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Planning For The Construction Of Landfills (Landfills) Towards Zero Waste In Batu Bara Regency

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***Abstract* — Waste management in Batu Bara Regency faces challenges in realizing the concept of zero waste. This research aims to analyze the existing conditions of waste management, identify obstacles and challenges, and formulate a zero waste-based landfill development planning strategy. The methods used were literature studies and interviews with relevant stakeholders. The results of the study show that limited infrastructure, funding, and regulation are the main obstacles. However, with a community-based approach, eco-friendly technology, and multi-stakeholder collaboration, the potential to reduce the volume of waste entering landfills can be achieved. The recommendations given include improving infrastructure, educating the public, strengthening regulations, diversifying funding, and cross-sector collaboration.**

Keywords: **Waste Management, Zero Waste, Landfill, Coal Regency, Infrastructure, Funding, Regulation, Collaboration, Waste Bank, Refuse Derived Fuel (RDF).**

I. INTRODUCTION

Waste management is one of the main challenges in sustainable development, especially in areas that experience rapid population growth and economic activity such as Batu Bara Regency. As the population increases and urbanization, the volume of domestic and industrial waste piles has increased significantly from year to year (Abdi Sugiarto et al., 2023). This condition demands an effective, efficient, and environmentally friendly waste management system. So far, waste management in Batu Bara Regency is still dominated by the open dumping system to the Final Disposal Site (TPA). This system not only causes various environmental problems such as groundwater, air, and soil pollution, but also has a negative impact on public health around the landfill site. In addition, the limited land and technical age of the existing landfill add to the urgency of the need for more modern and sustainable landfill planning.

The *zero waste* approach is a strategic alternative in answering waste management problems. This concept emphasizes the principle of reduction, reuse, and recycling (3R), as well as minimizing waste residue that must be stored in landfills. In the context of Batu Bara Regency, zero waste-based landfill planning is not only a technical effort, but also a social and institutional transformation that involves community participation, appropriate technology, and supportive local government policies. However, to realize this, landfill development planning is needed that not only pays attention to the technical aspects of construction, but also environmental, social, and institutional aspects. Without careful and integrated planning, efforts towards zero waste will only become slogans without real implementation. Therefore, it is important to conduct an in-depth study related to the planning for the construction of landfills towards zero waste in Batu Bara Regency so that it can be a long-term solution to the waste problem in the area.

The problem of waste in Batu Bara Regency is getting more complex and real from time to time. Every day, the volume of waste generated by households, markets, public facilities, and commercial activities continues to increase, while the available infrastructure and management systems are still unable to keep up with the growth rate of this waste. One of the crucial issues that arises is the condition of the Final Disposal Site (TPA) which is no longer adequate in terms of capacity and environmental feasibility. Currently, most of the waste is still disposed of directly into landfills with an open dumping system, without any sorting, recycling, or further processing processes. As a result, various negative impacts arise such as strong odors, groundwater and air pollution, and an increased risk of disease for the surrounding community. Furthermore, such a management pattern is also contrary to the principles of sustainable development and does not support national efforts to reduce greenhouse gas emissions and achieve zero waste targets.

On the other hand, public awareness of the importance of waste sorting and reduction is still low, and has not been supported by adequate support systems such as waste banks, 3R TPS, or continuous education programs (Lubis & Sugiarto, 2024). The local government has indeed shown commitment through various plans and policies, but the realization of the implementation of zero-waste-based landfill development still faces many obstacles, both in terms of technical, funding, and coordination between institutions. This phenomenon shows that there is a gap between the need for a sustainable waste management system and the actual conditions on the ground. Therefore, this research is important to identify existing problems, as well as formulate a more targeted and zero-waste principle-oriented landfill development plan, in order to answer the challenges of waste management in Batu Bara Regency in a comprehensive and sustainable manner.

This research has a high urgency considering that the problem of waste management in Batu Bara Regency has become an issue that cannot be ignored anymore. An increase in the volume of waste that is not proportional to the available management capacity has the potential to cause an environmental and public health crisis if not immediately addressed comprehensively. The existence of landfills with conventional systems currently in use has proven to be incapable of answering the challenges of long-term waste management, especially in the context of sustainable development and environmental protection. Planning landfill development towards a zero waste system is not only an option, but an urgent strategic need. The concept of zero waste encourages a paradigm shift from simply disposing of waste to reduction, reuse, and recycling, which is able to reduce the burden on the environment while improving the efficiency of waste management. With proper planning, Batu Bara Regency can be an example for other regions in implementing a modern waste management system that is environmentally friendly and future-oriented.

In addition, this research is also important as a basis for decision-making and policy for local governments in formulating strategies and designs for landfill development in accordance with local conditions (Saputra & Sugiarto, 2024). The results of the research are expected to make a real contribution in the form of applicable technical and policy recommendations, as well as encourage collaboration between the government, the community, and the private sector in realizing sustainable waste management. This research has urgency not only in the environmental aspect, but also in supporting the quality of life of the community, good governance, and the achievement of national development targets in the field of waste management and the environment. Various previous studies have discussed a lot about waste-based management *zero waste* in Indonesia. For example, research conducted in the city of Bandung shows that the application of the concept *zero waste city* can significantly reduce the volume of waste through the waste bank program and TPS 3R (Reduce, Reuse, Recycle). Another study in the city of Surabaya highlights the importance of local government support and active community participation in the successful implementation of community-based waste management towards zero waste. Meanwhile, in the Bali region, research on modern landfill management emphasizes the importance of applying waste management technologies such as incinerators and composting plants to reduce the burden of waste in landfills.

Although many studies have been conducted in major cities and tourist areas, research related to planning landfill development towards zero waste in developing areas such as Batu Bara Regency is still very limited. Most previous research has focused on household- or large-scale waste management with relatively better infrastructure support. The context of Batu Bara Regency, with its developing regional characteristics, limited facilities, and different levels of community participation, requires a more specific and adaptive planning approach. The research gap that emerged was the absence of a comprehensive study that specifically designed a plan for the construction of a zero-waste-based landfill in Batu Bara Regency, which takes into account technical, social, environmental, and institutional aspects in an integrated manner. In addition, there have not been many studies that examine the transition strategy from the conventional landfill system (open dumping) to a modern landfill system based on the principle of zero waste at the district level, especially with a participatory approach and based on local conditions.

Therefore, this research is important to fill this void, by producing a landfill development plan towards zero waste that is not only ideal on paper, but also applicable and in accordance with the socio-economic characteristics of Batu Bara Regency.

Problem Identification

Batu Bara Regency faces serious challenges in waste management along with the increasing population and economic activity. The ever-increasing volume of waste is not balanced by an effective and sustainable management system. Currently, waste management methods are still dominated by the collection-transport-disposal system to the Final Disposal Site (TPA) with open dumping techniques, which has the potential to have a negative impact on the environment and public health.

Some of the problems identified include:

1. Limited Landfill Capacity: Existing landfills have limited capacity and are not designed for long-term management, so they are at risk of overloading.
2. Lack of Supporting Infrastructure: Lack of supporting facilities such as Integrated Waste Management Sites (TPST) and waste treatment technology leads to low rates of recycling and waste reuse.
3. Low Community Participation: Community awareness and participation in waste management, such as sorting and reducing waste from its source, is still low.
4. Lack of Optimal Policies and Regulations: Policies and regulations that support zero-waste-based waste management have not been fully implemented effectively at the regional level.
5. Lack of Funding and Investment: Limited budgets and investments in the development of waste management infrastructure and technologies hinder efforts towards a zero waste system.

Problem Formulation

Based on the above problem identification, the problem formulation in this study is:

1. What are the existing conditions of waste management in Batu Bara Regency, especially related to the capacity and operation of the existing landfill?
2. What are the obstacles and challenges faced in waste management efforts towards the concept of zero waste in Batu Bara Regency?
3. How can landfill development planning in accordance with zero waste principles be designed and implemented in Batu Bara Regency?
4. What is the participation of the community and other stakeholders in supporting the planning and implementation of zero-waste-based landfills in Batu Bara Regency?
5. What strategies can be applied to overcome the limitations of infrastructure, funding, and

regulations in realizing landfills towards zero waste in Batu Bara Regency?

II. LITERATURE REVIEW

Final Landfill (TPA) Concept

The Final Disposal Site (TPA) is the last location in the waste management system used to dispose of waste permanently. According to Wulandari et al. (2022), an ideal landfill not only functions as a landfill, but should also have an environmental management system that minimizes negative impacts on soil, water, and air. In the context of modern management, landfills are an integral part of an integrated waste system that prioritizes the principles of reduction, reuse, and recycling (3R). Furthermore, Kurniawan and Sari (2022) emphasized that the transformation of landfills from the concept of open dumping to sanitary landfills, even to zero waste landfills, is an urgent need in sustainable urban infrastructure planning. The application of technology and environment-based policies is needed so that landfills do not become a source of pollution, but rather become a node for sustainable waste management.

2.2 The Concept of Zero Waste in Waste Management

Zero waste is a waste management approach that aims to eliminate waste through the redesign of production and consumption systems. According to Prasetya and Hidayati (2022), the zero waste approach encourages communities and governments to move from a linear system to a circular system, where waste is seen as a resource that can be reused. Furthermore, Hasibuan (2022) explained that the implementation of the zero waste concept requires thorough planning, including public education, sorting at the source, increasing recycling capacity, and the use of waste processing technology such as RDF (Refuse Derived Fuel), composting, and waste to energy. This strategy requires collaboration between local governments, the private sector, and the community to achieve management efficiency and effectiveness.

2.3 Zero Waste-Based Landfill Development Planning

Planning for the construction of a zero-waste-based landfill does not only consider technical, but also social, economic, and environmental aspects. According to Lestari and Nugroho (2022), good planning must include location feasibility studies, environmental impact analysis, operational models, and strategies to reduce the volume of waste entering landfills. Zone-based management, addition of recycling facilities, and processing of organic waste into fertilizer are examples of practices that need to be implemented in a zero waste landfill. In addition, Yusuf and Maulana (2022) emphasized the importance of implementing information systems and technology in landfill management, such as the use of sensors for methane gas monitoring, digital reporting systems, and waste data management applications. Planning that is integrated with regional policies will increase the accountability and operational efficiency of landfills.

2.4 Challenges and Opportunities for Implementation in the Regions

In areas like Batu Bara Regency, the main challenge in the development of landfills towards zero waste is limited land, funds, and public awareness. However, according to Handayani and Simanjuntak (2022), development opportunities remain large if the government is able to synergize with the private sector and access environmental grant funds from the central and foreign governments. Community involvement in waste sorting and reduction programs is also key to success. According to a study by Rahmawati et al. (2022), a community-based waste management approach has been proven to be able to reduce the burden of landfills by up to 30% through waste bank activities, household composting, and sustainable environmental education.

2.5 Frame of Mind

Waste Problems in Batu Bara Regency
↓
Need for the Construction of a Zero Waste Landfill
↓
Zero Waste Concept
↓
Landfill Development Planning Strategy:
↓
Landfills Towards Zero Waste
↓
Clean & Sustainable Coal Regency

1. Waste Problems in Batu Bara Regency
   ➔ The volume of waste continues to increase due to population growth and economic activity.
   ➔ Traditional waste management systems (open dumping) cause environmental pollution.
2. The Need for Zero Waste-Based Landfill Development
   ➔ Conventional landfill construction is not effective enough.
   ➔ Management transformation towards *the concept of Zero Waste* is needed to reduce waste disposed of in landfills.
3. Zero Waste Concept
   ➔ Emphasizing the reduction of waste at source, recycling, reuse, and processing waste into valuable products.
4. Landfill Development Planning Strategy Towards Zero Waste
   - Selection of suitable locations
   - Landfill design based on sanitary landfill and waste processing technology
   - Implementation of the 3R (Reduce, Reuse, Recycle) program
   - Education and community involvement
   - Ongoing regulatory and financing support
5. Final Destination
   ➔ Realizing an environmentally friendly, sustainable waste management system, and supporting the vision of clean and healthy Batu Bara Regency development.

III METHOD

3.1. Approaches and Types of Research

This study uses a descriptive qualitative approach, because it aims to describe in depth the planning process for the construction of the Final Disposal Site (TPA) towards

zero waste in Batu Bara Regency. According to Moleong (2022), a qualitative approach is used to understand social phenomena from the perspective of participants holistically and contextually. In this context, the qualitative approach allows researchers to explore in depth the dynamics of policies, public perceptions, and waste management practices in the field (Sugiarto et al., 2024).

3.2 Location and Subject of Research

The location of this research is in Batu Bara Regency, North Sumatra, especially in the area that is planned to be the location for the construction of landfills and related waste management agencies. The subjects of the study included informants from the local government (Environment Agency), waste managers, community leaders, and local residents.

The selection of subjects was carried out by purposive sampling, which is to select informants who are considered to know the most and are directly involved in planning and managing waste in the region. According to Sugiyono (2022), purposive sampling is suitable for use in qualitative research because of its focus on rich and relevant information.

3.3 Data Collection Techniques

Data collection in this study was carried out through several techniques, namely:

1. In-depth interview: used to explore the understanding, experience, and views of informants related to the concept of zero waste and landfill development planning.
2. Participatory observation: carried out to see firsthand the field conditions, waste management practices, and social interactions that occur.
3. Documentation: in the form of planning documents, regional regulations, landfill technical reports, and other supporting data.

As conveyed by Creswell and Poth (2022), this combination of techniques is important to improve the validity of the data in qualitative studies.

3.4 Data Analysis Techniques

The data analysis technique used is the Miles, Huberman, and Saldaña (2022) model which includes three main stages, namely:

1. Data reduction: sorting, simplifying, and focusing data from interviews, observations, and documentation.
2. Data presentation: organize data into the form of narratives, matrices, or thematic maps to make it easier to understand.
3. Conclusion drawing and verification: making provisional conclusions based on findings and retesting them through data triangulation.

3.5 Data Validity Test

The validity of the data in this study was tested using source triangulation techniques and techniques, namely by comparing data from various informants and various methods (interviews, observations, documentation). According to Patton (2022), triangulation is the main strategy in ensuring validity and reliability in qualitative research.

IV. Result And Discussion

What are the existing conditions of waste management in Batu Bara Regency, especially related to the capacity and operation of the existing landfill

Waste management in Batu Bara Regency currently still relies on conventional methods, namely the collection-transport-disposal system to the Final Disposal Site (TPA). Waste from various sources, such as households, markets, and public facilities, is collected and transported using special trucks to be disposed of at landfills. However, this system has not been able to solve the waste problem effectively

Figure 4.1 Existing Conditions of Waste Management in Batu Bara Regency

The landfills in Batu Bara Regency have not met environmentally friendly management standards. The open dumping method is still used, where waste is simply piled up without any further processing process. This has the potential to cause various negative impacts, such as groundwater, air, and soil pollution, as well as health risks to the surrounding community. The volume of waste entering the landfill also continues to increase in line with population growth and economic activity in the area. However, the limited capacity of the landfill leads to excessive accumulation of waste, thus worsening the surrounding environmental conditions.

The Batu Bara Regency Government has made various efforts to overcome this problem, such as the placement of garbage cans in various locations, the implementation of environmental care programs, and the cleaning of riverbanks. However, these efforts have not been optimally successful. In addition, public awareness of the importance of good waste management is still low. Community participation in activities such as waste sorting, recycling, and reducing waste from the source is still minimal. This is a challenge in realizing a sustainable waste management system.

What are the obstacles and challenges faced in waste management efforts towards the concept of zero waste in Batu Bara Regency

The implementation of the zero waste concept in Batu Bara Regency faces various complex obstacles and challenges, both from the technical, social, and institutional sides. Some of the main challenges faced include:

1. Limitations of Waste Management Infrastructure
   One of the main challenges is the limitation of adequate waste management infrastructure. The lack of waste sorting facilities at the household level, Integrated Waste Management Sites (TPST), and modern waste processing technology hinder the implementation of the zero waste principle. This leads to low recycling and waste reuse rates.

2. Low Community Awareness and Participation
   Public awareness of the importance of sustainable waste management is still low. Many people do not understand how to sort waste properly and the negative impact of waste on the environment. Lack of active participation in waste management programs such as waste banks and recycling programs is an obstacle in achieving the goal of zero waste.
3. Limited Funds and Resources
   Limited funding is one of the obstacles in the development of environmentally friendly waste management infrastructure and technology. Without adequate financial support, the implementation of the zero waste concept becomes difficult to achieve.
4. Limitations of Technology and Human Resources
   Effective waste management requires the right technology and skilled human resources. Limitations in this case hinder the ability of regions to process waste efficiently and sustainably.
5. Policies and Regulations That Are Not Optimal
   Although there are policies related to waste management, their implementation is often constrained by a lack of coordination between agencies, weak law enforcement, and a lack of support from the private sector. This causes existing policies to be ineffective in encouraging change towards zero waste.
6. Unsustainable Consumption and Production Behavior
   The consumption and production patterns of people who tend to use disposable products and pay less attention to environmental impact are a big challenge in the implementation of the zero waste concept. This behavior change requires a holistic approach and involves all relevant parties (Nuraini, 2004).

Facing these challenges, a comprehensive and collaborative approach is needed between the government, the community, the private sector, and non-governmental organizations. Increasing public awareness, developing adequate infrastructure, and strong policy and funding support are the keys to realizing zero waste-based waste management in Batu Bara Regency.

How can landfill development planning in accordance with zero waste principles be designed and implemented in Batu Bara Regency

To realize sustainable and environmentally friendly waste management in Batu Bara Regency, landfill development planning is needed that integrates zero waste principles. This aims to reduce the volume of waste that enters landfills, minimize negative impacts on the environment, and optimize the use of waste as a resource.

1. Application of Modern Waste Management Technology

One of the strategic steps is the application of efficient and environmentally friendly waste management technology. For example, the application of Refuse Derived Fuel (RDF) technology which processes waste into alternative fuels for industry. In Pati Regency, RDF technology has been applied to process domestic waste into energy, reduce the volume of waste that enters landfills and produce renewable energy.

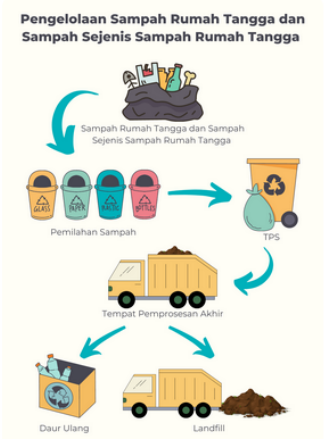

Figure 4.2 Zero Waste Concept-Based Management

Development of Integrated Waste Management Infrastructure

The construction of an Integrated Waste Management Site (TPST) equipped with sorting, composting, and recycling facilities is an important step in supporting the principle of zero waste. In Banjarbakula Regency, TPST is designed to process waste using the peuyeumization method in hollow bricks, converting organic and non-organic waste into solid fuel in the form of RDF/SRF products.

3. Application of Sanitary Landfill System

To reduce the negative impact of the open dumping system, the implementation of a sanitary landfill system that meets sanitary and environmental standards is very necessary. At the Sowi Landfill, Manokwari Regency, landfill land rehabilitation was carried out through the application of landfill mining combined with waste processing technology into RDF, as an effort to rehabilitate landfill land and reduce environmental impact (Akus Harmoko et al., 2024).

4. Increasing Community Awareness and Participation

Community awareness and active participation in waste management is very important in realizing zero waste. Education and training programs regarding waste sorting, recycling, and waste reduction from the source need to be encouraged. The Batu Bara Regency Government can collaborate with non-governmental organizations and the private sector to implement these programs.

5. Formulation of Supporting Policies and Regulations

The preparation of policies and regulations that support zero-waste-based waste management needs to be carried out. The policy must include technical, institutional, funding, and supervisory aspects. In addition, there needs to be incentives for the community and business actors who apply the zero waste principle, as well as sanctions for those who violate (Ramadhani & Nuraini, 2024).

What is the participation of the community and other stakeholders in supporting the planning and implementation of zero waste-based landfills in Batu Bara Regency

Community Participation in Zero Waste-Based Waste Management

The community plays an important role in the successful implementation of the zero waste concept. Active community participation can be done through:

1. Waste Sorting at Source: The community can sort organic and inorganic waste from the household. Organic waste can be processed into compost, while inorganic waste can be recycled or resold.
2. Household-Scale Composting: Simple composting techniques can be applied at the household level to reduce the volume of waste entering landfills. For example, in Jomblang Village, Semarang City, the community has successfully managed household waste into compost through sorting and processing at the source.
3. Education and Socialization: The community can play a role in disseminating information and educating the surrounding environment about the importance of good waste management.
4. Participation in Government Programs: The community can be involved in government programs such as waste banks, cleaning competitions, and waste management training.

The success of community-based waste management is greatly influenced by the level of knowledge, awareness, and active participation of the community in waste management activities (Saputra & Sugiarto, 2024).

The Role of Stakeholders in the Implementation of Zero Waste-Based Landfills

The implementation of a zero-waste-based landfill requires collaboration between various stakeholders, including:

1. Regional Government: The Batu Bara Regency Government plays a role as a policy maker and facilitator in the preparation of regulations, budget provision, and coordination between institutions. The government can also encourage community participation through programs that support zero-waste-based waste management.
2. Environment and Hygiene Agency (DLHK): As the technical coordinator, DLHK is responsible for planning, implementing, and evaluating waste management programs. DLHK can also conduct socialization and training to the community to increase capacity in waste management.
3. Private Sector: Companies can play a role in supporting waste management through Corporate Social Responsibility (CSR), the provision of waste management technology, and partnerships in waste recycling.
4. Non-Governmental Organizations (NGOs): NGOs can play a role in providing education, advocacy, and assistance to the community in waste management.
5. Academics and Researchers: Universities and research institutions can conduct studies, research, and technology development in waste management. The results of the research can be the basis for the formulation of effective waste management policies and strategies.

Strategic Recommendations to Increase Community and Stakeholder Participation

1. Environmental Counseling and Education: Conducting regular campaigns and trainings to increase public knowledge and awareness about the importance of zero waste-based waste management.
2. Provision of Supporting Infrastructure: Provide facilities such as separate bins, composters, and landfills to support waste sorting and processing at the community level.
3. Incentives and Awards: Providing incentives or awards to individuals, groups, or communities that are active in waste management as a form of appreciation and motivation.
4. Strengthening Regulations and Policies: Develop and implement policies that support zero-waste-based waste management, including sanctions for violators and incentives for active participants.
5. Multi-Stakeholder Collaboration: Building partnerships between governments, communities, the private sector, NGOs, and academia to jointly plan and implement sustainable waste management programs.

What strategies can be applied to overcome the limitations of infrastructure, funding, and regulations in realizing landfills towards zero waste in Batu Bara Regency

1. Strengthening Waste Management Infrastructure

Limited infrastructure is the main challenge in waste management. For this reason, it is necessary to do:

- Construction of Integrated Waste Management Sites (TPST): Establish facilities that are able to process waste from its source, such as sorting, composting, and recycling. For example, in Papayan Village, the community has successfully managed waste through sorting and processing at the source.
- Application of Environmentally Friendly Technology: Using technologies such as Refuse Derived Fuel (RDF) to process waste into alternative energy. In Pati Regency, RDF technology has been applied to process domestic waste into energy.
- Rehabilitation of Existing Landfills: Repairing and upgrading existing landfill facilities to meet environmental and health standards. At the Sowi Landfill, Manokwari Regency, landfill land rehabilitation was carried out through the application of landfill mining combined with waste processing technology into RDF.

2. Diversification of Funding Sources

Limited funding is often an obstacle in waste management. Some strategies to overcome this include:

- Public-Private Partnership (PPP): Involving the private sector in the construction and operation of landfills with a profit-sharing scheme or direct investment. At the Bantargebang Landfill, management is carried out by involving investors in the construction and operation of the landfill.
- Community-Based Funding: Implement a fair and transparent waste levy system, and develop waste banks as an alternative source of funding. In

Papayan Village, the proceeds from the sale of inorganic waste through the waste bank are used to finance waste management activities and community welfare

- Utilization of CSR Funds: Invite companies to participate in waste management programs through Corporate Social Responsibility (CSR) funds.
- Submission of Grants and Central Government Funds: Prepare project proposals that meet the criteria for obtaining grants from the central government or international institutions.

3. Preparation and Enforcement of Supporting Regulations

Clear and firm regulations are needed to support the implementation of zero waste. Some of the steps that can be taken include:

- Preparation of Regional Regulations (Perda): Making Regional Regulations that regulate zero-waste-based waste management, including the obligation to sort waste at the source, sanctions for violators, and incentives for active participants.
- Integration in Regional Development Plans: Integrating zero waste-based waste management programs in the Regional Medium-Term Development Plan (RPJMD) and Regional Government Work Plan (RKPD).
- Preparation of Waste Management Grand Design: Creating a comprehensive master plan regarding waste management from upstream to downstream, involving all stakeholders.
- Informal Sector Involvement: Drafting regulations that recognise and empower the informal sector in waste management, such as waste pickers and waste collectors, through partnership and training schemes.

4. Human Resource Capacity Building

The quality of human resources (HR) greatly determines the success of the zero waste program. Some of the steps that can be taken include:

- Training and Education: Provide training to cleaners, landfill managers, and the community on environmentally friendly waste management techniques.
- Education Program in Schools: Include materials on waste management and zero waste in the school curriculum, as well as encourage schools to have a school waste bank program.
- Community Empowerment: Establish community groups that are trained in waste management, such as composting groups and recycling groups.

5. Multi-Stakeholder Collaboration and Partnership

Zero waste-based waste management requires cooperation between various parties. Steps that can be taken include:

- Coordination Forum: Establish a coordination forum between the government, the community, the private sector, and Non-Governmental Organizations (NGOs) to plan and implement waste management programs.
- Partnerships with International Institutions: Collaborate with international institutions that have funding and technical programs in waste management.
- Community Participation: Invite the community to be active in every stage of waste management, starting from planning, implementation, to evaluation.

V. CONCLUSION

Conclusion

Waste management in Batu Bara Regency faces significant challenges related to infrastructure, funding, and regulations. Limited waste treatment facilities and low levels of community participation are the main obstacles in the implementation of the zero waste concept. However, with a community-based approach, such as the establishment of a Waste Bank, as well as the application of environmentally friendly technologies such as Refuse Derived Fuel (RDF), the potential to reduce the volume of waste entering landfills can be achieved. Collaboration between the government, the community, and the private sector is indispensable to create a sustainable and effective waste management system.

Suggestion

1. Improving Waste Management Infrastructure: Building adequate waste treatment facilities, such as Integrated Waste Management Sites (TPST) and recycling facilities, to support the implementation of zero waste.
2. Education and Socialization to the Community: Conducting regular campaigns and trainings to increase public knowledge and awareness about the importance of zero waste-based waste management.
3. Strengthening Regulations and Policies: Develop and implement policies that support zero-waste-based waste management, including sanctions for violators and incentives for active participants.
4. Diversification of Funding Sources: Develop a variety of funding sources, such as public-private partnerships, community-based funding, and grant applications, to support waste management programs.
5. Multi-Stakeholder Collaboration: Building partnerships between governments, communities, the private sector, Non-Governmental Organizations (NGOs), and academia to jointly plan and implement sustainable waste management programs.

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