



Socioeconomic and Public Health Impacts of Waste Management in Piyungan Landfill, Bantul-Indonesia

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Abstract

Piyungan Landfill in Bantul, Indonesia, still uses an open dumping system, leaving environmental impacts. This research examined the effects of open dumping on the socioeconomic and health conditions of nearby populations. Surveys and interviews using questionnaires were employed with households as the analysis unit. From four sub-villages (Ngablak, Banyakan III, Sentulrejo, and Baruwan I), 128 respondents were sampled randomly. Statistical quantitative analysis was employed to analyze the research data. Descriptive statistics were selected to describe sample data. Data were then expressed as percentages and presented in pie charts. Results show that for people who salvaged recyclables, the landfill was their primary source of livelihood. More than half (62.5%) earned an average of IDR1,093,095 (approximately USD70) per month as waste pickers. However, open dumping lowered the environment's aesthetic value due to the unpleasant view and smell, and large populations of animals like rats, flies, cats, and mosquitoes attracted to waste piles. Nearly all respondents (90.6%) expressed their anxiety about these adverse effects, triggering social conflicts. It was claimed that property values and public health were, however, unaffected. Most respondents stated that the landfill did not lower the property values (96.9%) and did not cause health concerns (71.9%).

Introduction

Waste remains a major environmental issue worldwide. The global average rate of waste generation is about 0.74 kg/person/day but varies widely across countries, from 0.11 to 4.54 kg/person/day (Mor *et al.*, 2023). These streams of waste end in municipal solid waste landfills or final disposal sites in their respective regions and can cause environmental impact unless properly managed (Simsek *et al.*, 2014; Dregulo *et al.*, 2022). Indonesia's Law No. 18 of 2008 on Waste Management defines landfills as a place to safely process and return waste to the natural media for humans and the environment. Landfills and all activities entailed should not negatively affect the environment because, as described in the Law above, waste

management aims to improve public health and environmental quality and turn waste into resources. However, with many landfills in Indonesia and other developing countries still practicing the open dumping system, numerous cases of environmental pollution, particularly groundwater contamination, have been reported due to the poor design (El-Mathana *et al.*, 2021).

Open dumping is not recommended for waste management because it merely accumulates waste in open fields without periodic compaction and burial. On the contrary, sanitary waste landfills are widely proposed because the designated areas are prepared and operated systematically by spreading, compacting, and covering or

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burying the waste daily—a technical definition laid in the Regulation of Indonesia Minister of Public Works No. 03/PRT/M/2013. Alao *et al.* (2023) stated that open dumping adversely affects the entire environmental components; it contributes 17% of global methane emissions, deteriorates soil and air quality, lowers property values, and adversely affects public health as it creates a breeding ground for disease-carrying vectors (e.g., rodents, flies, and mosquitoes) and produces leachate that contains toxic substances and pathogens.

The Piyungan Landfill in Bantul, Indonesia, has been operating since 1995 in a 12.5-ha area and still employs an open dumping system. It receives the waste streams from three regions: Bantul Regency, Sleman Regency, and Yogyakarta City. According to the Waste Management Center, Department of Environment and Forestry in Yogyakarta (2022), the city generated the most significant amount of waste fed to the landfill in 2019 and 2020, but in 2021 and 2022, Sleman was the largest waste contributor. In 2022, the landfill received 105,441 tonnes of waste from Sleman, 97,035 tonnes from Yogyakarta, and 67,677 tonnes from Bantul. More waste was transported from Sleman as customers of the garbage collection services grew in number, from 758 households in 2020 to 974 in 2022.

The landfill’s capacity to accommodate more waste accumulation decreases over time, raising environmental problems. More people who reside in neighboring areas are feeling disadvantaged and concerned about the open dumping. Since 2019, these unfavorable circumstances have occasionally burst into social conflicts that repeatedly end with residents blocking the landfill’s access roads. Therefore, this research was designed to investigate the socioeconomic and public health impacts of open dumping practices in the Piyungan Landfill. It is expected to provide input for evaluating and improving the waste management design to comply with Law No. 18 of 2008 on Waste Management in Indonesia and, ultimately, minimize threats to humans and the environment.

Methods

Piyungan Landfill is located in Ngablak Sub-village (Sitimulyo, Piyungan, Bantul Regency, Indonesia). The research location covered four sub-villages that were directly and indirectly affected by waste management activities in the landfill: Ngablak, Banyakan III, Sentulrejo, and Bawuran I. Administratively, these regions are part of Sitimulyo and Bawuran Villages (Figure 1.).

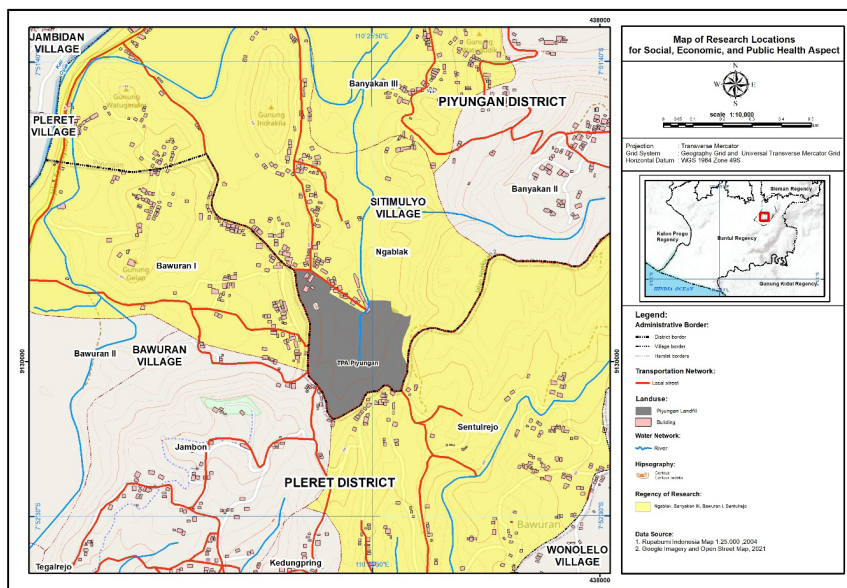


Figure 1. Map of the Research Location for Socioeconomic and Public Health Impact Analysis of Waste Management Activities (i.e., Open Dumping) in Piyungan Landfill, Bantul, Indonesia.

Surveys and interviews using questionnaires were conducted to obtain primary data, with households as the unit of analysis. From each sub-village, 32 samples of households were selected randomly and evenly distributed across neighborhood units (RTs); thus, the total sample size was 128. For the interviews, the respondents were the heads of households aged 17 years old and above that were directly or indirectly impacted by the open dumping. These interviews collected primary data on income, property prices, environmental aesthetics, public unrest, and public health.

Results and Discussion

Open dumping in Piyungan Landfill affects numerous components of the environment, including socioeconomic conditions and public health. Five parameters were gauged to assess these impacts: income, property prices, aesthetic values of the environment, public unrest, and public health. Piyungan Landfill has been the primary and secondary source of income for many people living in its surroundings. The survey results showed that of the 128 respondents, 80 (62.5%) reaped the benefits of it to earn money either as a main occupation (77 respondents) or as a side job (3 respondents). The latter respondents were engaged in waste management in the landfill to supplement their primary income from working as farmers or casual laborers. Most of the local population earned a living from salvaging, sorting, and selling reusable and recyclable waste or as garbage collectors. Based on data from the local waste pickers community “MARDIKO”, there were 14 garbage collectors and 467 waste pickers in 2020. These many laborers indicated that the materials disposed of into the landfill were not residues but still held some economic value. The sorted reusables or recyclables were sold to garbage collectors. From this, waste pickers received, on average, IDR1,093,095 (approximately USD70) per month, which is still far below the 2023 provincial minimum wage in Yogyakarta, IDR1,981,782.39 (USD130) per month. Meanwhile, garbage truck drivers could earn up to IDR4,000,000 (USD260) monthly. From these figures, it can be inferred that the landfill offers economic benefits through primary and

additional incomes for dependent households.

Waste picking can be seen as a new perspective on reducing the amount of waste accumulating in landfills because the collected salvageable materials are brought to garbage collectors, who then transport them and continue the waste processing outside landfills. Previous works confirmed that waste picking as an informal sector contributes to managing and decreasing waste both at the source (household) and on the regional scale, creating a new subdivision in the waste management system (e.g., Wilson *et al.*, 2006; Besiou *et al.*, 2012; Putra *et al.*, 2019; Chen *et al.*, 2021). This contribution can be substantially improved if informal sector recycling (ISR) is integrated into sustainable waste management, which relies upon several factors like “social acceptance, political will, mobilization of cooperatives, partnerships with private enterprises, management, and technical skills, as well as legal protection measures” (Ezeah *et al.*, 2013, p. 2509). Waste pickers play an essential part in economic growth, waste control, and conservation of resources and in providing secondary materials for the recycling industry (Asim *et al.*, 2012). Many examples have been discussed in the literature. In the Greater Accra Region, Ghana, waste pickers sort out recyclable materials from the waste stream, reducing total solid refuse, and earn USD 7–17 from the daily sale of plastics and metals collected from the city’s commercial districts and landfills (Rockson *et al.*, 2013). This exceeds the minimum daily income of USD1 set by the Millennium Development Goals as a reference target for halving the share of economically disadvantaged people. Similarly, after working for 10 to 12 hours, a waste picker in Abuja, Nigeria, can collect 19.76 kg of salvageable materials daily and earn USD2.8–4.20 from their sale (Ogwueleka *et al.*, 2021). Despite the significant contribution to waste control, waste pickers are exposed to serious health threats. Regardless of the risk, many decide to continue working in this field due to a lack of awareness and economic necessity. The same case has been observed in 33.6% of waste pickers in Tehran, Iran (Ghaedrahmati *et al.*, 2023).

In addition to income, property prices can also be used as a parameter to measure the socioeconomic impact of a landfill. Previous

studies have investigated the relationship between solid waste facilities and property values. A study in Hangzhou, China, found an increase of 0.027% in price for every 1% addition to the property's distance from the waste sorting and reduction complex (WSRC) (Wen *et al.*, 2022). Likewise, property prices in Bellville and Coastal Park (Cape Town, South Africa) increased respectively by 2% and 12% per km of distance away from landfills (Nahman, 2011). In other words, the closer the house or land is to the waste facility, the lower the property value. However, the opposite was observed in the study area. Based on the survey, 85 respondents (66.4%) stated that the Piyungan Landfill did not affect the neighboring land values (Figure 2.). According to 124 respondents (96.9%), there had not been a decline in the said land price over the last five years; instead, 106 respondents thought it was rising.

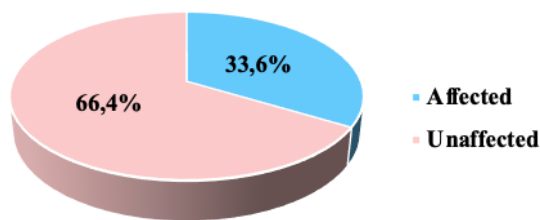


Figure 2. Public Perceptions of Property Values Around the Piyungan Landfill, Whether the Land Price is Affected or Unaffected by the Disamenities

The increase in land prices might be associated with a mountain landmark, Puncak Sosok, in Jambon Sub-village (Bawuran, Pleret Subdistrict, Bantul Regency). Bawuran is located next to the landfill, and the economic growth from managing a tourist attraction has sprawled to its surroundings, including high demand for land that inevitably raises the price. This phenomenon contradicts findings in other areas where the property values plummet due to proximity to landfill sites.

Environmental aesthetics is the broad term used to characterize the interaction between a person and their surroundings in terms of beauty (Jane Reece *et al.*, 2015). It was used to observe the environmental conditions of the Piyungan Landfill, including

the unpleasant smell and sight of scattered waste, the appearance of disease-carrying animals, loud noise, and road damage. It is necessary to understand public perceptions of environmental aesthetics as it can be used to quickly determine the landfill's performance in managing waste. Properly implemented waste management is manifested in an aesthetic environment because it aims to diminish the adverse impact associated with waste generation and processing to promote environmental and human health (Schmidt *et al.*, 2023).

The survey found that 76 respondents (59.4%) complained about the smell from waste putrefaction and, as a result, they had to buy air fresheners, wear masks, close the house doors, apply eucalyptus oil just below the nose, and turn on fans. However, the others felt that the odor was normal and only bothered them occasionally (47 respondents, 36.7%), and some rarely smelled the stench (5 respondents, 3.9%). The average cost incurred to overcome the foul odor was IDR29,075 (USD2) a month. Concerning environmental aesthetics, smell can be an aspect of disamenities that affect property values around landfills (Li *et al.*, 2018).

Furthermore, while being transported, waste might fall off garbage trucks onto the access roads to the landfill. The survey revealed that 74 respondents (57.8%) had varying perceptions as to how much waste was scattered afterward (Figure 3.), from "very small" to "very large", while 54 others (42.2%) answered with "none". There were generally more people around the landfill complaining about aesthetic disruptions from the litter. To clean it, they collected, burned, threw it away to unused lands or the river, left the waste as it was, or reported it to the Piyungan Landfill office. Waste piles also attract large populations of animals that potentially spread diseases to neighboring settlements, such as flies, rats, cockroaches, cats, and mosquitoes. In large numbers, disease-carrying animals are indications of poor environmental hygiene and sanitation, particularly mosquitoes. The mosquito larval count index is positively related to house cleanliness and environmental sanitation (Sukesi *et al.*, 2023). Therefore, the poorer the environmental hygiene, the more disease-carrying animals appear. To deal with

this, the respondents sprayed insecticide and applied glue traps to catch rodents. For this trouble, they had to spend an additional amount of IDR25,430 (USD2) monthly.

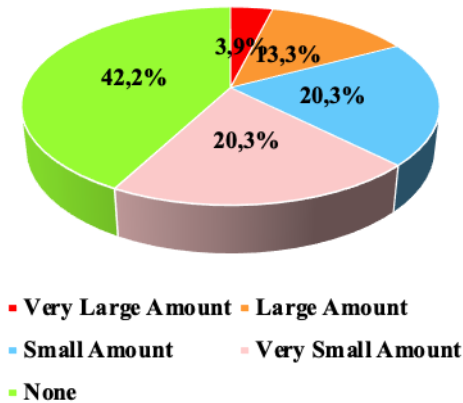


Figure 3. Public Perceptions of the Amount of Litter Scattered Around the Piyungan Landfill.

The respondents also expressed concerns about loud noises and damage to roads from the waste transport and unloading activities by garbage trucks. The survey identified different perceptions of the noise problem: 52 respondents (40.6%) were disturbed by the noise, while 74 others (57.8%) were not. These results depend on how close the respondent's house is to the landfill's access roads; noise from the garbage trucks entering and exiting the site would be louder to settlements nearby. In addition, 55 respondents (43%) explained that this traffic caused minor to severe damage to roads.

Social conflicts were the kind of public unrest specifically analyzed in this study as the social impact of open dumping. Social conflicts commonly occur concerning environmental injustice. Moreover, they are often an integral part of development processes (Owusu *et al.*, 2012). One of the issues that frequently sparked conflicts in neighboring sub-villages was the unmet demand for safe settlements. There were two opposing perceptions of land allocation in the area: whether the houses encroached on the land designated for open dumping or the landfill was developed in the middle of the residential zone.

The survey discovered that 116 respondents (90.6%) identified poorly designed waste management in the landfill as

the cause of social conflicts (Figure 4.). These conflicts occurred repeatedly, according to 55 respondents (43%), and had been more frequent since the landfill overflow and began to affect neighboring settlements negatively. Many times, these events led to protests and residents blocking the access roads to the dump site. Oppositions by residents to the continued open dumping practices were becoming more common. A similar situation has been reported in Campania, Italy, where residents were against landfill development in their area, commonly called the NIMBY (not in my backyard) syndrome (Gallo, 2019). Table 1. summarizes the solutions people in the four sub-villages demanded to address these persistent problems.

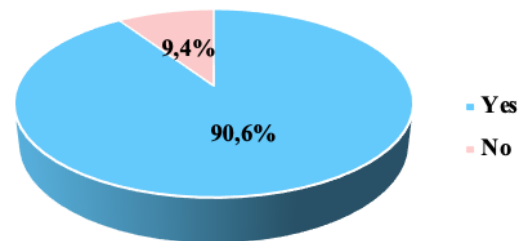


Figure 4. Public Perceptions of Social Conflicts, Whether or Not Open Dumping in the Piyungan Landfill is the Leading Cause

In addition to socioeconomic impact, open dumping is believed to harm public health. The survey inquired about the health condition of the residents in the last six months. Results show that 92 respondents (71.9%) did not experience any sickness related to activities in the landfill, while the remaining 36 (28.1%) had suffered some in the last six months (Figure 5.). The most common illnesses were headaches, colds, coughs, and nausea/vomiting. However, they could not be linked directly to the landfill. Respondents added that abnormally cold weather during the dry season in the last six months might have played a role. This corresponds to Norsa'adah *et al.* (2020), which ascertained the significant correlations between exposure to open dumps and throat problems/disorders, diabetes mellitus, and hypertension, but whether or not it was the cause of these diseases could not be determined. However, Vinti *et al.* (2021) reviewed nine studies publishing evidence that increased risks

Table 1. Causes and Expected Solutions of Social Conflicts Due to the Waste Management Activities in the Piyungan Landfill

Causes of Social Conflicts	Solutions Demanded by Affected Villages
Water pollution due to leachate generation in the Piyungan Landfill	<ul style="list-style-type: none"> a. Construction of a separate impermeable channel for leachate disposal b. Optimized leachate processing to be safely disposed of in the environment c. Construction of drilled wells and clean water facilities as substitutes for the contaminated wells
Air pollution due to the unpleasant smell from waste putrefaction	Improved waste processing technology at the landfill to control or eliminate odor
Road damage due to waste transport to the landfill	Restrictions on the number of garbage collection trucks
The landfill's capacity has long been exceeded (overflowing), creating more waste piles near the settlements	<ul style="list-style-type: none"> a. Expansion of the landfill area to the north b. Restrictions on landfill development near residential areas c. Establishing frequent communication with the residents about the landfill development
No compensation fund for losses suffered from poor waste management	Compensation for affected residents
Protests over the planned expansion of the landfill area	Landfill relocation
Disruptions to public health	Medical examination and public dissemination of information on potential health impacts of landfill operations by the authorized Health Office
Traffic jams due to long queues of garbage trucks entering the landfill	<ul style="list-style-type: none"> a. Operating hours for garbage trucks entering/exiting the landfill b. Truckloads should be covered with tarps to prevent waste from flying or falling off the trucks while waiting in line to enter the landfill

of adverse pregnancy outcomes, death from respiratory diseases, and mental health have been reported from households close to landfills. Living within 1 km of landfills is a health risk factor because the residential quality that does not meet physical requirements can lead to health problems (Farsida *et al.*, 2023). Therefore, proper waste management is needed to reduce the exposure of nearby settlements to medical disorders (Norsa'adah *et al.*, 2020). Moreover, it is necessary to provide health education for the public using an individual approach to prepare them for health emergencies (Handayani *et al.*, 2023).

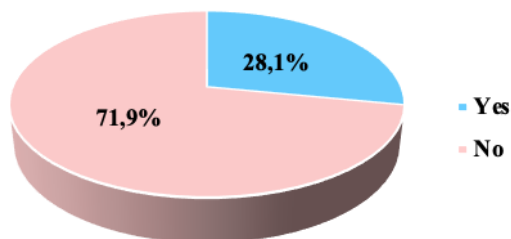


Figure 5. Public Perceptions of Health Problems Suffered in the Last Six Months

Based on the survey results, almost half of the respondents (46.1%) opposed the landfill operation in their area on account of its adverse socioeconomic and public health impacts on nearby settlements. Moreover, 75% felt disadvantaged by the landfill's presence in their area, and 89.1% agreed there should be compensation funds for the suffered losses and discomfort.

Conclusion

Open dumping in the Piyungan Landfill affects the socioeconomic and health conditions of nearby populations. The impacts are substantial on income, environmental aesthetics, and public unrest, but no direct link has been identified between proximity to the landfill and property values and public health. Waste pickers and collectors can earn daily to monthly income from the landfill. The aesthetic value of adjacent neighborhoods is reduced due to litter on the landfill's access roads (waste falling off open truckloads), unpleasant odors, and increasing populations of rats,

flies, cats, and mosquitoes. Environmental pollution has been pointed out as the leading cause of social conflicts, often resulting in repeated blocking of access roads. On the contrary, the landfill does not directly affect property values and public health. There is no decline in property values; instead, a rise in land price has been linked to the new tourist attraction “Puncak Sosok”, which is close to the landfill. While some cases of headaches, coughs, colds, and nausea/vomiting have been reported in the last six months, they cannot be directly linked to landfill operations due to the probable combined influence of weather conditions. Nevertheless, people living nearby also acknowledge that the landfill can cause various health problems, such as skin diseases, nausea, and dizziness. Therefore, considering the above socioeconomic and public health impacts, the government should immediately begin planning for and implementing a well-designed, environmentally friendly waste management system and technology to sustain its operation while complying with Law No. 18 of 2018 on Waste Management in Indonesia.

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