SWOT Analysis for Waste Management Recommendation of Bojong Village, Bogor Regency

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Abstract

Bogor Regency is a part of the National Central Activity System (Pusat Kegiatan Nasional, PKN) Jabodetabek Punjur, DKI Jakarta Province sub-urban. In the system, Bogor Regency plays the role of the nation’s capital’s buffer zone as a residential/settlement area and as the upstream area in the watershed system so that water will flow from Bogor Regency to Jabodetabek area. This makes waste management is an important focus to be fixed because residences in Bogor Regency contributes emission at value 19.3% from all emission of Bogor Regency (Nurmayati, 2020), is a largest waste producer in West Jawa (Dinas PUPR Jawa Barat, 2020), and the waste produced is not comparable with the management service (Mujiburrahmad & Firmansyah, 2014). Because of the background, this research aims to formulate a waste management strategy for urban slum residence in Bogor Regency (Study Case: Bojong Village) using SWOT and mapping analysis. The research concluded that Bojong Village needs to improve its disposal system by adding its waste infrastructure to shift villager’s habit to burn trash and to pile up on the roadside, and then to cooperate with the centralized waste infrastructure of TPPAS Nambo and IPLT Cileungsi.

Keywords: ArcMap 10.3, Settlement, Waste Management

1. Introduction

Bogor Regency is a part of the National Central Activity System (Pusat Kegiatan Nasional, PKN) Jabodetabekpunjur, DKI Jakarta Province’s sub-urban. Development area of Bodebekpunjur...
based on West Java Regional Spatial Plan (*Rencana Tata Ruang Wilayah, RTRW*) year 2009-2029 has focus on development in being buffer zone in the PKN system so that residential sector in Bogor Regency is not only destined for people in Bogor Regency itself but also for people who work in Bogor City, DKI Jakarta Province, and/or the surrounding area. It is seen in Bogor Regency Spatial Plan (*Rencana Tata Ruang Wilayah Kabupaten, RTRWK*) year 2016-2039, Bogor regency as part of the provision of urban residence which connected with Jabodetabek area. Bogor regency has a unique characteristic of its urban area, village area, and a characteristic namely *desakota* or urban-village, an area which has both agrarian and urban, formal and informal activity which is also associated with big industry and its employee and the intensity of working round-trip.

In this Global Pandemic COVID-19 era, we realised once again the importance of healthcare and the health system for virus transmission prevention. Epidemics associated with water contaminated with pathogens, which in the 19th century created cholera occurrence in Europe. Epidemiological studies have often shown association between human illnesses and proximity to a waste disposal site. In developing countries, the main issue is associated with infections and injuries from unregulated recycling in open dumps (Giusti, 2009). Residential in Bogor Regency still has homework regarding its environment amenities and health public facilities completeness. Waste is still a problem in Bogor Regency and the impact of the problem can affect its surrounding area because Bogor Regency has a higher contour and plays a role upstream in the Watershed system so that water will flow from Bogor Regency to Jabodetabek area. This makes waste management an important focus to be fixed. If Bogor Regency reaches its waste management carrying capacity, it will harm Jabodetabek and the surrounding area in the watershed downstream system or lower contour. Effort of keeping a healthy condition in cities especially through a good waste collection service is one of the physical elements and governance features of ISWM (Integrated and Sustainable Solid Waste Management) (Martinez & Pina, 2015).

Residences in Bogor Regency contribute emission at value 19.3% from all emissions of Bogor Regency (Nurmayati, 2020). Based on the West Java Housing and Settlement Agency year 2010 waste pile, Bogor Regency is the largest waste producer in West Java with 134,774.80 litre/day. One of the reasons for the waste piling is the waste produced per day is not comparable with the management service (Mujiburrahmad & Firmansyah, 2014). Capacity of the final disposal which supplies Bogor Regency is not able to accommodate and process waste from residences so community in Bogor Regency has their own way in the upstream to process waste with waste bank (*bank sampah*) and environmental friendly village (*kampung ramah lingkungan*). Eventually, this research will collect evidence or to identify strength, weakness, opportunity, and threat that Bogor Regency has in managing residential waste and produce a strategy of waste management.

This research aims to formulate waste management strategy for urban slum residence in Bogor Regency with targets as follows: (1) identify strength, weakness, opportunity, and threat of waste management elements in urban slum residence in Bogor Regency, (2) identify waste management strategy for urban slum residence in Bogor Regency.
2. Method

The data needed to conduct this research are the condition of waste disposal and management in settlement (upstream). This research is conducted with a qualitative analysis method with mapping technique. The method of data collecting is as follows:

1. Field observation by observing directly the field condition with notes.
2. Desk study or data collection from books, documents, and media.
3. Interview the key stakeholder of waste management in the area.

The research sequence is conducted in October 2020 until November 2020 using step 2 and step 3 of the six steps to reducing waste costs from Envirowise GG414 on (Chartered Institute of Purchasing & Supply, 2007). Step of performance comparison is using Bogor Regency Medium Term Investment Program Planning year 2015-2019 and found three locations of slum settlement. Then author choose the settlement which overlays development area unit (satuan wilayah pengembangan) and conservation zone (kawasan lindung) based on Bogor Regency Spatial Plan year 2016-2036. The author uses ArcMap 10.3 software to overlay these attributes then generate Pamagersari Village and Sipak Village in Jasinga Sub-District, and Bojong Village in Klapanunggal Sub-District. Bojong Village was chosen as the study area because it is relatively close to the author’s position for the field observation convenience, and also strategic because of its function as a buffer zone settlement area for the industrial district of Klapanunggal Sub-District.

The next step is data analysis which is conducted in two stages. The first stage is desk study of waste management conditions in Bogor Regency and study areas with content analysis. The second stage is analysis of spatial attributes with the help of ArcMap and narration from field observation results and interviews. From the first and second stage analysis, points of strength, weakness, opportunity, and threat by spatial and completed with description from the narration generated. The third stage is formulation of strategy with SWOT (strength, weakness, opportunity, and threat) analysis.

Data needed for this research are as follows:

1. Housing scatter map
2. Area of study area
3. Population
4. Number of house
5. Street condition
6. Topography condition
7. Land availability for temporary disposal station (tempat pembuangan sampah sementara) neighborhood scale

3. Results and Discussion

3.1. Results
Observation which has been done resulted in a map of waste conditions in Bojong Village which is shown in Figure 2. First field observation was conducted in the afternoon at 13:00-14:00 WIB. The observation gave an overview that waste management in Bojong Village can be grouped into several types. First type is the main road which is marked with an orange color, Klp. Manunggal street, waste is dropped on the ground (covered with single plastic sized 10 kg) on the edge of the main street without a trash bin as shown in picture 1 in Figure 2. Statements from villagers are that there will be officers to take the trash. The second type is housing complex which is marked with yellow color, trash is dropped in front of houses and street medians inside trash bins, shown in picture 2 in Figure 2. There is also an officer who will take those trash. The third type is village settlement which is marred with soft orange color. Here, trash is piled and burnt as shown in picture 3 and 5 of Figure 2. There are two waste facilities which are found when observation, a temporary disposal station which is shown in picture 4 and 6 of Figure 2.

Type of trash which is seen in Bojong Village is household trash consisting of organic waste from kitchen waste and inorganic plastic waste and other waste from household activity. There is no industrial activity which produces industrial waste. Trade and services activity existed also still in a small scale, but there is paddy field and village garden activity which will produce organic waste.

Settlement pattern in Bojong Village is linear, in line with the main road of Klp. Manunggal street with considerably high population growth. This makes the settlement in Bojong Village will be growing even more in the mean future. Physical building condition in the settlement is mainly permanent. The growth pattern in the main road is not really tidy but organic, but a tidy pattern is found in settlement areas made or managed by private developers. The density and population is considered as medium density with the number of houses as 4,729 houses in 2020 and total population of 9,400.
people (Data Desa Bojong, 2020). Land Use in Bojong Village generally is settlement and small scale trade and service. Accessibility facility that can reach centralized waste management infrastructure is the main road Klp. Manunggal Street sized 6 m wide and local streets sized 1-3 m wide asphalted.

Next will be an overview of strength, opportunity, weakness, and threat of waste management in Bojong Village based on field observation and interview. The interview conducted has a shortfall in the number and type of stakeholder it holds. Interviews to be SWOT analysis should be multi stakeholder (Martinez & Pina, 2015) (Mor, Kaur, & Khaiwal, 2016) (Leigh, 2010) or even through a focus interviews (Eheliyagoda, 2016) and continued with likert scored questionnaire to the stakeholders (Leigh, 2010) (Dyson, 2003). It can be conducted by only one person, but all stories should be known in the study area (Leigh, 2010). Here the author interviewed the Head of Village Government. The author synthesized the result below from the data collected.

Strengths and weaknesses are identified by an internal appraisal and the opportunities and threats by an external appraisal and the strategies are generated through the TOWS matrix. TOWS matrix is an attempt to connect internal and external factors to stimulate strategies (Dyson, 2003). The first strength is village contour. Bojong Village contour is considered flat, so that waste transportation will be able to reach every house in the settlement, even non motorized vehicles. The green area on Figure 4. Is the area with flat contour and suitable for waste transportation from house to house with non motorized vehicle (non motorized vehicle is relatively cheaper than motorized for the local government to provide), and the yellow area is an area with rising contour so motorized vehicle will be needed to transport waste from house to house in the area. Second strength is the settlement is agglomerated, eases the process of waste transporting by officers. Third strength is a clean blue open space and river in Bojong Village. The fourth strength is there is a lot of green open space which can be used as a waste infrastructure management area in Bojong Village.
Figure 3. Bojong Village Constellation to TPPAS Nambo dan IPLT Cileungsi

Opportunity regarding from the waste management of Bojong Village, it is near the development plan of Nambo Final Waste Disposal and Processing Site (Tempat Pengolahan dan Pemrosesan Akhir Sampah, TPPAS) (11 km), and Cileungsi Faecal sludge treatment installation (5 km). Second opportunity is there is already a cooperation between one of the stakeholders in Bojong Village with Bantar Gebang Integrated Waste Processing Site imply that there is already a relationship between village and centralized waste processing site (head of village interview result analysis, 2020).

First Bojong Village threat in term of waste management is its function as a growing settlement area near an industrial district which can be seen from development of housing complexes and availability of land which is meant to be developed in the mean future to be a housing and settlement area. Second threat is Bojong Village is a rendezvous of two water springs, Sodong water spring and Hualalai water spring which makes regular flood in the river banks when heavy rainfall occur (head of village interview, 2020)
First weakness of Bojong Village in terms of its waste management is that it comes under a flood prone area. Waste piles in land without a bin will harm both the environment and public health of Bojong Village when floods occur. Second weakness is the leak of waste facilities. There are many trans-pile points and several of them are in the drainage channel. Third weakness is people's habit of burning the trash pile. Lastly, the fourth weakness is the lack of government intervention in waste management, even in procurement of waste management facilities and cooperation with the regency's government in management and procurement.

Land Use in Bojong Village is dominated by residential and wet land use, no industrial activity and also less trade and service activity. Linear population distribution, which is in line with the main road and organically spread north, because the southwest is meant and planned for wet land use (paddy field). Type of houses on the main road are non multi level houses, while in housing complex, mainly row-non multi level houses. Both types of houses in Bojong Village are considered as low-moderate income houses.

People's habit of using fresh water is using their own dug well of groundwater. People's habit of disposing trash is to burn it on each house yard or on one landfill, meanwhile house complex communities throw in each house’s trash bin and are collected by officers.

Topography of Bojong Village is considered as flat with a slight lowering contour to the south. Flood is only occurs in housing complex in south area because of river overflow, therefore has been done some kind of river naturalization with heavy equipment to enlarge the river capacity and to prevent overflow which causes flood. Bojong Village also has a lot of green and blue open space in the form of gardens which are managed by the neighborhood, paddy field, and pond.

3.2. Discussion

Improvement of waste management is an important part in live, as declared in Sustainable Development Goals (SDGs) number 6 “Ensure availability and sustainable management of water and sanitation for all” with one of its target “By 2030, improve water quality by reducing pollution, eliminating dumping and minimizing release of hazardous chemicals and materials, halving the proportion of untreated wastewater and substantially increasing recycling and safe reuse globally” (United Nations, 2016). Here are the author's recommendations for waste management in Bojong Village based on collected and analysed data.

3.2.1. Strategy for Waste Management in Bojong Village
Here will be a waste management strategy based on strength, weakness, opportunity, and threat mentioned in the earlier section. In this stage, strength will be met with opportunity to create a strategy which uses strength to utilize opportunity using the SWOT matrix. Next, weakness will be met with opportunity to create a strategy that minimizes weakness using opportunities. Then, strength will be met with threat to create a strategy which uses strength to overcome the threat. Lastly, the assembly of weakness and threat which will create a strategy to minimize weakness and avoid threat.

Table 1. TOWS Matrix

| TOWS Matrix | Strength: | Weakness: |
|-------------|-----------|-----------|
|             | S.1. Flat Contour | W.1. Flood Prone Area |
|             | S.2. Agglomerated settlement | W.2. Leak of waste management facility |
|             | S.3. Clean river and blue open space | W.3. People habit to burn trash pile |
|             | S.4. A lot of green open space | W.4. Lack of intervention from Village Government in waste management |

Opportunity:
- O.1. Surrounded by waste management centralized infrastructure (TPPAS Nambo 11 km, IPLT Cileungsi 5 km)
- O.2. Cooperation with TPST Bantar Gebang

| TOWS Matrix | Strength: | Weakness: |
|-------------|-----------|-----------|
|             | Flat contour ease waste collecting and transporting activity from houses to centralized waste management installation | Development of Cooperation with centralized waste management infrastructure (TPPAS Nambo and IPLT Cileungsi) to initiate habit shifting of trash pile burning by improving village waste processing service |

Threat:
- T.1. Settlement area function which swiftly growing because located near industrial district
- T.2. Assembly area of two water spring which will resulted river overflow when heavy rainfall occurs

| TOWS Matrix | Strength: | Weakness: |
|-------------|-----------|-----------|
|             | Maximize waste collection and transporting activity from each house to centralized waste processing installation | (T.1.W.1) Minimize flood potential because of river overflow by revitalizing riverbank or normalizing riverbody (T.2.W.2.W.3.W.4) Complete village’s waste infrastructure to anticipate growth of trash produced by growing population |

By the SWOT Matrix, resulted action plan as follows for waste management in Bojong Village:
1. Maximize collecting and transporting activity from houses to centralized waste management installation
2. Development of Cooperation with centralized waste management infrastructure (TPPAS Nambo and IPLT Cileungsi) to initiate habit shifting of trash pile burning by improving village waste processing service
3. Minimize flood potential because of river overflow by revitalizing riverbank or normalizing riverbody
4. Complete village’s waste infrastructure to anticipate growth of trash produced by growing population

Overall, the action plan expresses one strategy that is internal maximization of operational practices including waste collecting and transporting activity. It is one of waste minimisation techniques based on EPA (1988) on (Chartered Institute of Purchasing & Supply, 2007). The strategy might mostly be about disposal but the disposal strategy is to support a goal of treatment of waste management hierarchy (Gertsakis & Lewis, 2003) in the centralized infrastructure, with Bogor Regency plan to make Nambo a Final Waste Disposal and Processing Site. It has also been reported that improper bin collection systems, poor route planning, lack of information about collection schedules, and insufficient infrastructure affects waste disposal choice and increases the probability of waste dumping in open areas and roadsides. The availability of equipment and machinery seem to be key factors that promote separation of waste at the household level (Guerrero, Maas, & Hogland, 2012).

As how (Piippo, Saawalainen, Kaakinen, & Pongracz, 2014) cite from World Bank (2001), Strategy part presents the overall framework for Municipal Solid Waste Management (MSWM) systems and standards, whereas the Action Plan part consists of the specific options to be achieved, and in order to meet the requirements, detailed design work (operational planning) is needed to set the precise arrangements for the implementation. After this strategy and action plan making process, the next section is about operational plans to achieve the action plan needed.

3.2.2. Quantity and Location of Waste Infrastructure Planning of Bojong Village

Based on first, second, and forth strategy to maximize waste collection and transporting activity and to complete waste facility to anticipate population growth, and to develop a cooperation with TPPAS Nambo and IPLT Cileungsi, we will be planning the quantity and location of waste infrastructure for Bojong Village based on Indonesia National Standard (Standar Nasional Indonesia, SNI) and overlay analysis on ArcMap 10.3 which will produce a map of location of waste facilities and infrastructure.

In 2020, Bojong Village has 9,400 population and 4,729 houses (Bojong Village Data, 2020). Based on Klapanunggal Sub-District in Figure year 2018 (Kecamatan Klapanunggal Dalam Angka), Bojong Village is sized 830 Ha, means Bojong Village has density amount 11.3 person/Ha and each
house is inhabited by 2 people. Bojong Village is considered as a low density area, but if we just count the area which is planned for settlement only based on Bogor Regency Spatial Plan year 2016-2036, the settlement area of Bojong Village has a density of 27 people/Ha.

The amount of trash pile of Bojong Village with mostly activities are residential is as follows:

\[ 4,729 \text{ houses} \times 2.5 \text{ L} = 11,822.5 \text{ L} \]

Types of minimum requirement of equipment and building for Bojong Village for Waste Management are as follows:

1. Based on SNI 03-1733-2004 of Planning Procedures for Housing in Urban Areas, neighborhood unit or every 2,500 people must have temporary disposal station (*Tempat Pembuangan Sementara, TPS*) with capacity of \(2 \text{ m}^3 - 6 \text{ m}^3\) with trash cart and small trash bin. Every village or 30,000 people has to have TPS also with capacity of \(2 \text{ m}^3 - 12 \text{ m}^3\) with trash cart and big trash bin.

Table 2. Equipment Necessity in Bojong Village Facility

| Place                  | Type of Equipment     | Service Capacity | Quantity Bojong Village Needed |
|------------------------|-----------------------|------------------|--------------------------------|
|                        |                       | Volume           | Family | People |                      |
| House                  | Small Trash Bin       | 1                | 5      | 4729   |
| Neighborhood Unit Facility | Neighborhood Unit Trash Bin | 6 m³          | 500    | 2,500  | 9                    |
|                        | Trash Cart            | 2 m³             |        |        |                      |
| Village Unit Facility  | Big Trash Bin         | 12-15 m³         | 6,000  | 30,000 | 1                    |

source: SNI 03 1733 2004 Analysis, 2020
By 4,729 inhabitant in Bojong Village, it is needed 1 small trash bin in every house, 9 trash bin size 6 m³ which distributed in Bojong Village to serve neighborhood (Rukun Warga, RW) in Bojong Village, 9 trash cart size 2 m³ to serve collection activity, and 1 big trash bin size 12 m³ – 15 m³. Location of the big trash bin can be located in the recommended location on Figure x.

Evermore, Bojong Village also needs 94 pieces of communal bin and manual composter sized 0.5 m³ – 1 m³ evenly distributed in Bojong Village, 3 pieces of arm roll container sized 6 m³ or 2 pieces of sized 10 m³, and 3 neighborhood scale waste recycling building station sized 150 m² which also needed recycling officer.

Table 3. Waste Equipment Necessity in Bojong Village

| Type of Equipment                               | Service Capacity | Technical Life (year) | Quantity Needed |
|------------------------------------------------|------------------|----------------------|----------------|
|                                                | Volume           | Family               | People         |                |
| Communal Bin                                   | 0.5-1 m³         | 20-40                | 100-200        | 94             |
| Manual Composter                               | 0.5-1 m³         | 10-20                | 50-100         | 94             |
| Armroll Container Truck                         | 6 m³             | 640                  | 3.200          | 5-8            |
|                                                | 10 m³            | 1.375                | 5.330          | 2              |
| Neighborhood Scale Recycling Building Station  | 150 m²           | 600                  | 3.000          | 20             |

source: SNI 3242 2008 Analysis, 2020
Subsequently, location for the equipments needed for Bojong Village based on settlement distribution from Open Street Map 2020 and land parcel information from Indonesia National Land Office (Badan Pertanahan Nasional, BPN) year 2020 are as follows:

![Figure 5. Base Map](source: Open Street Map 2020 and BPN 2020 Analysis, 2020)

The allotment area for waste building, equipment, and facilities is an area outside settlement with a minimum distance of 30 m, outside riverbank, 50 m from median of riverbody, and outside land with right of ownership, resulting in orange marked area on Figure 18. This area is sized 254 Ha meanwhile the land requirement for waste infrastructure is only 150 m². Other infrastructure needed is a small bin to be distributed evenly in Bojong Village.

One village scale big trash bin serves 30,000 people is marked with yellow dots in the middle of the village or it also can be located in the orange colored area. Then, three neighborhood recycling building stations are marked with orange dots in the southwest, middle, and northeast area of the village or also can be located in the orange colored area. Next, nine neighborhood scale units (rukun warga, RW) bin in each RW marked with light green and red dots on the edge of the main road with even distance. Red dots in the middle of the village's south area only served with one bin because of its low density settlement. Hereinafter, 94 communal bins marked with bold green is included in 18 RW scale trash bin is recommended to be located on the main road with 100 m distance from each other and distributed evenly in Bojong Village.
Disposal or operational practices strategy might also have shortfall on use of fuels and air emission from waste transportation and landfill impacts on the centralized infrastructure (Gertsakis & Lewis, 2003) but this strategy is made based on trust on Bogor Regency plan to Nambo TPPAS and the strategy is to support the plan from improvement of Bojong Village practices. In Padangtegal Village, Gianyar Bali, 1,73 ton/day waste from households were on site composted (Widyarsana & Salmaa, 2019). Should be possible to be implemented with Kampung Ramah Lingkungan Program by Bogor Regency officials, but village government should be able to fulfill waste infrastructure needs by itself to make a cooperation with Nambo TPPAS near the village as it is an internal affair that should not be waiting for external factors to intervene. A lot of factors affects waste management, those are technology, economics, sociocultural aspects, and politics (Martinez & Pina, 2015) (Abu Qdais, 2007; Kum, et al, 2005 on (Al-Khatib, Monou, Abu Zahra, Shaheen, & Kassinos, 2010) (Brunner & Fellner, 2007), with this research only consider the aspect of technology only. To improve the disposal strategy, effective interpersonal communication by officials, government workers, homeowners’ association officials, or seminar/training, and communication by media such as television channels must be explored for campaigns to sustain favourable behavior (Tatlonghari & Jamias, 2010).

4. Conclusion

In term of waste management, Bojong Village has strength of flat contour which ease collecting and transporting process, has agglomerated settlement, clean river and blue open space, and has a lot of open space; but Bojong Village has weakness as a flood prone area, leak of waste management facilities, has community habit on burning trash pile, and leak of village government intervention in waste
management; however, Bojong Village has opportunities as such: surrounded by centralized waste management infrastructure (TPPAS Nambo) and IPLT Cileungsi, and has a developed cooperation with centralized waste management infrastructure of Bantar Gebang; lastly, threat of Bojong Village is its function as swiftly growing settlement area because of its function near industrial district, and as an assembly area of two springs which makes some area is flood prone because of river overflow.

Strategy needed for Waste Management Bojong Village is to maximize collection and transportation activity from houses to centralized waste processing infrastructure and develop a cooperation with it (TPPAS Nambo and IPLT Cileungsi) to start a shift from the habit of trash pile burning by improving waste service of Bojong Village. Next is to minimize flood potency caused by river overflow by revitalizing the riverbank and normalizing riverbody. Lastly to complete a waste management facility to anticipate trash pile growth because of population growth. Equipment and facilities needed for Bojong Village are trash bin for each houses, 9 neighborhood unit scale trash bin and trash cart in every neighborhood unit (RW), 1 big trash bin for Bojong Village, 94 communal trash bin and manual composter, 3 or 2 arm roll container truck, and 3 neighborhood scale recycling building station to be located in the east, west, and south of the village. The recommended location for the facilities is shown in Figure 19.

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