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Mapping and analysis of temporary waste shelters using geographic information systems in Kambu District, Kendari City, Southeast Sulawesi Province, Indonesia, 2024

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Abstract

Background: Kendari City as one of the largest waste contributing cities in Southeast Sulawesi Province is also the capital area of Southeast Sulawesi Province. Data from the Kendari City Environment and Forestry Agency in 2017, calculated that the amount of waste managed at the Kendari City Final Disposal Site (TPA) was 43.2 thousand tons, then in 2018 it was 47.4 thousand tons, in 2019 it was 46.5 thousand tons, in 2020 it was 55.4 thousand tons, and until August 2021 the waste managed in the Kendari City Landfill was 44.4 thousand tons.

Methods: A research method with a descriptive observational approach where the researcher conducted a field survey and plotted coordinates with GPS, as well as measuring waste generation in respondents. The data were processed and analyzed spatially and normatively standards, then described as the Place and Time of the Research.

Results: The results of the study showed that the distribution of the population in the Kambu Village area was 7,114 or (30.51%) while the lowest was in the Mokoau Village area of 5,063 or (21.72%). The Temporary Disposal Sites (TPS) of Kambu District are dominated by unofficial polling stations of 29 places, while the official polling stations are 3 places.

Conclusion: The conclusion in this study is that the existence of Temporary Disposal Sites (TPS) is very influential in areas with high population density. The imbalance in the number and distribution of polling stations in dense areas leads to the accumulation of garbage, increases the risk of environmental pollution, and interferes with public health.

Keywords: Analysis; Temporary Disposal Sites; Geographic information system

1. Introduction

Waste management is an important environmental issue, especially in urban areas that have a high level of population density. Temporary Shelters (TPS) are an essential component in the urban waste management system because they function as transit locations before waste is transferred to the final disposal site (1). The imbalance between the volume of waste produced and the capacity of the TPS often causes problems such as garbage accumulation, air pollution, and groundwater pollution around settlements. Therefore, the placement and capacity of TPS must be properly regulated to ensure effectiveness in waste management (2).

Data from the Ministry of Environment and Forestry of the Republic of Indonesia, waste generation in 2021 was 41.48 million tons, while waste generation in Indonesia in 2020 touched 34.52 million tons. From the 2020 data above, it is also known that 19.5 million tons of waste (56.58%) have been managed and 14.98 million tons (43.42%) of unmanaged waste. The data for 2020 has increased from the previous year in 2019, which was 29.13 million tons. It is known that

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the largest contributor of waste in Indonesia comes from household activities, market activities, school activities and regional activities (3).

Kendari City as one of the largest waste contributing cities in Southeast Sulawesi Province is also the capital area of Southeast Sulawesi Province. Data from the Kendari City Environment and Forestry Agency in 2017, calculated that the amount of waste managed at the Kendari City Final Disposal Site (TPA) was 43.2 thousand tons, then in 2018 it was 47.4 thousand tons, in 2019 it was 46.5 thousand tons, in 2020 it was 55.4 thousand tons, and until August 2021 the waste managed in the Kendari City Landfill was 44.4 thousand tons. This shows that there is a fluctuation in waste management that enters the Kendari City landfill.The occurrence of waste in Kendari City comes from household

The Geographic Information System (GIS) provides an effective solution to map and analyze the location of polling stations to suit the needs of a particular region. GIS enables fast and accurate processing of spatial and non-spatial data, which is very useful in determining the optimal location of polling stations (5). By using GIS, the government or authorities can obtain a comprehensive picture of the distribution of polling stations in an area, so that the location of polling stations can be evaluated or improved based on the needs of the surrounding environment (6). The application of GIS in waste management has been proven to increase efficiency, especially in the context of TPS allocation in accordance with areas with high needs, such as densely populated areas (7).

Studies related to the application of GIS in waste management in various cities in Indonesia show that TPS mapping using GIS can reduce waste transportation travel time and significantly increase waste management service capacity (8). However, on the other hand, challenges still exist regarding accurate data collection and maintenance of GIS devices that require special costs and expertise (9). Therefore, further research is needed to understand the potential of GIS in increasing the effectiveness of polling stations and facing existing obstacles (10).

Mapping TPS facilities using GIS technology based on android applications (mobile GIS), in addition to facilitating and assisting the government in determining waste management policies, is also beneficial for the community to know the existence and reach of TPS services (11)

2. Method

This research method uses an observational descriptive approach where the researcher conducts a field survey and plots coordinates with GPS, as well as measuring waste generation in respondents. The data were processed and analyzed spatially and normatively standards, then described as the Place and Time of the Research. The data was analyzed using a geographic information system (GIS).

3. Results

3.1. Population Density Overview

Table 1 Population density of Kambu District

Neighborhoods	Inhabitant	Percentage (%)
Mokoau	5.063	21.72
Kambu	7.114	30.51
Padaleu	5.262	22.57
Lalolara	5.875	25.20
Total	23.314	100

Source: Secondary data, 2023

Based on the table, the area that has the most densely populated population distribution is in the Kambu Village area of 7,114 or (30.51%) while the lowest is in the Mokoau Village area of 5,063 or (21.72%).

3.2. Status of Temporary Disposal Sites (TPS) in Kambu District

Table 2 shows that from each sub-district the distribution of Temporary Disposal Sites (TPS) in Kambu District is dominated by unofficial polling stations of 29 places, while official polling stations are 3 places.

Illegal Temporary Disposal Sites (TPS) are locations that are used to dispose of garbage without permission or not in accordance with regulations set by the government. This type of TPS often causes environmental and health problems. Meanwhile, the Resm i Temporary Disposal Site (TPS) is a location determined by the government or related agencies to accommodate waste before being transported to the final disposal site (TPA). Official polling stations have several characteristics and management in accordance with regulations.

Table 2 Status of Temporary Disposal Sites (TPS) in Kambu District

Neighbor hoods	Number of TPS Location Points Unofficial	Number of TPS Location Points Official)
Mokoau	4	0
Kambu	11	1
Padaleu	5	1
Lalolara	9	1
Total	29	3

Source: Primary Data 2024

Figure 1 Map of TPS Station Kambu District

Based on the picture, it shows that almost the entire Kambu sub-district area is dominated by the existence of garbage cans that do not meet the standards, while there are quite a few garbage cans that meet the standards.

4. Discussion

4.1. Population Density Overview

High population density has a direct relationship with the amount of waste produced. The denser an area is, the greater the volume of waste produced, which in turn poses challenges in terms of waste management and environmental impact. The following is a discussion of the effect of population density on the amount of waste, which is discussed based on data, and a comparison between previous and recent research.

The high population density in an area contributes significantly to the increase in the amount of waste, especially household waste. Some important aspects associated with this influence such as Waste Volume: The amount of waste generated is directly proportional to the number of population. For example, data from the Central Statistics Agency (BPS) shows that cities with high population density such as Jakarta produced an average of 7,500 tons of waste per day in 2020, which is mostly composed of organic and inorganic waste.

The per capita waste production rate in high-density cities can reach 0.8–1.2 kg per day per person, depending on people's living standards and consumption habits. In a metropolitan city like Jakarta, this figure can be even higher (12).

Waste in Densely Populated Areas: In densely populated areas, space limitations and inadequate waste management infrastructure often lead to waste accumulation, especially in areas with minimal efficient waste transportation facilities.

Previous studies have highlighted the correlation between population growth and increased waste volume. Here are some findings from previous studies such as the 2010 study (Wibowo & Asnawi): This study states that the increase in the amount of waste in Indonesia's major cities is due to the high rate of urbanization and population density. In Surabaya, the population density is above 9,000 people/km^2, causing daily waste production to reach 1,500 tons. The study also highlights that population growth is faster than waste management capacity increase.

Another study found that in densely populated areas, the rate of uncontrolled waste disposal is very high. For example, in some areas in Jakarta, such as Jatinegara Village, more than 30% of garbage is littered into rivers due to inadequate waste transportation systems, which are exacerbated by high population density (13).

Recent research tends to focus more on the use of technology and more sustainable management strategies in the face of increasing waste in areas with high population density. Several recent studies show increased awareness of the importance of technology and more effective management.

Research by Rachman *et al*. shows that the increase in the amount of waste in dense cities such as Bandung is not only influenced by the number of population, but also consumption patterns and income levels. The study identified that people with higher economic levels produce more plastic and packaging waste compared to low-income communities, even though they live in areas of the same density. (14).

Utami *et al.*' s research where this study uses spatial data analysis and Internet of Things (IoT) applications to map waste collection points in densely populated areas, such as in Depok. With the help of this technology, they were able to identify critical areas with excess waste volumes, which allowed for more efficient waste transport planning. In addition, IoT technology also helps in predicting an increase in waste volume based on fluctuations in the population in a particular area (15).

Nugraha & Setiawan Research Where this research focuses on waste reduction efforts through a circular economy approach in densely populated areas, such as in Yogyakarta. They found that community-based waste management, such as waste banks and recycling programs, had a significant impact on reducing the amount of waste in dense areas. The study also emphasizes that by involving the community, especially in high-density areas, it can reduce waste production by up to 15% of the total daily waste production. When compared, old and new studies have significant differences in their approaches and findings. Previous research has emphasized the direct link between population growth and waste growth, focusing on inadequate infrastructure and ineffective waste transportation systems. Recent research, on the other hand, focuses on technology-based solutions and community-based management to address the problems faced by densely populated areas (16)

4.2. Distribution of Temporary Burial Sites (TPS) in Kambu District

Uneven distribution of Temporary Disposal Sites (TPS) is one of the main problems in waste management in urban areas, especially in densely populated areas. Based on recent research, this imbalance not only has an impact on the excessive accumulation of waste in certain polling stations but also causes serious environmental impacts, such as soil, air, and water pollution due to uncontrolled waste disposal. In some cases, this inequality encourages people to litter or use unofficial disposal systems, further exacerbating the city's waste problem.

Other research shows that the main factors contributing to the inequality of polling stations include the high rate of population growth and the lack of mature urban planning related to waste management infrastructure. These findings underscore that areas with high population densities need more TPS to accommodate the ever-increasing volume of waste. However, limited land in urban areas is an obstacle in building new polling stations. The focus of previous studies has been on increasing the number of TPS and improving the waste transportation system to correct the imbalance (18).

The comparison between previous and recent research shows that there is a paradigm shift from purely infrastructure-based solutions to a more participatory and technology-based approach. Previous research tends to focus on increasing the number of TPS and improving waste transportation systems, while recent research seeks to reduce dependence on TPS by involving the community and technology in waste management. This shift signals that the long-term solution to address the TPS imbalance in densely populated areas requires collaboration between the government, the community, and technology.

5. Conclusion

The existence of Temporary Disposal Sites (TPS) is very influential in areas with high population density. The imbalance in the number and distribution of polling stations in dense areas leads to the accumulation of garbage, increases the risk of environmental pollution, and interferes with public health.

Ineligible Temporary Disposal Sites (TPS) have a significant negative impact on public health and the environment. TPS that do not meet standards, such as inappropriate locations, inadequate facilities, or poor management, can cause soil, water, and air pollution.

Suggestion

Conduct periodic evaluations and audits of all existing polling stations to assess whether they meet the set standards. Unqualified polling stations must be repaired or closed immediately.

Prioritizing the construction of new TPS that meets the requirements and good environmental standards, including locations far from residential areas, adequate facilities, and effective management systems.

Improve waste management infrastructure, including transportation systems and waste treatment facilities, to ensure that waste is managed properly and does not pollute the environment.

Implement stricter regulations and policies related to the location selection, management, and operation of polling stations to ensure that all polling stations operate in accordance with the set standards and do not endanger public health.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

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