Identification and analysis the illegal dumping spot of solid waste at Ciliwung segment 5 riverbanks

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Abstract. Ciliwung River is the main river in the area of Jakarta that is divided into six segments across West Java and Jakarta. The study focuses on the fifth segment which is 30 km long, covering from Kelapa Dua Depok to Manggarai, South Jakarta. The survey of the river consists of 3 sub-segments: Lenteng Agung, Pejaten Timur and Manggarai. Objectives of the study are to describe the characteristics and typology of the residential surrounding the Ciliwung Segment 5 Riverbank, to identification the illegal dumping spot of solid waste, to measure the volume and composition of solid waste in the riverbank, to decide solid waste management for residential area surrounding river banks to control the river pollution. The study shows that there are 11 illegal dumping spot of solid waste consisting of 4.37 m$^3$ solid waste volume. The average composition of solid waste consists of 44% organic, 14% woods, 12% papers, 11% plastics, 3% rubbers, 1% metals and 2% others. To control the river pollution efforts are restoring the function of riverbanks to become green open space area, installing the trash rack into the river, to manage domestic solid waste based on 3R (Reduce, Reuse, Recycle) concept.

Keywords: illegal dumping spot, riverbank, solid waste

1. Introduction

Population increase and the increase of lifestyle are very influential to the volume of solid waste generation, especially in larger cities. The daily solid waste generation is increasing and increase in variation, which often makes solid waste management still a problem. Moreover, the space of final disposal is limited. The environmental problem due to the solid waste are among others is water pollution [1]. The tendency of the population to release the garbage into the river is basically a manifestation of the population perception [10]. The general problem in solid waste management in the cities is limited space, pollution, and social problem. Therefore it is necessary to find a solid waste management model that can benefit as effective as possible; using an easy technology, economical, environmentally friendly and acceptable to the population; and producing the product that is saleable like compost or other products. To support the idea, the solid waste management model is required having the characteristic of riverbanks within the integrated solid waste management concept.

The practice of dumping solid waste into the river by ignoring the consequences to the environment is affected by certain socioeconomic statuses such as gender, educational attainment, and household income and geographic risk factors such as residential areas and distance of residential homes to permitted waste
disposal facilities [4]. Eight states of India throw their waste into the river. In Varanasi also Nagar Nigam waste accounts for 60 percent of the total volume of waste dumped into the Ganges River, and the industry accounts for about 15 percent of river pollution. Industrial waste is smaller in number but the impact is more dangerous than waste pollution in rivers [6]. Whether in NGO or government spear headed projects, community in riverbanks area will participate in restoration activities if the benefits to them involved. The level of participation and sustainability depends on the appropriateness of the approach and process used in participation [8]. The concept of riverbanks management must begin with a good understanding of the conditions surrounding riverbanks and all the limitations to achieving ideal conditions [9]. From several studies that have been done, it shows that research related to solid waste management in riverbanks area has not much done yet, especially the research related to the amount and composition of solid waste.

The objective of this study is to find the characteristic or residential typology in the Ciliwung segment 5 riverbanks; to map the illegal dumping spot of solid waste in the riverbanks; to find out the source and composition of the solid waste in the riverbanks and to formulate the integrated solid waste management model for the residential area in the riverbanks.

2. Research Method

2.1. Sampling Location
This research was conducted at three sampling locations along the Ciliwung riverbanks on Segment 5 are located in Jakarta, namely Lenteng Agung (Sub-Segment 1), Pejaten Timur (Sub-segment 2), and Manggarai (Sub-segment 3). For more details of the research, location can be seen in Figure 1. Determining sampling locations were selected based on the amount of spot solid waste were obtained from a preliminary survey, the site makes it possible to do sampling and at the Ciliwung Segment 5 Riverbanks many of the inhabitants.

2.2. Identification of Solid Waste Illegal Dumping Spot and Measurement of Solid Waste Volume and Composition
The identification of the illegal dumping spot of solid waste along the Ciliwung Segment 5 riverbank is done by mapping directly in the field, through river trekking by boat and by road. Sampling was conducted using a plastic trash bag with a capacity of 50 L. The volume of solid waste was measured at each illegal dumping spot. Determination of waste composition is done by the following formula:

\[
\% \text{ Components of solid waste} = \left(\frac{\text{Component weight (kg)}}{\text{Total solid waste weight (kg)}}\right) \times 100\%
\]  

(1)

2.3. Data analysis
Data have been obtained subsequently tabulated and analyzed descriptively.

3. Results and Discussion

3.1. Characteristic and typology of the Ciliwung Segment 5 Riverbanks
Ciliwung Segment 5 River has 30 km length which starts from Kelapa Dua, Depok until floodgate Manggarai, South Jakarta. The riverbank is the left and right of the area along the river, including the artificial river that has important benefits for maintaining the preservation of the river. In the riverbanks area is forbidden: a). disposing of garbage, solid or liquid waste; b). establishing permanent buildings for residential and business premises [5].

The area along the riverbank, in fact, is not supported by the presence of green open space (RTH) which is capable of functioning as an ecological, aesthetic and socio-cultural and economic, it happens due to the imbalance in the proportion and distribution of green open space on the riverbank area. Household waste is one of the factors which led to pollution of river water, for household waste being dumped and passed
through the gutters will ultimately lead to the river. In addition to containing organic and inorganic substances, household waste also carry germs that can be transmitted to humans, which can result in extensive epidemics in the community.

The increasing human population in the metropolitan city of Douala, has led to an increase in agricultural, and industrial activities in this area. Therefore, a better distribution system, effluent discharge, and municipal waste management for the safety of public health and environment in Douala, is imperative [2]. The results of research by [7] concluded that one of the reasons residents live on the riverbanks is the ease in discharging both liquid and solid waste directly into the river.

![Figure 1. Sampling location in Ciliwung segment 5 riverbank.](image)

Ciliwung Segment 5 riverbank covered of 8 districts and 21 urban villages in East Jakarta and South Jakarta. The land use changes so fast in the Jakarta area as well due to the construction of housing and other facilities are also driven by the weak control of land use by the local government of DKI Jakarta. In the effort of management of residential area on the Ciliwung riverbanks is the involvement of the community in spatial planning. In this case, it is demanded by the government to act as facilitator and do excellent services.
3.2. Solid Waste Volume

Ciliwung Segment 5 is 30 km long covering from Lenteng Agung District Area to Manggarai. The illegal dumping spot along the Ciliwung Segment 5 Riverbanks consist of 11 illegal spot and of various volume of the solid waste, see Table 1.

Referring to the masterplan solid waste management of DKI Jakarta Province [3], the generation rate of solid waste is 3.1 l/cap/day, then it can be calculated the volume of solid waste in the Ciliwung Segment 5 Riverbanks is 286.17 m³/day. Therefore it can be estimated that 35.17 m³/day of solid waste is not transported and 17% of solid waste is released into the river, riverbanks and burnt by the community of the riverbanks. The average volume of solid waste volume in illegal dumping spot of solid waste along the Ciliwung Segment 5 Riverbank amounting to 0.40 m³. The largest volume of solid waste is located in spot 11th is 1.43 m³ and the smallest is located in spot 6th and 10th each one consist of 0.02 m³.

The condition of the physical environment of each illegal dumping spot that on spot 11th of the Ciliwung Segment 5 Riverbank is covered with a limited number of shrubs and trees. The location is full of community residential and the illegal dumping spot is located behind their residence along 50 meters. The community living in the riverbanks are using the river water for daily activities. The area is considered as a high slum area.

Table 1. Estimates of solid waste volume at the illegal dumping spot.

| Illegal dumping spot | Latitude | Longitudinal | District Area | Estimates of Solid Waste Volume (m³) |
|----------------------|----------|--------------|---------------|---------------------------------------|
| 1.                   | -6.3322  | 106.8407     | Lenteng Agung | 0.60                                  |
| 2.                   | -6.3237  | 106.8415     | Lenteng Agung | 0.85                                  |
| 3.                   | -6.3028  | 106.8546     | Gedong        | 0.85                                  |
| 4.                   | -6.2826  | 106.8488     | Pejaten Timur | 0.02                                  |
| 5.                   | -6.2705  | 106.8549     | Pejaten Timur | 0.08                                  |
| 6.                   | -6.2937  | 106.8537     | Bale Kambang  | 0.30                                  |
| 7.                   | -6.2572  | 106.8600     | Rawajati      | 0.08                                  |
| 8.                   | -6.2573  | 106.8599     | Rawajati      | 0.09                                  |
| 9.                   | -6.2344  | 106.8662     | Kebon Baru    | 0.05                                  |
| 10.                  | -6.2385  | 106.8631     | Kebon Baru    | 0.02                                  |
| 11.                  | -6.2077  | 106.8485     | Manggarai     | 1.43                                  |

3.3. Solid Waste Composition

Solid waste composition in illegal dumping spot along the Ciliwung Segment 5 Riverbanks is conducted by 3 days continuous sampling approach. In three location considered representative, namely in Sub-Segment 1 (Lenteng Agung District Area), Sub-Segment 2 (Pejaten Timur District Area) and Sub-Segment 3 (Manggarai District Area). Solid waste composition based on sampling result in the location see Table 2.

Analysis of solid waste composition in the 3 sub-segment shows that organic waste is 42%, inorganic waste that consist of wood 14%, paper and plastic each one consist of 12%, glass 11%, others 4%, textile, rubber and metal each one consist of 1% at the Ciliwung Segment 5 Riverbank. The solid waste composition diagram see at Figure 2. Based on the current condition and to reduce the illegal dumping spot, in solid...
waste management can be implemented in integrated solid waste management in the area along the along
the Ciliwung Segment 5 Riverbank.

Table 2. Solid waste composition in Ciliwung segment 5 riverbanks.

| Composition | Location |
|-------------|----------|
|             | Sub-Segment 1 (%) | Sub-Segment 2 (%) | Sub-Segment 3 (%) |
| Organic     | 35        | 47        | 44        |
| Inorganic   |           |           |           |
| Wood        | 18        | 11        | 14        |
| Paper       | 15        | 11        | 11        |
| Plastic     | 14        | 11        | 11        |
| Textile     | 1         | 0         | 2         |
| Rubber      | 1         | 0         | 3         |
| Metal       | 3         | 0         | 1         |
| Glass       | 9         | 14        | 11        |
| Others      | 4         | 7         | 2         |

Figure 2. Solid waste composition.

4. Conclusion
The area along the Ciliwung riverbank, in fact, is not supported by the presence of green open space (RTH) which is capable of functioning as an ecological, aesthetic and socio-cultural and economic, it happens due to the imbalance in the proportion and distribution of green open space on the riverbank area.

The number of illegal dumping spot along the Ciliwung Segment 5 Riverbank are 11 spots, with the total volume of solid waste that is equal to 4.37 m³. Average percentage of solid waste composition in Ciliwung
Segment 5 Riverbanks is in Lenteng Agung, Pejaten Timur and Manggarai consists of organic waste by 42%, followed by 14% wood, 13% of paper, and plastic respectively by 12%, glass by 11%, miscellaneous junk by 4%, rubber by 2%, textile/leather and metal respectively by 1%.

In the effort of management of residential area on the Ciliwung riverbanks is the involvement of the community in spatial planning. In this case, it is demanded by the local government to act as facilitator and do excellent services.

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