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Implementation of Surabaya-Kitakyushu City Cooperation in the Development of Waste-to-Energy Power Plant (PLTSa) Technology, 2024-2025

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ABSTRACT

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INTRODUCTION

The increase in urban waste generation has become a major governance problem in many cities. Rapid urbanization, consumption growth, and limited landfill capacity have increased pressure on municipal waste systems (United Nations Environment Programme, 2024). At the same time, the waste sector contributes to greenhouse gas emissions through methane released from landfill-based waste decomposition. This condition encourages many cities to seek waste management models that reduce landfill dependence and support the transition toward low-carbon energy. Waste-to-Energy (WtE) technology is one response to this problem because it converts waste into electricity while reducing the volume of waste sent to landfills. This approach has been developed in several countries, including Japan, as part of circular economy practices and modern urban environmental governance (Cui et al., 2024; Vukovic & Makogon, 2024). In Asia, WtE has become increasingly relevant because many large cities face rapid waste growth, limited land availability, and uneven waste management infrastructure.

Indonesia faces similar pressure. National waste generation continues to increase, while many landfills still experience overcapacity and some waste remains unmanaged (Lu et al., 2025; Suryawan & Suryani, 2025). In response, the government has encouraged urban waste processing through environmentally friendly technology and the development of Waste-to-Energy Power Plants, known in Indonesia as PLTSa (Presidential Regulation No. 109 of 2025). This policy places PLTSa as part of both waste reduction strategy and renewable energy diversification. Surabaya is one of the leading Indonesian cities in this field. The city manages large daily waste volumes through the Benowo Landfill, which has been developed into a Waste-to-Energy facility. The Benowo PLTSa shows how municipal waste can be transformed into an energy source, but its implementation is not only a technical matter. It also depends on institutional capacity, financing, regulatory stability, public acceptance, local adaptation, and the ability of local governments to learn from external partners.

One important external partnership is the cooperation between Surabaya City and Kitakyushu City. This partnership developed through the Green Sister City framework and focuses on environmental management, waste reduction, knowledge exchange, and technical learning. Kitakyushu has long been known for environmental recovery and urban waste management experience, while Surabaya needs to strengthen local capacity in waste governance and WtE implementation. This makes the cooperation relevant for understanding how city-to-city cooperation contributes to PLTSa development.

However, the core issue is that the existence of cooperation does not automatically guarantee balanced technology transfer or sustainable implementation. The Surabaya-Kitakyushu partnership has produced concrete activities, including technical forums, field visits, composting development, and support for environmental management. Yet, the implementation of PLTSa-based WtE still faces challenges related to technological dependence, institutional readiness, financing, and regulatory change. Therefore, the main problem is not whether cooperation exists, but how it works and how far it strengthens Surabaya's capacity to manage WtE technology independently.

Previous studies on WtE mostly discuss technological efficiency, environmental impact, financing, or its role in energy transition. Other studies on sister city or city diplomacy tend to discuss symbolic cooperation, paradiplomacy, or general environmental collaboration. These studies provide useful insights, but they have not sufficiently examined the implementation of Surabaya-Kitakyushu cooperation in PLTSa development through the operational dimensions of city-to-city cooperation. This study addresses that gap by analyzing how information flow, reciprocity, mutual understanding, and leadership shape the implementation of Surabaya-Kitakyushu cooperation in developing PLTSa-based WtE technology during 2024-2025.

Based on this gap, this study asks: How is the cooperation between Surabaya City and Kitakyushu City implemented in the development of PLTSa-based Waste-to-Energy technology in 2024-2025, and what factors enable or constrain its effectiveness? The novelty of this study lies in its argument that city-to-city cooperation in WtE development should not be understood only as technical assistance, but also as a governance mechanism that can strengthen or limit local capacity, depending on the balance of knowledge transfer, institutional commitment, and local adaptation.

METHOD

This study uses a descriptive qualitative method with a single case study design. The case selected is the cooperation between Surabaya City and Kitakyushu City in the development of PLTSa-based Waste-to-Energy technology during 2024-2025. This design is appropriate because the study seeks to explain the implementation process, institutional relations, and governance challenges of intercity cooperation rather than to measure statistical causality.

The research uses secondary data obtained through literature and document studies. The data sources include official documents and press releases from the Surabaya City Government, policy documents related to PLTSa and waste management, publications from relevant institutions such as IGES, reports on the Benowo PLTSa, academic articles on Surabaya-Kitakyushu cooperation, and literature on city-to-city cooperation, sister city practices, Waste-to-Energy, and urban waste governance.

The documents were selected based on four criteria. First, the document had to be directly related to Surabaya-Kitakyushu cooperation, Green Sister City activities, PLTSa development, or urban waste management. Second, the document had to contain information relevant to the 2024-2025 implementation period. Third, the source had to be institutionally credible, such as government agencies, academic journals, recognized research institutions, or reputable media. Fourth, the document had to provide empirical information that could be linked to the analytical dimensions of city-to-city cooperation.

The analytical framework used in this study is the concept of City-to-City Cooperation. UN-Habitat (2002) defines City-to-City Cooperation as collaboration between local governments across countries to pursue mutual interests, exchange knowledge, and strengthen local government capacity. Tjandradewi and Marcotullio (2009) identify key elements for successful city-to-city cooperation, including free flow of information, reciprocity, mutual understanding, and leadership. These four dimensions are used as operational indicators in this study.

Table 1. Operationalization of City-to-City Cooperation Dimensions

Dimension	Operational Meaning	Indicator in This Study
Free flow of information	Openness and continuity of information exchange between cities	Official meetings, technical forums, field visits, training, documentation, and publication of cooperation activities
Reciprocity	Mutual benefits received by each city	Capacity gains for Surabaya and international environmental diplomacy benefits for Kitakyushu
Mutual understanding	Shared policy direction and recognition of local context	Common sustainability agenda, environmental cooperation, and adaptation

		of methods to Surabaya's conditions
Leadership	Political will and institutional commitment that sustain cooperation	Role of city governments, regional agencies, IGES/KUC, coordination mechanisms, and program continuity

Data analysis was conducted in four stages. First, the collected documents were classified based on source type, topic, and relevance to the 2024-2025 cooperation period. Second, the data were coded according to the four dimensions of City-to-City Cooperation. Third, the coded data were interpreted to identify patterns of implementation, benefits, constraints, and institutional dynamics. Fourth, the findings were compared across sources through source triangulation to improve credibility and reduce dependence on a single document or institutional perspective.

This study has limitations. It relies on secondary data and does not include interviews with policymakers, technical operators, or community groups. Therefore, the findings focus on document-based interpretation of cooperation implementation. However, source triangulation from government documents, institutional reports, academic studies, and public reports helps strengthen the reliability of the analysis.

RESULTS AND DISCUSSION

The implementation of Surabaya-Kitakyushu cooperation in 2024-2025 developed within the Green Sister City framework. This cooperation was strengthened through the visit of the Kitakyushu City Government delegation to Surabaya on August 27-30, 2024, which included discussions on environmental and waste management issues (Legal and Cooperation Section of the Surabaya City Regional Secretariat, 2024). The cooperation was implemented through coordination meetings, technical forums, field visits, and composting development activities supported by IGES and Dr. Koji Takakura. These activities show that the partnership moved beyond symbolic sister city relations toward technical learning and institutional coordination.

Table 2. Summary of Empirical Findings

Aspect	Main Result	Analytical Meaning
Cooperation mechanism	Delegation visits, technical forums, and field visits.	The cooperation functions as a learning platform, not only as ceremonial diplomacy.
Knowledge transfer	Exchange on composting, waste management, and environmental governance.	Information flow exists, but local absorption capacity determines its effect.
PLTSa implementation and constraints	Benowo PLTSa operates as a WtE project, but faces technical, financing, and regulatory constraints.	Technology implementation requires institutional support and governance stability.

The actors involved in this cooperation include the Surabaya City Government, Kitakyushu City Government, IGES, the Kitakyushu Urban Center, and several Surabaya regional agencies, including Bappeda Litbang, the Environmental Service, the Legal and Cooperation Section, and local technical implementation units. Their involvement indicates that the cooperation is not carried only by political elites, but also by bureaucratic and technical institutions that support program implementation.

In relation to PLTSa development, the Benowo Waste-to-Energy facility functions as the main empirical site showing how Surabaya applies WtE technology. The facility combines landfill gas and gasification technology and has been presented as a model for energy-based waste management in Indonesia (Ministry of Energy and Mineral Resources, 2024; Ministry of Public Works, 2025). The continuation of emission monitoring, operational supervision, and reported electricity output indicates that PLTSa implementation has produced concrete results in waste-to-energy conversion.

However, the implementation also shows several constraints. Technical challenges relate to process stability, system efficiency, and facility performance. Financial challenges emerge because PLTSa requires large investment, high operational costs, and a stable financing scheme. Regulatory challenges arise from changes in the national policy framework, including changes related to tipping fee mechanisms. Institutional challenges relate to coordination capacity, risk management, and the ability of local governments to manage complex cooperation.

DISCUSSION

Information Flow and Knowledge Transfer in Surabaya-Kitakyushu Cooperation

The first dimension of City-to-City Cooperation is the free flow of information. In the Surabaya-Kitakyushu case, this dimension appears through official visits, technical discussions, institutional publications, and field-based learning. The 2024 visit of the Kitakyushu delegation to Surabaya shows a structured communication channel because it involved both political and technical actors. This pattern matters because WtE implementation requires more than equipment transfer. It requires technical knowledge, regulatory understanding, operational skills, and institutional coordination.

The involvement of IGES and the Kitakyushu Urban Center strengthens this information flow by providing technical support and a platform for knowledge exchange. The composting development project and field visits also show that information exchange operated through practical learning, not only through formal meetings (Institute for Global Environmental Strategies, 2025). This finding supports the City-to-City Cooperation argument that successful cooperation depends on open and continuous knowledge circulation. However, the critical issue is whether information transfer becomes local capacity. The Surabaya case shows progress in knowledge exchange, but the persistence of technical and institutional constraints indicates that information flow has not fully transformed into independent technological capability.

Reciprocity and Asymmetrical Benefits

The cooperation also reflects reciprocity because both cities receive benefits. Surabaya gains access to technical knowledge, environmental governance experience, and support for improving waste management capacity. Kitakyushu gains international visibility, strengthens its image as an environmental model city, and expands its role in city diplomacy. This confirms that city-to-city cooperation can create mutual benefits even when the benefits are different in form.

Nevertheless, the reciprocity is not fully balanced. Kitakyushu contributes more technical knowledge, while Surabaya functions more as the recipient and local implementer. This creates an asymmetrical relationship. The asymmetry is not automatically negative because developing cities often need external expertise. The problem emerges when cooperation does not sufficiently strengthen local autonomy. If Surabaya remains dependent on external standards, technology, and technical support, then the cooperation risks becoming a dependency channel rather than a capacity-building mechanism. Therefore, the quality of reciprocity should be evaluated not only from whether both parties benefit, but also from whether the recipient city becomes more capable of sustaining the program independently.

Mutual Understanding, Sustainability Vision, and Local Adaptation

The third dimension is mutual understanding. The Surabaya-Kitakyushu cooperation is supported by a shared concern for sustainable urban development, environmental management, and waste reduction. This shared vision helps explain why the cooperation has continued and why it can be connected to PLTSa development. Both cities understand waste not merely as a sanitation issue, but as part of a broader environmental and energy governance agenda.

However, shared vision alone is not enough. WtE technology must be adapted to local waste characteristics, financing capacity, regulatory environment, and community conditions. The Surabaya case shows that adaptation is still a central challenge. Kitakyushu's model cannot be copied directly because Surabaya has different institutional capacity, waste composition, infrastructure readiness, and policy constraints. Therefore, mutual understanding should be interpreted as a process of contextual translation. The cooperation becomes effective when external knowledge is adjusted to Surabaya's local needs rather than adopted as a fixed model.

Leadership and Institutional Continuity

Leadership is another key element of the cooperation. The Surabaya-Kitakyushu partnership shows institutional leadership rather than purely personal leadership. The cooperation is sustained through local government agencies, formal coordination mechanisms, and supporting institutions such as IGES and the Kitakyushu Urban Center. This institutional character is important because environmental cooperation and PLTSa development require long-term commitment that should not depend on one mayoral period or one political figure.

The strength of institutional leadership can be seen in repeated coordination activities, official documentation, and the involvement of several technical agencies. These mechanisms help maintain continuity. Yet, leadership also faces limits. PLTSa development involves financial risk, technical complexity, regulatory shifts, and coordination with private actors. Strong leadership is therefore measured not only by the existence of cooperation forums, but also by the ability to solve implementation barriers. In this sense, the Surabaya-Kitakyushu cooperation has a solid institutional foundation, but it still needs stronger operational governance to manage long-term PLTSa sustainability.

Critical Synthesis: From Technology Transfer to Governance Capacity

The findings show that Surabaya-Kitakyushu cooperation contributes to PLTSa development by facilitating information exchange, technical learning, and institutional coordination. However, the implementation also reveals that WtE cooperation cannot be reduced to technology transfer. The success of PLTSa depends on whether local institutions can absorb knowledge, manage financing, adapt technology, respond to regulatory change, and coordinate actors effectively.

This means that the main value of city-to-city cooperation lies in governance capacity building. The partnership is useful because it gives Surabaya access to external experience and technical models. Yet, its long-term impact depends on local institutional autonomy. If cooperation only imports technical ideas, its impact will remain limited. If cooperation strengthens local decision-making, risk management, technical skills, and financing capacity, it can become a strategic instrument for sustainable urban waste governance.

The main finding of this study is that Surabaya-Kitakyushu cooperation supports the development of PLTSa-based Waste-to-Energy technology through four interconnected mechanisms. First, it creates information flow and knowledge transfer through official meetings, technical assistance, field visits, and institutional publications. Second, it creates reciprocal benefits, although the relationship remains asymmetrical because Kitakyushu provides stronger technical expertise while Surabaya remains the main implementing city. Third, it builds mutual understanding through a shared sustainability agenda, but this agenda must be translated into

local adaptation. Fourth, it is sustained by institutional leadership involving local governments and supporting institutions rather than by personal leadership alone.

The novelty of this study lies in its contribution to the literature on city-to-city cooperation and Waste-to-Energy governance. While previous studies often discuss WtE from technical, environmental, or financing perspectives, this study shows that intercity cooperation is a key governance variable in WtE implementation. The study argues that city-to-city cooperation should be assessed not only by the existence of joint programs, but also by its ability to reduce implementation gaps, strengthen local capacity, balance reciprocity, and prevent technological dependence. This contribution positions Surabaya-Kitakyushu cooperation as a case of environmental paradiplomacy that links urban diplomacy with practical waste-to-energy governance.

CONCLUSION

This study concludes that the implementation of cooperation between Surabaya City and Kitakyushu City in the development of PLTSa-based Waste-to-Energy technology during 2024-2025 has contributed to Surabaya's urban waste management and energy transition agenda. The cooperation operates through knowledge exchange, technical learning, institutional coordination, and a shared commitment to sustainable urban development. The Green Sister City framework and the Benowo PLTSa show that city-to-city cooperation can support the transformation of municipal waste into an energy resource.

However, the cooperation has not eliminated all implementation barriers. The study finds persistent challenges related to technological dependence, asymmetrical reciprocity, institutional capacity, financing uncertainty, regulatory dynamics, and operational sustainability. These constraints show that WtE development cannot rely only on external cooperation or technology adoption. It requires local institutional strengthening and long-term governance capacity.

Theoretically, this study contributes to the City-to-City Cooperation literature by showing that information flow, reciprocity, mutual understanding, and leadership are useful dimensions for analyzing environmental technology cooperation. The study also adds that these dimensions should be evaluated through their effect on local capacity and implementation sustainability. Practically, the findings suggest that Surabaya should strengthen local technical expertise, improve cross-agency coordination, develop stable financing mechanisms, and create clearer risk-sharing arrangements with private and institutional partners.

Operationally, the Surabaya City Government should establish a regular technical evaluation forum for PLTSa, prepare a capacity-building roadmap for local operators, integrate community-based waste reduction with downstream WtE processing, and improve transparency in environmental monitoring. The national government should provide regulatory certainty, especially on financing mechanisms and incentives for WtE projects. Future research should use interviews with policymakers, operators, community groups, and private partners to examine how cooperation is experienced by actors directly involved in implementation. Comparative studies with other Indonesian cities developing PLTSa are also needed to test whether the Surabaya-Kitakyushu model can be replicated in different local contexts.

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