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Collaborative Governance in the Management of Hazardous and Toxic Medical Waste (B3) (Study at Menur Mental Hospital)

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Abstract

Background The management of hazardous and toxic medical waste (B3) is a critical issue in healthcare because it poses potential risks to public health and the environment. The complexity of medical waste management requires the involvement of various parties through a collaborative governance approach to ensure the management process runs effectively and complies with regulations.

Methods This study employed a qualitative descriptive method using the Collaborative Governance Regime approach by Emerson et al. Data collection was conducted through interviews, observations, and documentation of actors involved in the management of hazardous medical waste at Menur Mental Hospital, Surabaya. Data were analyzed using data reduction, data presentation, and conclusion drawing techniques.

Results The results show that hazardous medical waste management is implemented through collaboration between Menur Mental Hospital, Surabaya, PT Arah Environmental Indonesia, the East Java Provincial Health Office, and the East Java Provincial Environmental Office. Collaboration is realized through communication, coordination, division of tasks, supervision, and the use of a digital reporting system. This collaboration contributes to increased regulatory compliance, strengthened oversight systems, improved hospital service quality, and reduced environmental pollution risks.

Conclusion Collaborative governance in the management of hazardous medical waste at Menur Mental Hospital, Surabaya, has been effective and supports more effective, transparent, and sustainable waste management. However, operational capacity improvements are still needed, particularly to ensure smooth medical waste transportation.

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Keywords
Key words: Collaborative Governance; B3 Medical Waste; Waste Management; Hospitals; Public Governance

Introduction

The management of hazardous and toxic (B3) medical waste is an important concern in healthcare services because of the risks it poses to human health and the environment. Waste generated from patient care, medical procedures, laboratory activities, and pharmaceutical services may contain infectious materials, sharps, chemical substances, and pharmaceutical residues. Unlike ordinary waste, these materials require specific procedures for segregation, storage, transportation, treatment, and disposal. Improper handling may lead to environmental contamination, disease transmission, and occupational risks for healthcare workers, waste handlers, and nearby communities. Healthcare facilities are therefore responsible for ensuring that their medical waste is managed safely and in accordance with applicable standards.

The growing number of healthcare facilities and the expansion of medical services have also increased the amount of medical waste generated in Indonesia. This problem became more visible during the COVID-19 pandemic, when the use of personal protective equipment and other disposable medical supplies rose sharply. At the same time, many hospitals still have limited facilities and technical capacity to treat their medical waste independently. They consequently rely on licensed companies to transport and process the waste, while government agencies are responsible for supervision and regulatory control. Medical waste management is therefore not simply an internal hospital matter. It involves several organizations whose responsibilities are closely connected.

This situation can also be observed at Menur Mental Hospital Surabaya, a hospital owned by the East Java Provincial Government. Its B3 medical waste is generated through various healthcare and supporting activities. The management process involves Menur Mental Hospital Surabaya as the waste generator, PT Arah Environmental Indonesia as the licensed transporter and treatment provider, the East Java Provincial Health Office, and the East Java Provincial Environmental Office. Each institution has its own authority and responsibilities, but none can carry out the entire process alone. The hospital depends on external providers for transportation and treatment, while the government agencies perform guidance, monitoring, and regulatory supervision. These relationships reflect a form of collaborative governance involving public institutions and a private organization.

Collaborative governance provides a useful perspective for understanding how these actors work together. Emerson et al. (2012) describe a *Collaborative Governance Regime* (CGR) as a system of cross-boundary collaboration through which public and non-public actors address problems that cannot be handled effectively by one organization. The framework focuses on three related components: principled engagement, shared motivation, and capacity for joint action. These components help explain how actors communicate, build trust, develop a shared understanding of the problem, and use their respective resources and authority. Trust, commitment, and a clear division of responsibilities are particularly important when government institutions and private companies are involved in the same public service process (Gimnastiar et al., 2023). Coordination between institutions is also necessary to deal with technical limitations and to maintain the continuity of environmental management policies (Prasetiyo, 2021).

Several studies have examined collaborative governance in environmental and waste management. Amelinda et al. (2021) found that effective communication and continuous

monitoring supported collaboration in integrated waste management. Sabarna et al. (2025) identified leadership, interdependence among actors, and policy incentives as important factors in the effectiveness of waste-management collaboration. Bonti et al. (2024) focused more strongly on the involvement of government, communities, academics, and other stakeholders in community-based waste-management programs. In the area of plastic waste reduction, Laurens (2025) showed that collaboration among stakeholders could encourage environmental policy innovation. Fadhlan (2025), meanwhile, emphasized facilitative leadership, face-to-face dialogue, and trust-building as important elements of the collaborative process.

These studies provide valuable explanations of how collaboration works in environmental management. Nevertheless, most of them deal with household waste, municipal waste, community-based waste programs, or plastic waste. The management of B3 medical waste has different characteristics. It is subject to stricter health and environmental regulations, requires licensed transportation and treatment services, and relies on documentation that allows the movement of waste to be traced from the healthcare facility to the final treatment stage. The actors involved are also more specialized. Rather than depending mainly on community participation, medical waste management brings together healthcare institutions, private waste-management companies, health authorities, and environmental authorities. For this reason, findings from studies of ordinary waste management do not fully explain the institutional relationships found in the management of B3 medical waste.

Research on collaborative governance in medical waste management, particularly in mental hospitals, is still limited. Existing studies have generally paid more attention to communication, stakeholder participation, leadership, and trust, while the role of digital monitoring has received less attention. In practice, systems such as ME-SMILE, SIKELIM, and SIPELITA are increasingly used in the reporting and supervision of medical waste. These systems influence how information is recorded, shared, and verified by hospitals, private service providers, and government agencies. However, it is not yet clear how their use supports collaboration, whether they improve accountability and waste traceability, or what difficulties arise when digital reporting is integrated into routine coordination. This leaves an empirical gap concerning both the management of B3 medical waste in a mental hospital and the place of digital monitoring within cross-sector collaboration.

This study therefore examines collaborative governance in the management of B3 medical waste at Menur Mental Hospital Surabaya using the CGR framework developed by Emerson et al. (2012). It focuses on how the participating actors develop principled engagement, shared motivation, and capacity for joint action in carrying out their respective responsibilities. The study differs from previous research by examining a highly regulated type of waste in the specific institutional setting of a mental hospital. It also considers the use of digital monitoring systems as part of the collaborative process rather than treating them merely as administrative tools. The novelty of the study lies in bringing together the institutional context of a mental hospital, public–private collaboration, and digital waste monitoring within a single analysis. Its scientific contribution is to extend the use of the CGR framework to B3 medical waste management and to provide a clearer understanding of how digital systems influence coordination, information exchange, traceability, and accountability among collaborating institutions. The findings are also expected to offer practical recommendations for improving cross-sector coordination and strengthening the

safe and sustainable management of B3 medical waste in healthcare facilities.

Methods

This study used a qualitative descriptive approach to examine the implementation of collaborative governance in the management of hazardous and toxic (B3) medical waste at Menur Mental Hospital Surabaya. The analysis was guided by the Collaborative Governance Regime framework developed by Emerson et al. (2012), which includes system context, drivers, principled engagement, shared motivation, capacity for joint action, collaborative actions, impacts, and adaptation. The research was conducted from May to June 2026. Menur Mental Hospital Surabaya was selected because its medical waste management involves the hospital, a licensed private waste-management company, and provincial government agencies. The hospital also uses digital systems for waste reporting and monitoring, making it relevant to the focus of this study.

Informants were selected through purposive sampling based on their knowledge, responsibilities, and direct involvement in B3 medical waste management. The study involved four informants: the Head of the Environmental Health Installation at Menur Mental Hospital Surabaya, a representative of PT Arah Environmental Indonesia, a representative of the East Java Provincial Health Office, and a representative of the East Java Provincial Environmental Office. These informants represented the main institutions involved in waste segregation, temporary storage, transportation, treatment, reporting, and government supervision. The number of informants was determined by the specific and bounded nature of the case rather than by the need to represent a wider population. Each informant held a key institutional position and possessed detailed information directly related to the research questions. This selection is consistent with the principle of information power, which suggests that a small sample may be sufficient when the study has a narrow focus, the participants have specialized knowledge, and the information obtained is relevant and detailed (Malterud et al., 2016). Data collection was considered sufficient when comparisons across interviews no longer produced new categories related to the CGR dimensions. The interview data were also supported by observations and documentary evidence, indicating that thematic saturation had been reached within the specific institutional scope of the study.

Data were collected through semi-structured interviews, observation, and document review. Interviews explored the actors' responsibilities, communication and coordination practices, trust, resource sharing, institutional constraints, and the use of digital monitoring systems. Observations covered waste segregation, collection, labeling, temporary storage, and transfer to the licensed transporter. The documents reviewed included relevant regulations, digital B3 waste manifests, cooperation agreements, waste-management reports, annual supervision reports, and photographic records. The researcher served as the primary instrument, supported by an interview guide, an observation sheet, an audio recorder, field notes, and photographic documentation. The interview guide was developed based on the CGR dimensions to ensure that the information collected remained consistent with the research objectives. The credibility of the data was examined through source triangulation by comparing information from the four institutions and method triangulation by comparing interview findings with observations and documents.

Data were analyzed using the interactive model of (Miles & Huberman, 1994), and Saldaña

(2013) which consists of data condensation, data display, and conclusion drawing and verification. Data condensation involved selecting, coding, and grouping information according to the research questions and the dimensions of the CGR framework. The findings were then organized into systematic narrative descriptions to compare the roles and perspectives of the participating institutions. Conclusions were developed gradually and repeatedly checked against interview transcripts, field observations, and documentary evidence. This process allowed the researcher to identify patterns of engagement, shared motivation, capacity for joint action, collaborative activities, outcomes, and adaptation in the management of B3 medical waste.

Results and Discussion

The management of hazardous and toxic (B3) medical waste at Menur Mental Hospital Surabaya involves four main actors: the hospital, PT Arah Environmental Indonesia, the East Java Provincial Health Office, and the East Java Provincial Environmental Office. Although each actor has a different area of responsibility, their work is connected throughout the waste-management process. The hospital manages waste from the point of generation to temporary storage, while PT Arah Environmental Indonesia transports and treats the waste. The Provincial Health Office provides guidance and monitors compliance with healthcare and patient-safety standards, whereas the Provincial Environmental Office supervises compliance with environmental regulations. The distribution of these responsibilities is presented in Table 1.

Table 1. Actors and Their Roles in B3 Medical Waste Management

Actor	Duties and roles in medical waste management
Menur Mental Hospital Surabaya	1. Segregating medical waste at its point of generation in healthcare service units. 2. Providing safety boxes, medical waste containers, and a licensed temporary B3 waste storage facility with technical approval (Rintek). 3. Temporarily storing medical waste before collection by the third-party provider. 4. Recording and reporting the amount of medical waste generated. 5. Allocating an operational budget for medical waste management. 6. Coordinating the waste-collection schedule with the transporter. 7. Monitoring medical waste-management quality indicators. 8. Supervising the implementation of medical waste-management procedures.

PT Arah Environmental Indonesia	1. Transporting medical waste from the hospital's temporary storage facility. 2. Providing vehicles specifically licensed for transporting B3 waste. 3. Treating and disposing of medical waste in accordance with applicable regulations. 4. Ensuring that waste is collected according to schedule. 5. Preparing documentation and medical waste manifests. 6. Ensuring that the transportation process is safe and transparent. 7. Coordinating with the hospital regarding the volume of waste and collection schedule.
East Java Provincial Health Office	1. Providing guidance on hospital medical waste management. 2. Monitoring and supervising hospital environmental health operations. 3. Monitoring the hospital's compliance with medical waste-management standards. 4. Evaluating healthcare facility quality indicators and patient-safety standards. 5. Monitoring the hospital's medical waste-management reports.
East Java Provincial Environmental Office	1. Issuing technical approval (Rintek) for the temporary B3 waste storage facility. 2. Supervising B3 waste management from an environmental perspective. 3. Auditing and monitoring compliance with medical waste-management requirements. 4. Validating B3 medical waste administration and reporting. 5. Supervising the storage, transportation, and treatment of medical waste. 6. Ensuring that waste-management activities do not cause environmental pollution.

Source: Processed by Author (2026)

The distribution of responsibilities in Table 1 illustrates the interdependence that drives collaboration among the four institutions. Menur Mental Hospital Surabaya is responsible for the stages that take place within the hospital, but it does not perform the entire transportation and treatment process independently. It therefore depends on PT Arah Environmental Indonesia, which has the vehicles, licenses, and technical capacity required to transport and process B3 medical waste. At the same time, both organizations operate under the guidance and supervision of the Provincial Health Office and the Provincial Environmental Office. This interdependence corresponds to the drivers component of the CGR framework, particularly because no single actor has sufficient authority, facilities, and resources to manage every stage independently.

The arrangement also reflects principled engagement, which can be seen in the coordination between the hospital and the transporter regarding the volume of waste and its collection schedule. Engagement also takes place through reporting, monitoring, administrative validation, and government supervision. These activities provide opportunities for the actors to exchange information and address operational issues that arise during waste storage, transportation, and treatment. Communication is particularly important because delays in collection may increase the amount of waste stored at the hospital and create health and environmental risks. This finding supports Amelinda et al. (2021), who identified effective communication and continuous monitoring as central elements of collaboration in waste management.

The actors share a common concern with maintaining regulatory compliance, protecting patient and worker safety, and preventing environmental pollution. This provides a basis for shared motivation, although each institution approaches the issue from a different mandate. The hospital emphasizes service quality, occupational safety, and safe temporary storage; the private company focuses on secure transportation and treatment; the Health Office monitors healthcare and patient-safety standards; and the Environmental Office focuses on environmental compliance. Their different mandates do not necessarily weaken collaboration. Instead, they create complementary responsibilities that allow medical waste to be managed across organizational boundaries. This supports the argument of Sabarna et al. (2025) that interdependence among actors is an important condition for effective environmental collaboration.

The collaboration is also supported by a capacity for joint action. At the hospital level, this capacity includes trained personnel, safety boxes, medical waste containers, a temporary B3 waste storage facility, operational funding, and internal records. PT Arah Environmental Indonesia contributes licensed transportation vehicles, treatment facilities, technical expertise, and waste-manifest documentation. The two provincial agencies provide regulatory authority, supervision, evaluation, and administrative validation. The capacity of the collaboration therefore does not come from one institution alone but from the combination of authority, facilities, funding, technical knowledge, and information held by the participating actors. A clear division of responsibilities makes it easier to identify the institution responsible at each stage and reduces the possibility that medical waste will be left unmanaged.

Hospital records for January–April 2026 show that the amount of medical waste generated and the amount transferred to the third-party provider varied each month. These data are presented in Table 2.

Table 2. B3 Medical Waste Generated and Transferred to the Third-Party Provider, January–April 2026

Month	Waste generated (kg)	Waste transferred to the third-party provider (kg)
January	948.33	1,021.20
February	847.90	795.70
March	894.45	889.65
April	949.35	957.15
Total	3,640.03	3,663.70
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Source: Menur Mental Hospital Surabaya medical waste records, 2026

During the four-month period, the hospital generated 3,640.03 kg of medical waste and transferred 3,663.70 kg to the third-party provider. The amount transferred was therefore 23.67 kg higher than the amount generated during the same reporting period. This difference does not necessarily indicate an inconsistency in waste management because waste generated near the end of one reporting period may remain in temporary storage and be collected in the following period. For example, the amount transferred in January was 72.87 kg higher than the amount generated, while in February the amount transferred was 52.20 kg lower than the amount generated. Such monthly variations may result from the timing of waste generation, temporary storage, and scheduled collection. Nevertheless, these differences show why opening and closing storage balances should be recorded clearly so that the movement of waste can be traced and reconciled across reporting periods.

The monthly figures indicate that waste transportation continued throughout the observed period and that the accumulated waste was transferred to the licensed third-party provider. However, the effectiveness of the collaborative process cannot be assessed only by comparing the total amount generated and transported. It also depends on whether the waste was correctly segregated, stored within the permitted period, transported according to schedule, and documented through a valid manifest. Regular comparison between hospital records, transporter manifests, and government reporting systems is therefore necessary to identify delayed collection, incomplete records, or differences between the physical amount of waste and the amount reported.

Digital monitoring supports this recording and verification process. Menur Mental Hospital Surabaya uses ME-SMILE in the management and reporting of medical waste. The system provides a digital record that can support communication between the hospital and the

waste-management provider, particularly in relation to the amount of waste, collection activities, and waste manifests. In the CGR framework, this digital system forms part of the capacity for joint action because it provides an information infrastructure through which collaborative activities can be recorded and monitored.

Figure 1. ME-SMILE System Used in Medical Waste Management

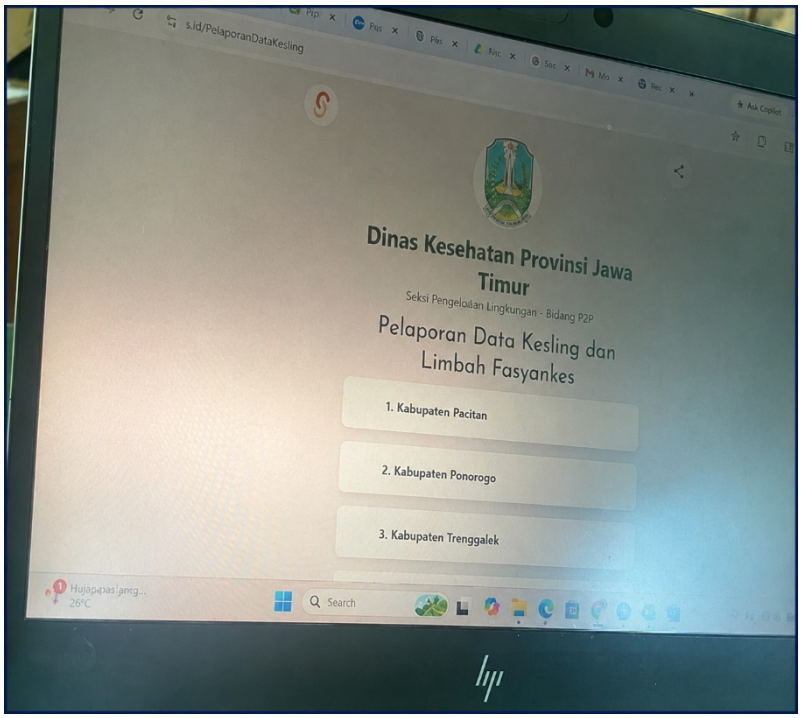


Source: Authors' documentation, 2026

The use of ME-SMILE can improve waste traceability by connecting operational records with the transportation and treatment process. Digital records also make it easier to compare the amount of waste stored by the hospital with the amount collected by the transporter. However, the contribution of the system depends on the accuracy and timeliness of data entry. A digital platform cannot by itself resolve discrepancies if the participating institutions do not regularly verify the information recorded in the system. Its effectiveness therefore remains closely related to communication, staff competence, and institutional commitment.

In addition to ME-SMILE, SIKELIM is used in reporting and monitoring activities related to environmental health and medical waste management. Its use allows information on medical waste management to be included in a broader monitoring process conducted by the relevant government institution. This creates a connection between hospital-level management and external supervision.

Figure 2. SIKELIM System Used for Medical Waste Reporting and Monitoring



Source: Authors' documentation, 2026

The simultaneous use of operational records, digital manifests, ME-SMILE, and SIKELIM shows that digital reporting has become part of the collaborative arrangement. These systems support transparency by making waste-management information more accessible for monitoring and verification. They also strengthen accountability because the responsibilities of the waste generator, transporter, treatment provider, and supervising agencies can be traced through the available records. In this respect, digital technology does not replace collaboration but provides an infrastructure that can make coordination and supervision more consistent.

The waste-management activities carried out by the four actors represent the collaborative actions component of the CGR framework. These actions include waste segregation, temporary storage, scheduled collection, transportation, treatment, reporting, monitoring, and regulatory supervision. Their immediate impact can be seen in the continued transfer of medical waste to a licensed treatment provider and the availability of administrative and digital records. From an environmental and public health perspective, these actions are intended to reduce the risks of infection, occupational exposure, and pollution associated with improperly managed medical waste.

The findings also show the importance of adaptation in maintaining the collaborative process. Changes in waste volume, transportation schedules, reporting requirements, or digital systems require the actors to adjust their procedures and coordination practices. The monthly differences between generated and transported waste, for example, require regular reconciliation rather than reliance on cumulative figures alone. The use of digital monitoring systems similarly requires staff to adapt from conventional administrative procedures to timely and consistent digital reporting. Adaptation in this context involves not only the

adoption of technology but also changes in working practices, verification procedures, and communication among institutions.

Overall, collaborative governance in B3 medical waste management at Menur Mental Hospital Surabaya is built on a clear division of responsibilities and the complementary resources of the participating institutions. The hospital, private waste-management provider, Health Office, and Environmental Office contribute different forms of authority, knowledge, infrastructure, and supervision. This finding extends previous studies that have mainly examined collaboration in domestic, municipal, and plastic waste management by showing how collaborative governance operates in a more regulated healthcare setting. It also shows that digital systems can strengthen the capacity for joint action by supporting reporting, traceability, and institutional accountability. Their contribution, however, remains dependent on accurate data entry, regular reconciliation, and sustained coordination among the actors involved.

Conclusion

This study shows that B3 medical waste management at Menur Mental Hospital Surabaya is carried out through collaboration among the hospital, PT Arah Environmental Indonesia, the East Java Provincial Health Office, and the East Java Provincial Environmental Office. The collaboration is driven by the actors' interdependence, institutional leadership, regulatory requirements, and the operational complexity of medical waste management. Each actor contributes a different but complementary role. The hospital manages waste from its point of generation to temporary storage, the private provider handles transportation and treatment, and the two provincial agencies provide guidance, monitoring, and regulatory supervision. This division of responsibilities allows the entire waste-management process to operate across institutional boundaries.

The collaborative process is reflected in continued communication, coordination of waste-collection schedules, shared commitment to regulatory compliance, and the use of complementary human, technical, financial, and institutional resources. These conditions support joint actions in waste segregation, storage, transportation, treatment, reporting, and supervision. Digital systems, particularly ME-SMILE and SIKELIM, have also become part of the collaborative arrangement by supporting reporting, waste traceability, information exchange, and institutional oversight. Nevertheless, differences between the monthly amounts of waste generated and transferred to the third-party provider indicate the need for regular reconciliation between hospital records, digital manifests, and government reporting systems. Overall, the findings demonstrate the usefulness of the Collaborative Governance Regime framework in explaining how public institutions and a private provider manage a highly regulated environmental and healthcare issue.

This study is limited to a single hospital and four key institutional actors. Its findings therefore describe a specific collaborative arrangement and are not intended to represent all healthcare facilities. The study also focuses on governance processes and does not directly measure treatment efficiency, operational costs, emissions, or long-term environmental outcomes. Future research could compare several healthcare facilities with different organizational and waste-management characteristics, involve frontline healthcare workers and other affected groups, and combine governance analysis with technical and environmental performance measurements. For practice, the hospital, government agencies,

and private provider should strengthen routine coordination, improve staff capacity, establish a consistent mechanism for reconciling waste records, and ensure that digital reporting systems are used accurately and on time. These measures are important for maintaining medical waste management that is safe, accountable, and environmentally sustainable.

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