The Effectiveness of the Implementation of Batam City Regional Regulation No. 11 of 2013: A Study on Waste Management (2024–October 2025)

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Waste management issues in Batam City have become a critical environmental concern amid rapid population growth and intensive industrial activities. Although the Batam City Government has enacted Regional Regulation Number 11 of 2013 on Waste Management as a legal framework, its implementation in practice continues to face significant challenges. This study aims to analyse the effectiveness of the regulation and its legal implementation during the period 2024–2025, as well as to identify the inhibiting factors affecting its enforcement. The research employs an empirical legal method using statutory and sociological approaches, supported by interviews with officials from the Environmental Agency and officers at the Telaga Punggur Final Disposal Site (TPA). The findings indicate that the effectiveness of the regulation remains low due to weak law enforcement, limited infrastructure and facilities such as waste collection fleets and heavy equipment and low public awareness regarding waste segregation and management. Based on Soerjono Soekanto's theory of legal effectiveness, these constraints are closely related to law enforcement actors, supporting facilities, and the legal culture of the community. This study recommends strengthening regulatory enforcement, upgrading waste management facilities, enhancing public education, and fostering synergy among government, communities, and the private sector to achieve an effective and sustainable waste management system in Batam City.

Keywords: Legal Effectiveness, Waste Management, Regional Regulation, Batam City, Regulatory Implementation

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1. Introduction

Waste management has become a critical environmental issue both globally and in Indonesia. The World Health Organization (WHO) defines waste as the residue of human activities that is no longer used or desired. Poorly managed waste threatens environmental cleanliness, causes unpleasant odours, and increases public health risks, while public awareness of these impacts remains relatively low (Putri et al., 2023).

As one of Indonesia's major industrial zones (Winsherly Tan, 2024), Batam City faces increasingly complex waste management challenges driven by rapid population growth and intensified economic activity. Illegal dumping remains widespread across several districts, including Batu Ampar, Nongsa, Sungai Beduk, Lubuk Baja, Sekupang, Sagulung, and Batu Aji. Large-scale clean-up operations removed approximately 20 tonnes of waste from illegal temporary disposal sites (TPS) located in areas such as the Bulog Office in Batu Ampar, Kampung Dalam towards DC Mall, and access roads to Sido Mulyo in Sagulung District (Asrul Rahmawati, 2025).

To address this issue, regulatory measures have been established at both national and local levels. Nationally, waste management is governed by Law No. 18 of 2008, while locally it is regulated through Batam City Regional Regulation No. 11 of 2013 on Waste Management. Enforcement mechanisms include

the establishment of a Night Patrol Team (*Tim Patroli Malam/PALM*), the installation of warning signs at illegal dumping hotspots, and the imposition of fines of up to IDR 2.5 million under Article 69 paragraph (1) (Batam, 2013b). These measures are reinforced by Batam Mayor Regulation No. 10 of 2019, as amended by Regulation No. 5 of 2023, which outlines regional strategies for sustainable household waste management (Pratika & Hidayat, 2024; Batam, 2013a). Nevertheless, low public awareness and persistent illegal dumping continue to undermine regulatory effectiveness, resulting in environmental degradation and slum-like conditions (Pratiwi, 2022).

In legal and public policy analysis, regulatory effectiveness is commonly assessed through the gap between *das Sein* (empirical reality) and *das Sollen* (normative expectations). Previous studies indicate that the implementation of Batam City Regional Regulation No. 11 of 2013 remains constrained by low public participation, weak law enforcement, and inadequate waste management infrastructure (Riyanda, 2017; Novela Sari & Firdaus Yustisia, 2024). Despite clearly defined obligations and sanctions, illegal dumping and non-compliance persist (Pratika & Hidayat, 2024), suggesting that the regulation has not yet functioned as an effective instrument for achieving sustainable development goals (Alriyadi et al., 2023).

Accordingly, this study examines the effectiveness of the implementation of Regional Regulation No. 11 of 2013 during the 2024–2025 period and identifies key factors hindering the achievement of its intended objectives. While prior research has explored waste management in Batam City, most studies focus on technical aspects, environmental impacts, waste bank programmes, or linkages to the Sustainable Development Goals, without comprehensively evaluating regulatory effectiveness and legal implementation at the local level (Riyanda, 2017; Frencilyka Manalu, 2020; Pratika & Hidayat, 2024; Lesna Nainggolan et al., 2023; Alriyadi et al., 2023). This study addresses this gap by offering a holistic evaluation of Regional Regulation No. 11 of 2013 through the simultaneous analysis of regulatory substance, institutional capacity, law enforcement, and public compliance. Emphasising long-term effectiveness particularly in 2025, more than twelve years after the regulation's enactment this research integrates normative, structural, and cultural dimensions within a contemporary temporal context, grounded in the *das Sein–das Sollen* analytical framework.

To support this analysis, the study adopts the theory of legal effectiveness as its conceptual framework. Legal effectiveness refers to the capacity of law to regulate social behaviour and ensure compliance with established norms. Soerjono Soekanto argues that legal effectiveness is not determined solely by the normative substance of legislation, but is also shaped by external factors, including the quality of law enforcement officials, the availability of adequate facilities and infrastructure, and the level of legal awareness within society. Social behaviour thus serves as a key indicator of effectiveness, as the success of law is reflected in the extent to which societal actions align with regulatory objectives.

This perspective aligns with Rahardjo's view that law is effective only when it genuinely functions in social life rather than remaining merely normative. Similarly, Friedman conceptualises legal effectiveness through three interrelated elements: legal structure, legal substance, and legal culture. In the context of waste management, legal structure refers to enforcement institutions and judicial mechanisms; legal substance to waste management regulations; and legal culture to public awareness and behavioural patterns related to responsible waste management practices.

Ali further emphasises that legal effectiveness depends on effective legal communication, namely the ability of regulations to convey their objectives to the public, which in waste governance necessitates continuous socialisation and education. Sidharta highlights the importance of aligning legal implementation with social and cultural contexts, while Asshiddiqie advocates a holistic approach that integrates legal, social,

economic, and cultural dimensions through synergy between law enforcement, incentives, environmental education, and community empowerment (Herdianto, 2024).

Soerjono Soekanto systematises legal effectiveness into five interrelated factors: (1) legal substance, (2) law enforcement officials, (3) supporting facilities and infrastructure, (4) society, and (5) culture. Legal effectiveness can only be achieved when these factors function harmoniously; deficiencies in any one factor such as unclear regulations or low public awareness will diminish implementation outcomes (Orlando, 2022). Within legal research, this theory functions as an analytical framework for assessing whether a regulation operates effectively in practice or remains confined to the normative level. Clear legal substance alone is insufficient without integrity-driven enforcement, adequate facilities, and a law-abiding society.

The relevance of this framework to the present study lies in its focus on the effectiveness and implementation of Batam City Regional Regulation Number 11 of 2013 on Waste Management. Using this framework, the regulation is analysed in terms of its normative conformity with higher-level legislation, the performance of the Environmental Agency and enforcement bodies, the availability of waste management facilities, levels of public compliance, and prevailing legal culture related to environmental cleanliness. Through this integrated approach, the study aims to identify structural, institutional, and cultural challenges in waste management governance and to formulate evidence-based policy recommendations to strengthen legal compliance and enhance public trust in law enforcement (Agus Rahmanto et al., 2021).

2. Research Methodology

This study employs an empirical legal research method, based on the consideration that the focus of analysis extends beyond the written norms contained in Batam City Regional Regulation Number 11 of 2013 on Waste Management to include its practical implementation in 2025. This method is appropriate for addressing the research questions concerning regulatory effectiveness, both in terms of consistency with higher-level legislation and in relation to its enforcement by local government authorities and compliance by the community.

As part of the research design, a statutory approach is applied to examine the hierarchy and substance of the relevant legal instruments, while an empirical (sociological) approach is employed to assess the extent to which the regulation is implemented and complied with in practice (Tan, 2021).

The data sources for this study comprise primary data obtained through interviews with officials from the Batam City Environmental Agency, managers of the Final Disposal Site (*Tempat Pembuangan Akhir/TPA*), and members of the public who utilise waste management services. In addition, secondary data are used, consisting of primary legal materials such as the 1945 Constitution of the Republic of Indonesia, Law Number 18 of 2008 on Waste Management, Government Regulation Number 81 of 2012 on Household Waste Management, Batam City Regional Regulation Number 11 of 2013, and Batam Mayor Regulation Number 10 of 2019 concerning regional policies and strategies for managing household waste and similar waste, as amended by Batam Mayor Regulation Number 5 of 2023. Secondary legal materials include academic literature, legal journals, and findings from previous studies, while tertiary legal materials consist of legal dictionaries and legal encyclopaedias.

Data collection techniques involve document analysis of relevant regulations and literature, as well as in-depth interviews to obtain empirical information from the field. All data are analysed using descriptive qualitative analysis, involving the interpretation, comparison, and integration of legal provisions with empirical findings in order to assess the effectiveness of the regulation and its legal implementation in waste management practices in Batam City (Disemadi, 2022).

3. Results and Discussion

The Effectiveness of Batam City Regional Regulation No. 11 of 2013 on Waste Management in Batam City (2024–October 2025)

Batam City is widely recognised as one of the rapidly developing cities in the Riau Islands Province, both in terms of population growth and economic activity. According to data from the Central Statistics Agency (BPS) in 2024, Batam City's population exceeded 1.34 million, with a population density considerably higher than that of other regions in the province (Andani et al., 2024; Anto, 2025). This growth has not only accelerated infrastructure development and industrial expansion but has also directly contributed to the increasing volume of urban waste (Andani et al., 2024). As a result, waste management has become a strategic issue requiring effective regulation and implementation.

As an industrial city and international trading hub, Batam exhibits social and economic dynamics that differ from those of other cities (Lesna Nainggolan et al., 2023). Manufacturing activities, tourism, and the expansion of residential areas significantly contribute to waste generation (Priatna et al., 2024). Data from the Batam City Environmental Agency (DLH) indicate that in 2024, total waste generation reached approximately 432,868 tonnes per year, or an average of more than 1,150 tonnes per day. This figure highlights substantial challenges related to waste collection and management capacity, particularly at the Telaga Punggur Final Disposal Site (TPA), which serves as the primary waste disposal facility.

Total Waste Generation in Batam City

Item	Description
Reference Code	N/A
Region	Batam City
Period	2024
Total Amount	432,868 tons
Unit	Tons
Data Provider	Environmental Agency
Release Date	January 8, 2025
Level of Detail	Not specified

* N/A indicates that the data is not available.

Source 1: (satudata.batam, 2025b).

Waste management in Batam City continues to face significant challenges, particularly due to the limited availability of waste collection fleets and supporting infrastructure. In response, the Batam City Government, through the Environmental Agency (DLH), has implemented various initiatives, including the socialisation of the 3R programme (Reduce, Reuse, Recycle), the development of Integrated Waste Management Facilities (TPST), and the establishment of waste banks at the sub-district level to reduce waste accumulation and generate economic value from recyclables.

Batam generates approximately 1,200 tonnes of household waste per day, yet limited collection fleets result in suboptimal services and the proliferation of illegal dumping sites. Waste collection is coordinated between the Environmental Agency and district administrations, transporting waste from households to temporary disposal sites (TPS) and ultimately to the Telaga Punggur Final Disposal Site (TPA). Although Batam City Regional Regulation No. 11 of 2013 provides a legal framework for waste governance, effective

and sustainable waste management requires stronger synergy among government authorities, communities, and the private sector, including increased collection capacity and infrastructure upgrades (Ombudsman, 2025; Media Center, 2025; Representative of Riau Islands, 2025; InfoPublik, 2025a).

The current waste crisis is driven by multiple interrelated factors. First, public behaviour remains problematic, with low awareness and persistent indiscriminate disposal despite prohibitions and warning signs (Batam Pos, 2025b; DataKepri, 2025a). Second, fleet limitations are severe, with approximately 34 damaged collection units and insufficient heavy equipment at the TPA, causing delays and waste accumulation (DataKepri, 2025a; Iman Wachyudi, 2025; GudangBerita, 2025; Batam Pos, 2025b). Third, source-based waste segregation remains minimal, with only about 18 per cent of waste separated, increasing the burden on management systems (Redaksi, 2025). Fourth, overcapacity at the Punggur TPA, compounded by illegal dumping, further strains sanitation workers (Batam Pos, 2025b; DataKepri, 2025b; GudangBerita, 2025). Fifth, irregular and delayed collection particularly in areas without official TPS exacerbates waste accumulation (Batam Pos, 2025a; Batam Pos, 2025b). These conditions have prompted public criticism regarding ineffective waste management and underscored the need for stronger political commitment and adequate budget allocation (Batam Now, 2025).

To address daily waste generation of approximately 1,200 tonnes, the Batam City Government has adopted several strategic measures, including increasing waste collection fleets (arm-roll trucks and compactors), intensifying public education and socialisation of 3R principles, and promoting household waste segregation to reduce waste volumes by up to 40 per cent (Ekobrurianto, 2023; InfoPublik, 2025b). The government has also strengthened multi-stakeholder collaboration involving local authorities, businesses, and communities to support sustainable waste management (Kominfo Batam, 2025). At the Punggur TPA, additional facilities such as bin containers and heavy equipment have been deployed to improve efficiency, particularly during peak waste generation periods (Ajijah, 2025). These measures are supported by long-term planning aimed at identifying permanent solutions to Batam's evolving waste challenges.

In addressing land shortages for TPS and TPA facilities, the government has pursued legally compliant land acquisition in accordance with Ministry of Environment and Forestry standards, although progress is constrained by land certification requirements (*clean and clear*) (Candra Gunawan, 2025). Synergy with the Batam Indonesia Free Zone Authority (BP Batam) has been strengthened to accelerate land allocation (Iman Wachyudi, 2025). As an interim measure, bin containers are used to reduce illegal dumping, while additional fleets and heavy equipment are deployed to mitigate waste accumulation. Source-based segregation is further promoted to extend facility lifespans, and waste management planning has been integrated into the Regional Medium-Term Development Plan (RPJMD) to ensure sustainability.

Overall, Batam City's response combines legal land procurement, institutional collaboration, interim containment solutions, expanded collection capacity, and long-term infrastructure planning to create a cleaner and healthier urban environment. These conditions highlight the central role of Regional Regulation No. 11 of 2013 as a key legal instrument governing waste management from reduction and segregation to transportation and final processing. However, its effectiveness depends not only on regulatory quality but also on law enforcement capacity, infrastructure availability, public participation, and local legal culture. Accordingly, the regulation's effectiveness during 2024–2025 is analysed using Soerjono Soekanto's five factors of legal effectiveness: legal substance, law enforcement structure, facilities and infrastructure, society, and legal culture.

From the legal substance perspective, the regulation mandates waste segregation and imposes fines of up to IDR 2.5 million. In practice, however, imposed sanctions are often substantially lower, creating normative uncertainty and weakening deterrence (Muhammad Bunga Ashab, 2025). From the law enforcement

perspective, although the Environmental Agency has conducted inspections and enforcement actions, effectiveness remains limited due to personnel shortages and weak supervision, allowing violations to persist (Ahmadi Sultan, 2025).

The facilities and infrastructure factor represents a major constraint, as many waste collection vehicles have exceeded their operational lifespan, and the Telaga Punggur Final Disposal Site has experienced overcapacity. In 2024, only approximately 17.52 per cent of total waste was successfully managed through the 3R system (Reduce, Reuse, Recycle), indicating limited processing capacity and system effectiveness (Satu Data Batam, 2025a).

Data Components

Indicator	2021	2022	2023	2024
Waste Collection Percentage	80	75.05	77.50	79.44%
Percentage of Waste Managed through the 3R System	7	13.26	16.53	17.52%
Total	87	0	0	0

* N/A indicates that the data is not available.

Source 2: (satudata.batam, 2025a).

Source 3: (satudata.batam, 2025a).

From a societal perspective, compliance with waste segregation remains low, habitual indiscriminate disposal persists, and household participation in 3R programmes is uneven across districts (Satu Data Batam, 2024). This condition reflects a weak legal culture, where long-standing behavioural patterns of non-segregated waste disposal are difficult to change. Consequently, despite the existence of legal norms, their practical effectiveness remains limited (Muhammad Solihin, 2019).

Accordingly, the effectiveness of Regional Regulation No. 11 of 2013 in Batam City during the 2024–2025 period continues to face significant structural and cultural barriers. Addressing these challenges requires strengthened regulatory enforcement, improved facilities and infrastructure, and sustained transformation of community legal culture.

The regulation obliges local government to provide adequate waste management infrastructure; however, as of 2025, the Telaga Punggur Final Disposal Site has not met sanitary landfill standards. Operating since 1997 and covering approximately 47 hectares, the site was originally designed as a controlled landfill, yet in practice continues to rely largely on open dumping methods (Yodi, 2019).

In addition, the existing waste collection fleet can handle only around 1,200 tonnes per day, while waste volumes reached approximately 1,300 tonnes per day in 2025, resulting in waste accumulation in densely populated areas. Organic waste processing facilities and waste banks are also unevenly distributed across districts, indicating disparities in public service provision.

Waste management levies constitute an important source of local revenue. Between January and August 2024, realised local revenue (PAD) from waste and sanitation levies reached IDR 20.8 billion, representing 45.3 per cent of the annual target of IDR 45.8 billion an increase of approximately IDR 7.5 billion compared to 2023 (Yusuf Parsoran Togatorop, 2022; Iman Wachyudi, 2024). According to Eka Suryanto of the Environmental Agency (DLH), levies range from IDR 7,000 to IDR 50,000 depending on building size and are partially allocated to waste management. However, interviews indicate that this system has fostered a public perception that waste management responsibilities are fulfilled solely through levy payments.

Resistance to volume-based waste levies further reflects opposition to the *user-pays principle*, which has been adopted in Indonesia's environmental legal framework, including Law No. 32 of 2009 on Environmental Protection and Management. Although essential for equitable and sustainable waste management, compliance remains low, as evidenced by persistent illegal dumping, the proliferation of informal TPS sites, and limited participation in source-based waste segregation indicating weak legal awareness.

Although social campaigns and educational initiatives have been conducted by the Environmental Agency and environmental communities, their reach remains limited, particularly in coastal areas and lower-middle-income neighbourhoods. Moreover, industrial and tourism sectors which are expected to play leading roles in independent waste management have not fully complied with obligations under the regulation.

Previous studies similarly highlight these challenges. Riyanda (2017) found that the implementation of Regional Regulation No. 11 of 2013 has been constrained by insufficient government outreach and low public awareness, aligning with this study's findings on low compliance with waste segregation. Pratika and Hidayat (2024) identified weak law enforcement as a primary driver of continued illegal dumping, a conclusion supported here by evidence of low enforcement ratios due to limited personnel and weak inter-agency coordination, resulting in reduced deterrence.

Alriyadi et al. (2023) linked the regulation's implementation to the Sustainable Development Goals (SDGs) and found limited effectiveness due to inadequate facilities and weak government support for community participation. This study confirms these findings, particularly regarding deficiencies in infrastructure that has yet to meet sanitary landfill standards. Novela Sari and Firdaus Yustisia (2024) further noted that waste bank programmes in Batam remain ineffective due to low participation and limited socialisation, while Lesna Nainggolan et al. (2023) found these programmes moderately effective but still constrained by participation levels. Consistent with these studies, the present research demonstrates that community legal culture has not been fully internalised, resulting in uneven implementation of waste bank initiatives across districts.

From an operational standpoint, the Head of the Batam City Environmental Agency, Herman Rozie, reported that most waste collection vehicles were procured between 2012 and 2017 and therefore require renewal. Of the 140 available vehicles including dump trucks, arm-roll trucks, and conveyor units 52 are over ten years old, five are severely damaged and unfit for use, and around 20 are undergoing routine

maintenance, a condition that further constrains waste management capacity amid high daily waste generation (Batam Pos, 2024).

Waste generation volumes in Batam City show a consistent upward trend in line with population growth. According to records from the Batam City Environmental Agency (DLH), daily waste generation currently ranges between 1,150 and 1,200 tonnes. This volume is produced by approximately 1.3 million residents distributed across the entire Batam City area, including hinterland regions. The term *hinterland* refers to peripheral or remote areas that maintain economic and social functional linkages with nearby urban growth centres (Aprianti & Asmara, 2023). Waste volumes are expected to continue increasing, particularly during weekends. Eka Suryanto, Head of the Waste Management Division of the Environmental Agency, noted that waste generation has risen compared to the previous year in line with population growth and is projected to increase further, especially during weekends when community activities intensify (Iman Wachyudi, 2024).

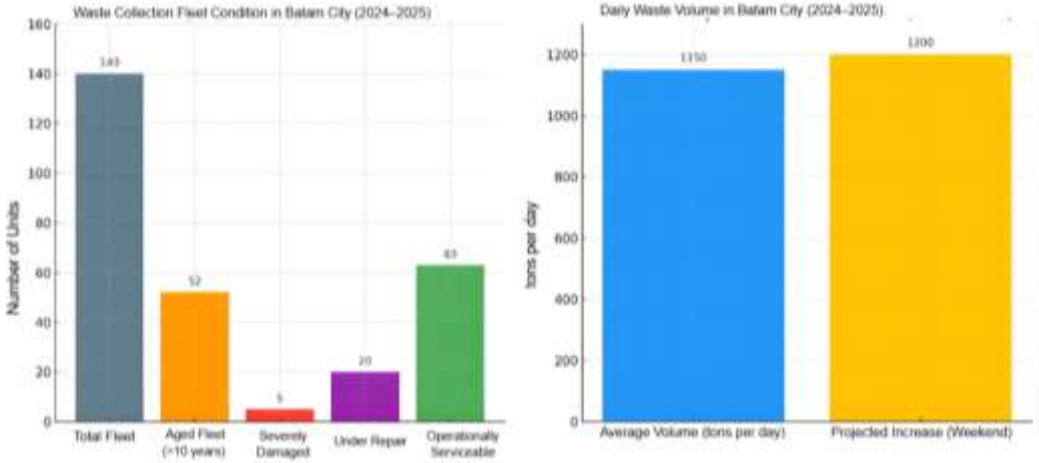

Figure 4: Left: Condition of Batam City waste collection fleet (2024–2025).
Right: Average daily waste generation and projected increases during weekends.
Source: Compiled from observations and online data, 2025.

Overall, the findings of this study reinforce previous research highlighting the limited effectiveness of Regional Regulation No. 11 of 2013, while offering a novel contribution through a comprehensive analysis based on Soerjono Soekanto's five factors of legal effectiveness. This study demonstrates that the primary challenges lie in weak law enforcement, inadequate facilities and infrastructure, and low levels of public legal awareness and legal culture. The contribution of this research lies in illustrating that, although the Regional Regulation constitutes an important legal instrument, its effectiveness cannot be realised in practice without strong enforcement mechanisms, adequate infrastructure, and active community participation.

The Effectiveness of the Resolution of Waste Management Regulation in Batam City

The implementation of waste management regulations in Batam City, as governed by Regional Regulation No. 11 of 2013, aims to reduce waste generation and increase public participation in 3R-based practices (Reduce, Reuse, Recycle) (Utami & Suwandi, 2020). However, its effectiveness remains constrained. Data from the Environmental Agency (DLH) indicate that daily waste generation reached approximately 1,200 tonnes in 2024 and ranged between 850 and 1,300 tonnes in 2025 (Sari et al., 2024), equivalent to about 1 kg per capita per day given Batam's population of 1.34 million (Iman Wachyudi, 2024; Jamil Qasim, 2025). Persistent waste accumulation at several Temporary Disposal Sites (TPS) since late 2024 has been

attributed mainly to limited waste collection fleets, increasing vulnerability to illegal dumping and undermining regulatory effectiveness (Rhuuzi Wiranata, 2025).

Regional Regulation No. 11 of 2013 provides the legal foundation for waste governance from source to final processing, including TPS development, waste banks, and TPS3R facilities, and is supported by Government Regulation No. 4 of 2014 on hazardous waste management (Solihin & Mulda, 2019). Nevertheless, implementation faces persistent challenges: low household-level waste segregation, suboptimal use of waste bins, limited socialisation of the 3R concept, insufficient collection fleets relative to population growth, and underperforming waste banks and TPS3R due to constraints in human resources, management capacity, and incentives (Solihin & Mulda, 2019). Limited landfill capacity has further prompted exploration of waste-to-energy solutions. Overall, waste management remains hindered by operational constraints, inadequate socialisation, and limited facilities, requiring continuous improvement.

Normatively, the regulation has been disseminated through various media and community forums, yet outreach has not fully reached all segments particularly new residents resulting in incomplete implementation and continued waste accumulation amid rapid urbanisation. Substantively, low legal compliance persists, reflected in indiscriminate disposal, limited participation in waste bank programmes, and weak environmental awareness. At the same time, supporting factors include the presence of waste banks, cooperation with central government and private actors in waste-to-energy projects at the Punggur TPA, and ongoing awareness campaigns such as National Waste Awareness Day (Riyanda, 2017).

The success of waste management in Batam is strongly influenced by public awareness and participation, especially in supporting 3R practices at the household level. TPS3R facilities play a critical role in initial waste segregation and processing, enabling organic waste to be converted into compost or biogas and reducing the volume transported to the Final Disposal Site (Kristina et al., 2025). Other determining factors include the availability and quality of TPS, TPS3R, and TPA facilities, effective law enforcement through consistent sanctions, and sustained environmental education via media, communities, and schools (Muhammad Solihin, 2019). Rapid population growth and urbanisation further increase waste volumes, making effective management dependent on integrated, multi-stakeholder efforts.

Community participation remains pivotal. Active involvement in decision-making, problem-solving, and waste management activities fosters ownership and environmental responsibility, encouraging pro-environmental behaviour and policy support (Lesna Nainggolan et al., 2023). In Batam, participation is reflected in waste bank involvement and household waste segregation, yet remains uneven due to limited understanding in some groups despite ongoing education, resulting in suboptimal waste processing and environmental impacts (Sari et al., 2024). Strengthening participation therefore requires intensive socialisation, continuous education, and consistent supervision (Marpaung et al., 2022).

To enhance awareness, Batam City has adopted a comprehensive strategy combining education, collaboration, training, facility strengthening, and supervision. Through DLH, programmes include Black Soldier Fly (BSF) maggot cultivation for organic waste, plastic waste processing education, and climate village initiatives (Sukmareni et al., 2023). In line with good governance principles, community participation is actively promoted (Bustomi et al., 2022), involving market managers, businesses, and industries to position waste management as a shared responsibility (Media Center, 2024). Technically, fleet expansion and waste-to-energy initiatives such as Solid Recovered Fuel (BBJP) for co-firing in power plants aim to reduce landfill loads and land demand while addressing energy needs (Pirngadi et al., 2023). These efforts are reinforced by public campaigns, media engagement, supervision of TPS and TPA operations, and a target to reduce waste generation by 30 per cent by 2025 (Media Center, 2024).

Education plays a decisive role in improving waste management knowledge and behaviour. Low public understanding remains a key factor limiting environmental awareness (Khaerudin & Amalia, 2024). Empirical studies demonstrate that education significantly improves knowledge and attitudes towards waste management, as evidenced by statistically significant post-intervention results in Bantul ($p < 0.05$) (Isni & Mustanginah, 2023) and Cihanjaro Village (knowledge $p = 0.001$; attitude $p = 0.017$) (Khaerudin & Amalia, 2024). Continuous education, supported by waste bank managers, is therefore essential in fostering sustained behavioural change.

Field interviews at the Telaga Punggur Final Disposal Site further reveal suboptimal management due to damaged heavy equipment, limited land utilisation, and the absence of modern technologies such as incineration. With daily waste volumes of approximately 1,200 tonnes and only four heavy equipment units some of which are non-functional operations remain inefficient despite the site's 47.8-hectare area. Consequently, stronger synergy among government, communities, and the private sector is required to upgrade facilities, expand capacity, and enhance education and technological adoption to ensure sustainable waste management at Telaga Punggur.

4. Conclusion

Based on the findings of this study, it can be concluded that the effectiveness of the resolution and legal implementation of Batam City Regional Regulation Number 11 of 2013 on Waste Management up to 2025 continues to face significant structural and cultural challenges. Normatively, the regulation provides a relatively comprehensive legal framework governing waste management, from reduction and segregation to final processing. However, its implementation in practice has not yet been optimal due to weak law enforcement, limited facilities and infrastructure such as waste collection fleets and heavy equipment at the Telaga Punggur Final Disposal Site and low levels of public awareness regarding the importance of source-based waste segregation.

From the perspective of Soerjono Soekanto's theory of legal effectiveness encompassing legal substance, law enforcement structure, facilities and infrastructure, society, and culture the primary obstacles lie in law enforcement capacity, supporting facilities, and the low level of legal culture within the community. The implications of these findings highlight the need to strengthen regulatory enforcement, renew waste management facilities, and enhance public education in order to cultivate a sustainable culture of environmental awareness. Practically, the government must improve inter-agency coordination, increase transparency in the management of waste service levies, and expand community-based educational programmes. Accordingly, this study affirms that the success of waste management in Batam City is highly dependent on synergy among government institutions, communities, and the private sector in establishing an effective, adaptive, and sustainability-oriented waste management system.

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