total area). This UPS served only 2.6% of area Cipayung sub-district. If compared with other sub-districts as we can see from Table 5, Cipayung does have small area that is only about 11.45 km$^2$.

Figure 4. Map of the Potential Waste Generation and Composition of Depok in 2028.

Figure 6 also shows that Pancoran Mas and Cilodong were the only sub-districts which did not have UPS for local service. This sub-district only received municipal service for organic waste collection. It means organic waste generation within this area collected by using pick-up car and brought to UPS in another sub-districts. Nevertheless, there is not only Pancoran Mas but other sub-districts which received municipal service for organic waste collection particularly areas that have been implementing sorting activities for their waste generation. Municipal of Depok City has been promoted a waste sorting program on a household scale since a couple years ago known as Depok sorting of their waste program [15]. The mapping on organic waste collection by municipal service will not be discussed further in this paper.

3.3. Assessment of UPS Service Level
The service level referred to in this research is number of people served by UPS within each district. This population number to be served is obtained by dividing total population by number of active UPS in each district. The higher number of the results, then the higher number of populations to be served by each UPS. Nonetheless, each UPS has a maximum capacity that is about 5 tonnes/day or 1,825 tonnes/year. Based on this value and previous explanation that the average organic waste generation for residents of Depok City which is 118 kg/capita/year, thus the maximum number of populations to be
served by each UPS is approximately 15,466 people. As can be seen in Table 5, all UPS’ looked like had to serve more than 15,466 people. Sukmajaya and Cimanggis are sub-districts which the highest number of populations need to be served for each UPS, each UPS had to serve more than 300,000 people/UPS. Other districts, except Bojongsari, had service level in the range of 40,000 to 139,000 people/UPS. Meanwhile, Bojongsari showed having service level at approximately 18,413 people/UPS. This value is close enough to the maximum number of populations to be served at UPS (15,466 people).

Based on service coverage area, the average service area of each UPS is 2.02 km². Service coverage area of UPS in Cinere was the smallest one which only covered 0.30 km² or 2.84% of Cinere total area. The largest service coverage area was found out in Bojongsari which covered 5.09 km². At the average, each UPS covered 16% of each sub-district total area, not included Bojongsari.

It is found out that distribution of UPS throughout the city has been not distributed well. Most UPS that has been observed located in Bojongsari. Meanwhile, other sub-districts only have not more than 3 units of UPS even 2 others sub-districts do not have any UPS. This condition caused a gap between organic waste generation and organic waste that can be processed. This service level also showed as if each UPS has been worked at its maximum and already overloaded. But in reality, most of UPS are still under-utilized. Previous study showed amount of organic waste that processed at UPS in the period of 2016-2019 averagely 114 tonnes/year [1]. This value demonstrated that utilization rate of UPS only reached 6% from its maximum capacity.

Figure 5. Map of the Potential Organic Waste Generation of Depok in 2028.

Based on service coverage area, the average service area of each UPS is 2.02 km². Service coverage area of UPS in Cinere was the smallest one which only covered 0.30 km² or 2.84% of Cinere total area. The largest service coverage area was found out in Bojongsari which covered 5.09 km². At the average, each UPS covered 16% of each sub-district total area, not included Bojongsari.

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Figure 6. Local service areas of UPS that conduct independent waste collection.

Table 5. UPS Service Levels and Service Areas in Depok 2019.

| Sub-District | Number of Active UPS (Unit) | Area of Sub-District (km²) | Population (Person) | UPS Service Level (People/UPS) | UPS Service Areas (Average) (km²/UPS) | Mapping Result of Real UPS Service Areas for year of 2020 (km²) |
|--------------|-----------------------------|-----------------------------|----------------------|-------------------------------|-------------------------------------|----------------------------------------------------------|
| Sawangan     | 2                           | 26.19                       | 159,613.00           | 79,807                        | 13.095                              | 1.00                                                    |
| Bojongsari   | 7                           | 19.3                        | 128,894.00           | 18,413                        | 2.76                                | 5.09                                                    |
| Pancoran Mas | -                           | 18.03                       | 273,447.00           | -                             | -                                   | -                                                       |
| Cipayung     | 4                           | 11.45                       | 165,361.00           | -                             | -                                   | -                                                       |
| Sukmajaya    | 1                           | 17.35                       | 302,719.00           | 302,719                       | 17.35                               | 1.84                                                    |
| Cilodong     | -                           | 16.19                       | 161,866.00           | -                             | -                                   | -                                                       |
| Cimanggis    | 1                           | 21.58                       | 313,987.00           | 313,987                       | 21.58                               | 2.00                                                    |
| Tapos        | 3                           | 33.26                       | 280,121.00           | 93,374                        | 11.09                               | 2.97                                                    |
| Beji         | 2                           | 14.56                       | 215,215.00           | 107,608                       | 7.28                                | 3.20                                                    |
| Limo         | 1                           | 11.84                       | 113,684.00           | 113,684                       | 11.84                               | 1.20                                                    |
| Cinere       | 1                           | 10.55                       | 139,606.00           | 139,606                       | 10.5                                | 0.30                                                    |
4. Conclusion
The amount of waste generation in 2018 at Depok City is approximately 594,450 tonnes/year and projected will increase up to 886,589 tonnes/year. The organic waste fraction was projected 44% and will grow at a rate 3.9% per year in the period of 2018-2028. With this fraction value, the amount of organic waste in 2018 is approximately 272,850 tonnes/year and enlarge into 390,098 tonnes/year within 10 years. Each resident of Depok City projected will generate organic waste at about 118 kg/capita/year. The results showed that Cimanggis and Sukmajaya were sub-districts with the highest amount of waste and organic waste generation among others sub-districts in Depok City. Although both sub-districts were having highest number of waste generation, however both were having only one UPS and smallest collection services coverage area as well as high number of populations to be served for each UPS. Organic waste collection service coverage area can be distinguished by 2 schemes which were local and municipal services. It is found out that 22 UPS served for local services and 8 UPS served for municipal services. Each UPS designed can handle maximum 1,825 tonnes/year of organic waste or organic waste from 15,466 people. Based on calculation, all UPS looked like overburden particularly in Cimanggis and Sukmajaya. But in reality, most of UPS are still under-utilized.

The results of this research are expected helping The Environmental and Sanitation Office of Depok City as an input to improve waste management system in Depok City. As can be seen from waste and organic waste generation maps from Figure 2 to Figure 5 as well as Table 5, Cimanggis and Sukmajaya are sub-districts which generated higher amount of waste and UPS service level. It means both sub-districts demonstrated in high demand for additional number of UPS. With high population and having only one UPS, both sub-districts can be put as priorities for next planning in order to broaden and expanding of organic waste collection service coverage area and utilization of UPS. It is obvious that this research can make a significant contribution and helpful in planning of waste management system.

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