Media Publikasi Promosi Kesehatan Indonesia

e-ISSN 2597-6052
PUBLISHED BY
Fakultas Kesehatan Masyarakat
Universitas Muhammadiyah Palu
Indonesia

RESEARCH ARTICLE

Mapping Communal Waste Shelters as Empirical Evidence to Support Health Policy Planning in Jambi Province

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ARTICLE HISTORY
Received: 21 Nov 2025
Revised: 12 June 2026
Accepted: 25 July 2026
Published: 19 August 2026

ARTICLE IDENTIFIERS
Volume 9 - **Issue** 8 - 2026
Pages: 1554-1561
DOI: 10.56338/mppki.v9i8.9280

ABSTRACT

Introduction: Waste management remains a major challenge in Indonesia, where 32.93% of waste is unmanaged. In Jambi Province, population growth of 1.30% has increased the volume of waste deposited at both standardised and non-standardised communal waste shelters. Under SNI 19-2454-2002, standardised shelters must be durable, watertight, cost-effective, publicly accessible, and easy to empty. This study aimed to map communal waste shelters as empirical evidence for health policy planning in Jambi Province.

Methods: This quantitative descriptive survey mapped communal waste shelters using a geographic information system (GIS). The base map was derived from the Bakosurtanal Digital Topographic Map. Thematic data were collected, processed, categorised, and integrated into the base map. Field observations in Batanghari, Tanjung Jabung Barat, and Tanjung Jabung Timur Regencies were used for updating and verification.

Results: Tanjung Jabung Barat Regency had the largest number of communal waste shelters (n = 186; 45% standardised and 55% non-standardised), followed by Tanjung Jabung Timur Regency (n = 144; 31% standardised and 69% non-standardised) and Batanghari Regency (n = 53; 13% standardised and 87% non-standardised). Across the three regencies, 383 shelters were identified. Overall, 35.25% were standardised, with a mean volume of 43.93 m³, whereas 64.75% were non-standardised, with a mean area of 30.23 m². Based on SNI 19-2454-2002, the minimum requirement was 2,562 standardised communal waste shelters.

Conclusion: The findings provide empirical evidence to support health policy planning and indicate a shortfall of 2,427 standardised communal waste shelters relative to the stated minimum requirement.

Keywords: Geographic Information Systems; Waste Management; Communal Waste Shelters; Environmental Health; Health Policy

INTRODUCTION

Human activities generate solid waste, the volume of which increases with population growth and technological development. Plastic waste, composed of synthetic polymers, does not readily biodegrade and can adversely affect environmental sustainability (1)(2)(3). According to the World Health Organization, environmental factors such as water and air pollution, inadequate sanitation, and toxic chemicals account for approximately one-quarter of deaths worldwide (4). Effective waste management is therefore an important component of public health, as cleaner environments may prevent approximately 25% of the global disease burden (5). It also supports the 2030 Sustainable Development Goals by enabling present needs to be met without compromising ecosystems and resources for future generations (6,7).

Sustainable waste management requires a shift towards a circular economy, in which waste is processed for reuse as a manufacturing input, recycled, or converted into usable energy (8-10).

Without proper management, waste can pollute the environment, harm human health, and facilitate disease transmission (11). Factors that influence waste management and may impede effective systems include population distribution and density; the availability of waste shelters; monitoring and law enforcement; socioeconomic conditions; physical environmental characteristics; and community attitudes, behaviours, and culture (12,13).

Improper waste disposal and handling can create unsanitary surroundings, contaminate air, soil, and groundwater, increase disease risks, degrade environmental amenity, and produce unpleasant odours (14). Waste management has remained a major concern in Indonesia for many years. Communal waste shelters must therefore be sufficient to accommodate the volume generated. Where adequate standardised shelters are unavailable, non-standardised disposal practices may become more common (15).

According to the Ministry of Environment, Indonesia generates 56.63 million tonnes of waste annually, of which 60.99% is unmanaged. This waste may be deposited in open dumps or end-of-pipe disposal sites, leak into the environment through open burning, or enter water bodies, thereby affecting the quality of water, air, and soil near disposal sites (16).

Waste-management policies have been implemented by government and private-sector stakeholders to mitigate environmental impacts (17). Institutional drivers may play an important role in accelerating waste-management practices (18), while multi-stakeholder approaches may improve management outcomes (19). Effective policy formulation requires a comprehensive understanding of current waste-management and disposal systems (20), for which GIS-based mapping is commonly used.

GIS-based mapping can capture, manage, and disseminate information needed to optimise waste management (21). It can support decision-making, land-suitability assessment, and the siting of treatment facilities or collection points (22). Spatial mapping can also depict behavioural patterns related to community waste-disposal practices (23,24) and identify non-standardised communal waste shelters in an accessible, rapid, and accurate manner (22).

Global solid-waste generation reached 2.01 billion tonnes in 2016 and is projected to rise to 3.4 billion tonnes by 2050 (25). In Indonesia, 18.4 million tonnes of waste were generated in 2023, of which 32.93% was unmanaged. More effective management could reduce the amount disposed of in landfills. Indonesia's waste-management system includes collection at communal waste shelters and final processing at landfills, although non-standardised burning and dumping remain common (15). Jambi Province lies between 0°45′ and 2°45′ south latitude and 101°10′ and 104°55′ east longitude. It covers 49,026.579 km² and comprises nine regencies, two cities, 144 districts, 1,414 villages, and 171 subdistricts. Continued population growth is expected to increase waste generation, underscoring the need to address the growing number of non-standardised communal waste shelters.

A preliminary study in Batanghari, Tanjung Jabung Barat, and Tanjung Jabung Timur Regencies found no inventory or GIS-based map of communal waste shelters. Community members also continued to dispose of waste outside designated areas, including in yards, along drainage channels and roadsides, or through burning; at least 20 non-standardised communal waste shelters were identified. This study therefore aimed to develop a regency-level GIS inventory of communal waste shelters, distinguish spatially between standardised and non-standardised shelters, and estimate infrastructure shortfalls using SNI standards. The resulting evidence can inform health-promotion policy and practice by helping stakeholders plan the distribution, number, and suitability of communal waste shelters in the three regencies.

METHODS

Study Design

This study used a quantitative descriptive survey design to characterise field conditions.

Study Population and Sampling

A census approach was used to identify communal waste shelters in Batanghari, Tanjung Jabung Barat, and Tanjung Jabung Timur Regencies, Jambi Province. All shelters located along national, provincial, regency, city and village roads within the three regencies were surveyed. Data collection was conducted over 65 days by five enumerators who had received technical training in data collection and processing. Observations were recorded on standardised forms and validated to confirm that the shelters had been accurately identified and mapped. The verified data were then processed in a GIS.

Setting and Study Period

The study was conducted in Batanghari, Tanjung Jabung Barat, and Tanjung Jabung Timur Regencies, Jambi Province, from February to December 2024.

Operational Definitions and Data Verification

Communal waste shelters were classified as standardised when the containers were durable, watertight, cost-effective, readily accessible to the public, and easy to empty, in accordance with SNI 19-2454-2002. Shelters that did not meet these criteria were classified as non-standardised. Verification involved reconfirming the accuracy of ground-control points using GPS; comparing mapped features, including village boundaries, rivers, and roads, with field conditions; and checking spatial and attribute data for overlaps or substantial distance discrepancies.

Data Sources and Software

The following data sources and tools were used:
Bakosurtanal digital topographic maps, used to display a representation of the earth's surface in a ready-to-use digital format.
A global positioning system (GPS) device to determine site coordinates.
A digital camera, used to take pictures of objects and document research work.
MapInfo Professional 10.5 for map digitisation, analysis, and presentation.
ArcGIS 10 for processing Landsat 8 imagery.

GIS and Remote-Sensing Workflow

Define the mapping objective as the spatial distribution of communal waste shelters.
Acquire the Bakosurtanal Digital Topographic Map as the remote-sensing base data.
Conduct field surveys to record site coordinates, shelter characteristics, distance from road access, road type, and waste volume and area.
Apply radiometric and geometric corrections.
Integrate the data into GIS software, including ArcGIS.
Interpret and analyse spatial patterns and shapes quantitatively.
Validate and verify the results by comparing remote-sensing data with field-survey observations.
Present the results as maps and graphs.

Data Analysis

Data were analysed in ArcGIS using overlay and buffer techniques to describe the distribution of communal waste shelters and identify areas without such facilities. The output was a thematic map of shelter distribution. The minimum number of standardised communal waste shelters required was calculated in accordance with SNI 19-2454-2002, which specifies at least one 1,000-litre shelter per 80 households, using the following formula. Any non-integer result was rounded up to the next whole shelter.

Minimum standard number of communal waste shelters under SNI 19-2454-2002 (1,000 L capacity)
= Number of family heads ÷ 80 family heads

Ethical Considerations

This study involved no human participants, personal data, or direct interaction with residents. It formed part of the principal author's research and was approved by the Health Research Ethics Committee, Faculty of Medicine and Health Sciences, Universitas Jambi (No. 189/UN21.8/PT.01.04/2024). Informed consent and data-confidentiality procedures were therefore not applicable. Government Regulation No. 81 of 2012 on the Management of Household Waste and Waste Similar to Household Waste, Chapter VI, Article 34(4), states that waste-management information systems must be accessible to everyone.

RESULTS

The study covered 32 subdistricts, 297 villages, and 49 subvillages across Batanghari, Tanjung Jabung Barat, and Tanjung Jabung Timur Regencies. Field data comprised the coordinates of standardised and non-standardised communal waste shelters; supporting data included area, population, population density, and waste volume. Most shelters were located on vacant, unused land near local roads: 94.74% were near local roads and 5.26% were near neighbourhood roads.
Figures 1 and 2 show that Tanjung Jabung Barat Regency had the largest number of communal waste shelters (n = 186; 45% standardised and 55% non-standardised), followed by Tanjung Jabung Timur Regency (n = 144; 31% standardised and 69% non-standardised) and Batanghari Regency (n = 53; 13% standardised and 87% non-standardised).

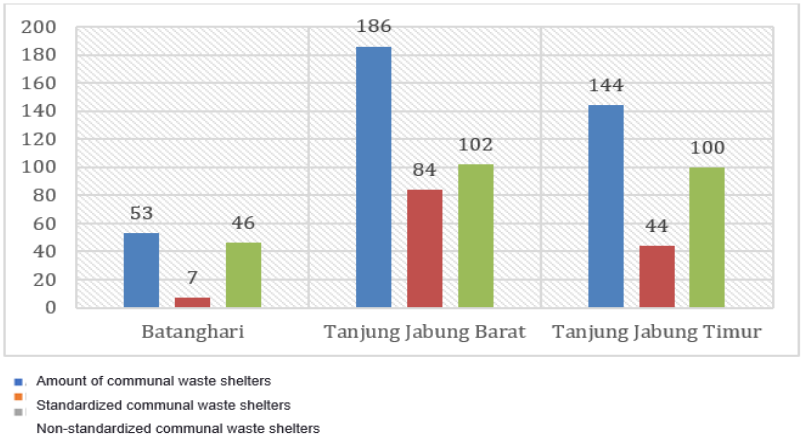

Figure 1. Numbers of Standardised and Non-standardised Communal Waste Shelters by Regency.
Source: Authors, 2024

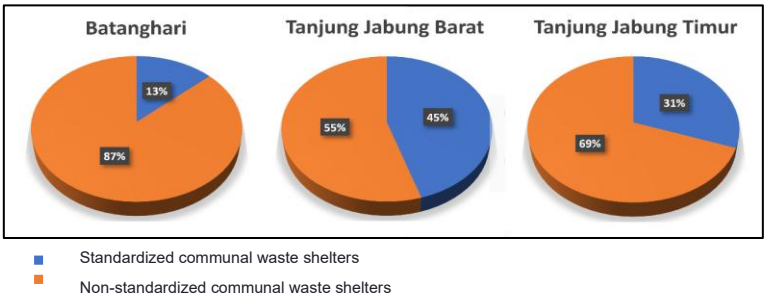

Figure 2. Proportional Distribution of Standardised and Non-standardised Communal Waste Shelters by Regency.
Source: Authors, 2024

Figure 3 shows 53 communal waste shelters in Batanghari Regency: 7 standardised and 46 non-standardised shelters distributed across 8 subdistricts, 110 villages, and 9 subvillages.

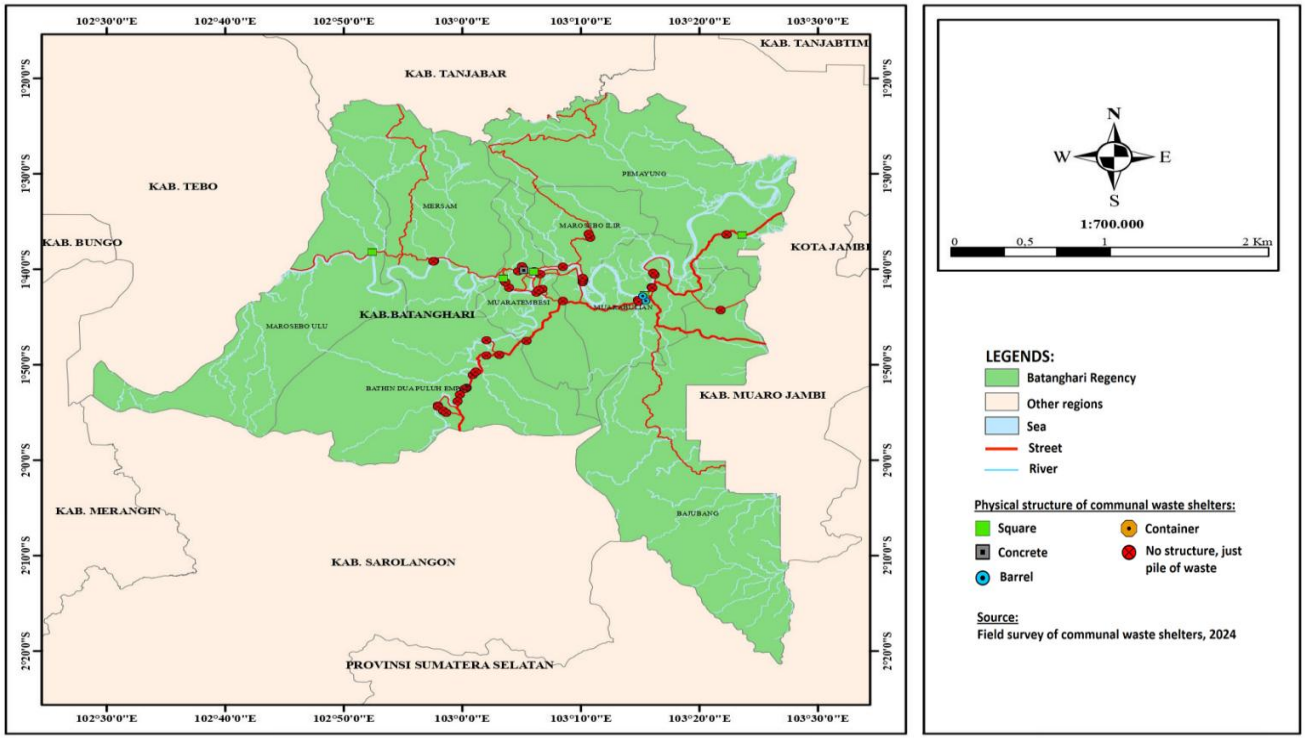

Figure 3. Distribution of Communal Waste Shelters in Batanghari Regency
Source: Authors, 2024

Figure 4 shows 186 communal waste shelters in Tanjung Jabung Barat Regency: 84 standardised and 102 non-standardised shelters distributed across 13 subdistricts, 114 villages, and 20 subvillages.

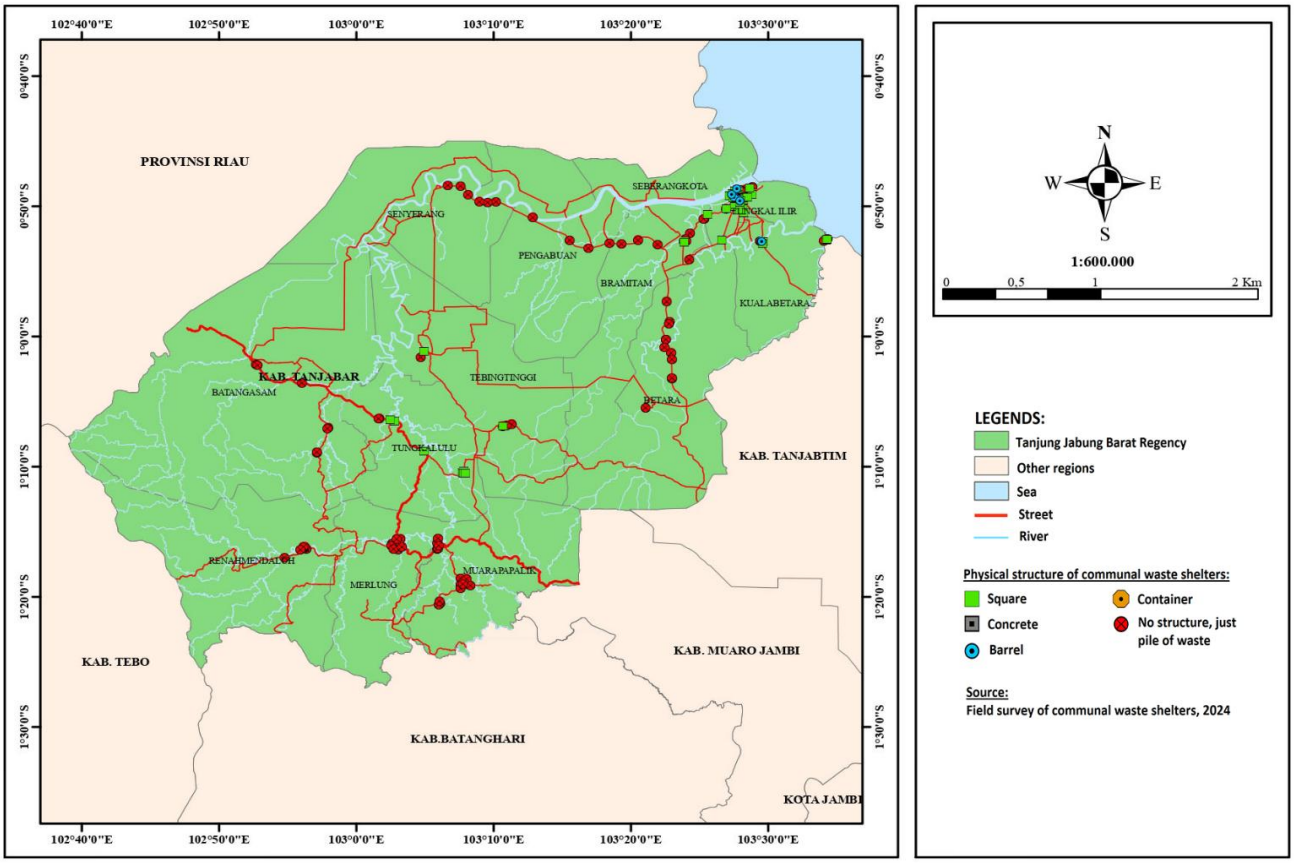

Figure 4. Distribution of Communal Waste Shelters in Tanjung Jabung Barat Regency
Source: Authors, 2024

Figure 5 shows 144 communal waste shelters in Tanjung Jabung Timur Regency: 44 standardised and 100 non-standardised shelters distributed across 11 subdistricts, 73 villages, and 20 subvillages.

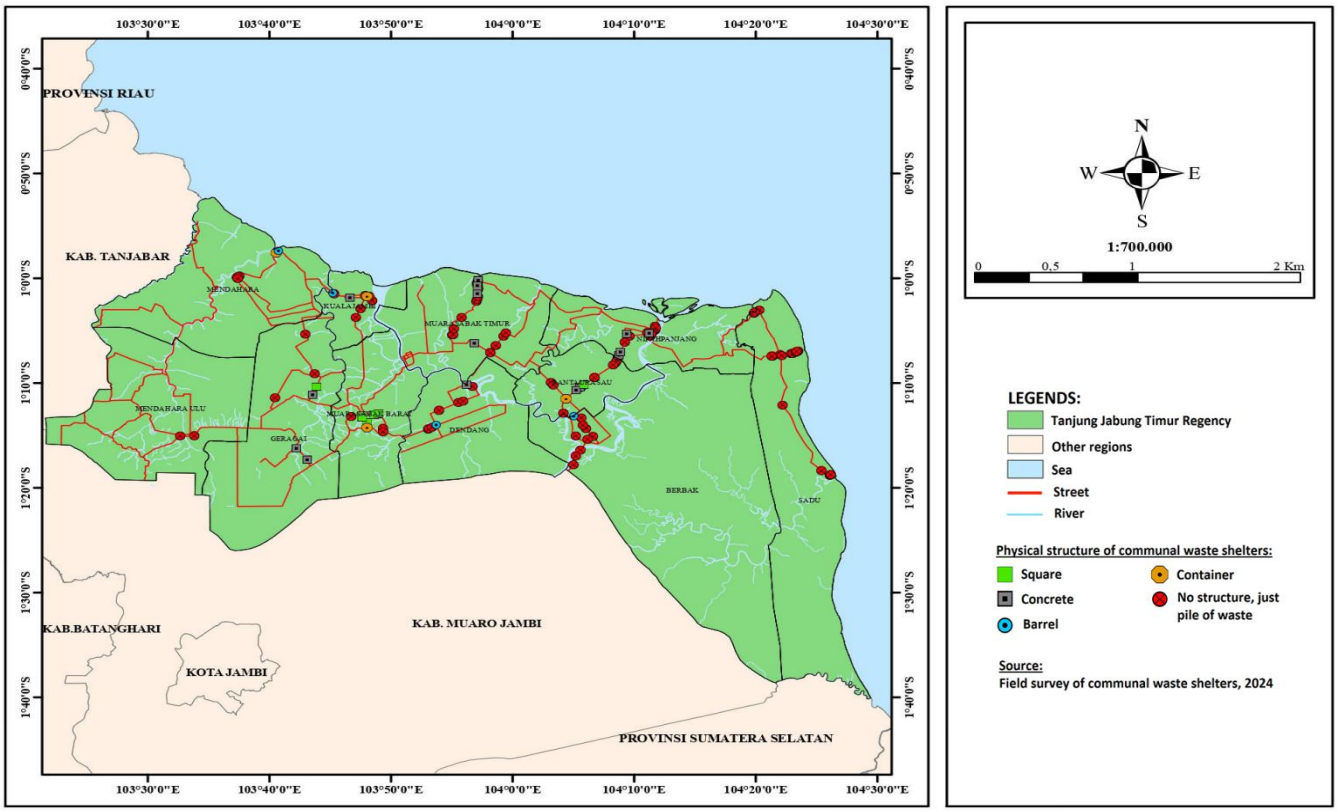

Figure 5. Distribution of Communal Waste Shelters in Tanjung Jabung Timur Regency
Source: Authors, 2024

Table 1 summarises 383 communal waste shelters. Of these, 35.25% were standardised, with a mean volume of 43.93 m³, and 64.75% were non-standardised, with a mean area of 30.23 m²; all three regencies were classified as having moderate population density.

Table 1. Characteristics of Communal Waste Shelters in Jambi Province

No	Regency	Area (km²)	Population (n)	Population density (people/km²)	Density category	Standardised waste shelters			Non-standardised waste shelters		
						Site count	Proportion (%)	Mean waste volume (m³)	Site count	Proportion (%)	Mean shelter area (m²)
1	Batanghari	5,804.83	312,729	54	Medium	7	13	37.7	46	87	21.01
2	Tanjung Jabung Barat	5,009.82	331,058	66	Medium	84	45	84	102	55	46.33
3	Tanjung Jabung Timur	5,087.07	236,727	47	Medium	44	31	10.08	100	69	23.36
	Overall/mean	**5,300.57**	**293,505**	**56**	**Medium**	**135**	**35.25**	**43.93**	**248**	**64.75**	**30.23**

DISCUSSION

Across the three regencies, 383 communal waste shelters were identified. Of these, 35.25% were standardised, with a mean volume of 43.93 m³, and 64.75% were non-standardised, with a mean area of 30.23 m². All three regencies were classified as having moderate population density.

Most communal waste shelters were located on vacant, unused land. This finding suggests that the availability of unoccupied land may facilitate the establishment of standardised shelters and is consistent with Siswandi and Wahyudin (2020) (26).

The characteristics of communal waste shelters were also examined by road type. Road categories were based on Government Regulation of the Republic of Indonesia No. 34 of 2006 concerning roads (27), which classifies roads as arterial, collector, local, or neighbourhood roads according to traffic characteristics and transport patterns. Most non-standardised shelters were located near local roads (94.74%), while 5.26% were near neighbourhood roads.

Field observations indicated that non-standardised communal waste shelters tended to be located near local roads. This finding is consistent with Faradilla et al. (2018) and Ristianto et al. (2022), who reported that road type and accessibility influence the location of non-standardised shelters (28,29). Sites near local roads may be convenient for both nearby residents and road users from other communities, thereby encouraging roadside disposal. Duh et al. (2017) described non-standardised waste sites as a public-health concern because they may increase environmental exposure to human pathogens; however, the associated health risks require further epidemiological and environmental investigation (30).

Previous research suggests that suboptimal household waste management, including burning and littering, may reflect limited knowledge and awareness of community-based waste reduction and handling. Communities may also lack the skills needed to convert waste into products of economic value. Strengthening institutional capacity, local regulations, and law enforcement may therefore improve household waste management and discourage non-standardised disposal (31-33).

The study reported that 35.25% (135 sites) of communal waste shelters met the requirements of Regulation of the Minister of Public Works No. 03/PRT/M/2013, while 64.75% (248 sites) were non-standardised. Based on the SNI 19-2454-2002 calculation shown in Figure 6, 2,562 standardised 1,000-litre shelters would be required for 204,900 households, leaving a reported shortfall of 2,427 shelters. Addressing this shortfall will require coordinated action by public, private, and civil-society stakeholders to improve both the number and suitability of communal waste shelters (34,35).

Minimum standard number of communal waste shelters under SNI 19-2454-2002 (1,000 L capacity)
= Number of family heads ÷ 80 family heads
= (Family heads in Batanghari + Tanjung Jabung Barat + Tanjung Jabung Timur) ÷ 80
= (66,500 + 83,600 + 54,800) ÷ 80 = 204,900 ÷ 80
= 2,562

Figure 6. Calculation of the Minimum Required Number of Standardised Communal Waste Shelters

Strengths And Limitations

A strength of this study was its census-based field mapping across national, provincial, regency, municipal, and village roads in three regencies. Data collection required 65 days, and some locations were accessed by river because of the geographic conditions. However, site identification was limited to shelters observable along the surveyed roads, and the manuscript does not report inter-rater reliability for classification against the SNI criteria. The findings describe conditions observed from February to December 2024 in the three study regencies and may not be generalisable to other locations or time periods.

CONCLUSION

Most communal waste shelters in the three regencies were reported as non-standardised (64.75%). Under SNI 19-2454-2002, the stated minimum requirement was 2,562 standardised shelters, each with a capacity of 1,000 litres, leaving a reported shortfall of 2,427 shelters. Because these non-standardised sites are located near roads in residential areas, they may contribute to environmental contamination and potential disease-transmission risks.

DECLARATIONS

Author contributions: Arnild Augina Mekarisce: Conceptualisation, Supervision, Project administration, Writing – original draft. Samsidar: Project administration, Supervision. Zuli Rodhiyah: Methodology, Formal analysis. Fajrina Hidayati: Methodology, Writing – original draft. Andree Aulia Rahmat: Writing – review and editing. All authors approved the final manuscript and accept accountability for the work.

Conflicts of interest: The authors declare no conflicts of interest.

Declaration of Generative AI And AI-Assisted Technologies in the Writing Process: The authors used the online DeepL Translator from November 2025 through August 2026 for translation and language editing. The authors reviewed and approved the final content and accept full responsibility for it.

Source of Funding Statements: This research was funded by *Kementerian Pendidikan, Kebudayaan, Riset, dan Teknologi* under Decision No. 1703/UN21/PT/2024 and Agreement/Contract No. 1597/UN.21.11/PT.01.05/SPK/2024. The funder had no role in the study design, data collection, analysis, interpretation, manuscript preparation, or decision to publish.

Acknowledgments: The authors thank all individuals and institutions involved in the study, from conceptualisation and data collection to data processing, analysis, and dissemination, particularly *Kementerian Pendidikan, Kebudayaan, Riset, dan Teknologi* and Universitas Jambi.

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