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Investigating the Operational Feasibility of Waste Management at Integrated Waste Management Sites in Balikpapan City

Dian Ameliana Putri[1], Rahmat Aris Pratomo[2*]
[1,2] Urban and Regional Planning Study Program, Institut Teknologi Kalimantan, Balikpapan, Indonesia

[*]Correspondent Email: r.a.pratomo@lecturer.itk.ac.id

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Abstract: Referring to the Balikpapan City Medium-Term Development Plan for 2021-2026, the percentage of waste transported to the Final Waste Processing Site (FWPS) is 75.45%, which is higher than the percentage of waste management. As of now, there are 2 Integrated Waste Management Sites (IWMS) in Balikpapan, namely MRF and ITF. Based on data from 2019, waste management at MRF decreased by 51.14%. Meanwhile, ITF only utilizes 25.98% - 31.31% of total incoming waste, with the remainder being sent to Manggar FWPS. This decline in performance is also related to the deteriorating condition of approximately 62% of waste management infrastructure in Balikpapan, so evaluation of the operational aspects of waste management becomes a crucial factor in addressing this issue. In addition, the ideal condition of waste management according to standards serves as the main indicator in assessing the performance of waste management. This research aims to evaluate operational aspects of waste management at Balikpapan IWMS by applicable regulations. Analysis methods used are mass balance analysis and operational performance analysis. Research findings show that waste management at IWMS Balikpapan City can reduce the volume of waste in Balikpapan City. However, the operational performance of MRF did not meet established standards, especially in terms of waste removal and processing systems, with a score of 19. On the other hand, ITF is considered sufficient by provisions of PUPR Minister Regulation Number 03 of 2013 and Indonesian National Standard 19-2454-2002 with a score of 23.

Keywords: *Balikpapan, FWPS, IWMS, Management, Waste*

INTRODUCTION

Waste management is a complex problem and is faced by many countries around the world, including Indonesia. On the other hand, the state should regulate good waste management and penalize those who break waste management regulations (Widowaty, Astuti, & Adrian, 2023).

Waste management is a name given to a waste collection system, including its transportation, disposal or recycling (Pardini, Rodrigues, Kozlov, Kumar, & Furtado, 2019). Waste is a global issue that needs to be handled comprehensively and integrated from the source to the final disposal (Fadilla & Kriswibowo, 2022).

Waste has become a serious problem in people's lives, especially regarding environmental problems (Wahyu Maesarini, 2023). According to Law No. 18 of 2008 concerning Waste Management, waste management is a systematic, comprehensive, and sustainable activity that includes reducing and handling waste.

Garbage is one of the important factors that can damage the balance of the environmental ecosystem (Mardhiyah, Islami, Gusdiansyah, Saputra, & Farma, 2022). Waste management strategies include collection, transportation, treatment, and disposal of waste, and must be accompanied by waste management monitoring and

regulations (Gobai & Surya, 2021). The implementation of waste management is influenced by various factors such as increasing population growth, rapid economic development, urbanization, and rising people's living standards (Wulandari, 2021). The increase in population and various human activities have an impact on increasing the amount and type of waste which has the potential to endanger health and the environment.

The common problems are: no separation at source, complicated collection processes, open dumped landfill, and no control of gas emissions and leachate in landfill (Dhokhikah & Trihadiningrum, 2012). During the night, some 2.7 million cubic meters of garbage, hazardous waste, and mud swept like an avalanche through the villages of Cilmius and Cireundeu (Macmillan, 2007).

Currently in Indonesia, many waste management systems that rely on collection, transport, and disposal methods. Factors such as rapid urbanization, industrialization, and intensive agriculture have led to serious environmental degradation (Fatimah, Sunarsih, Sitorus, & ..., 2024). The solution commonly used by cities to deal with the waste problem is to transport it to the Final Waste Processing Site (FWPS) using waste trucks. However, if waste is not managed properly, it can have dangerous impacts.

First, waste can be a source of disease and pollute the environment, creating a breeding ground for pathogenic microorganisms, and wild animals that are dangerous to human health. Second, if waste is burned, it causes air pollution which harms people's health and triggers global warming. Third, decomposing waste produces an unpleasant odor and is dangerous to health, and liquids that seep into the ground can pollute wells and groundwater. Fourth, dumping waste into rivers or bodies of water causes shallowing of rivers which has the potential to trigger flooding (Kahfi, 2017).

In 2022, it was decided that the East Kalimantan region, especially Kutai Kartanegara Regency and Penajam Paser Utara Regency, would become the new capital of Indonesia, replacing Jakarta. Balikpapan City acts as the partner of Nusantara Capital City, experiencing a two-fold increase in population since the transfer of IKN (BPS Balikpapan City, 2020-2023).

This is the consequence of Balikpapan City facing challenges related to the environment, especially the problem of waste. This challenge arises as a result of increasing population growth which has an impact on increasing the volume of waste in Balikpapan City. Head of the Balikpapan City Environmental Service, Sudirman Djayaleksana, estimates that the Manggar FWPS will only operate until 2026 because it will reach its capacity. Manggar FWPS can accommodate 400 to 700 tons of household waste per day.

Meanwhile, the results of the Preliminary Study of the Government Cooperation Project with Business Entities (KPBU) for the Manggar FWPS in 2020, show that Balikpapan City produces around 555 tons of waste per day, which is estimated to increase to 1,120 tonnes per day in 2045. Referring to achievement measurements performance in handling waste problems in the Balikpapan City RPJMD 2021-2026, the percentage of waste transportation to FWPS is 75.45% or relatively higher compared to the percentage of waste management. In the Presidential Regulation of the Republic of

Indonesia Number 97 of 2017, it is stated that the target for reducing waste before it is disposed of in the landfill is 30% of the waste generation rate. However, Balikpapan City has only succeeded in reducing waste by 22%. As an Integrated Waste Management Site (IWMS) in Balikpapan City, based on 2019 data, waste management at the Material Recovery Facility (MRF) decreased by 51.14% of the total incoming waste.

Meanwhile, at the Intermediate Treatment Facility (ITF), only 25.98% - 31.31% of the total incoming waste can be used as compost, and the remaining residue is sent to the Manggar FWPS. This decline in performance is also related to the damaged condition of around 62% of the waste management infrastructure in Balikpapan City.

Therefore, sustainable waste management is very necessary to achieve various targets. The urban waste management system is seen through interrelated components such as technical operations, organization and management, laws and regulations, financing, and the role of the community (Effendy & Dibyosaputro, 2015; Mandasari, N., & Eliyanti, 2021).

Evaluation of operational aspects of waste management is an important factor in overcoming this problem. Ideal conditions for waste management following standards are the main indicator in assessing waste management performance (Gobai et al., 2021).

To improve the performance of waste management in Balikpapan City, this research was carried out by evaluating the operational technical aspects of waste management at Balikpapan City IWMS by PUPR Ministerial Regulation Number 03 of 2013 and Indonesian National Standard (INS) 19-2454-2002. Therefore, it is hoped that it can increase the efficiency and effectiveness of waste management in Balikpapan City and contribute to presenting the latest facts regarding the implementation of waste management in Kalimantan City.

LITERATURE REVIEWS

The urban waste management system is seen through components that support each other to achieve the goal of a clean, healthy, and orderly city (Mandasari, N., & Eliyanti, 2021).

These components include technical operations, organization and management, laws and regulations, financing, and the role of the community which are detailed as follows (Effendy & Dibyosaputro, 2015; Gobai & Surya, 2021).

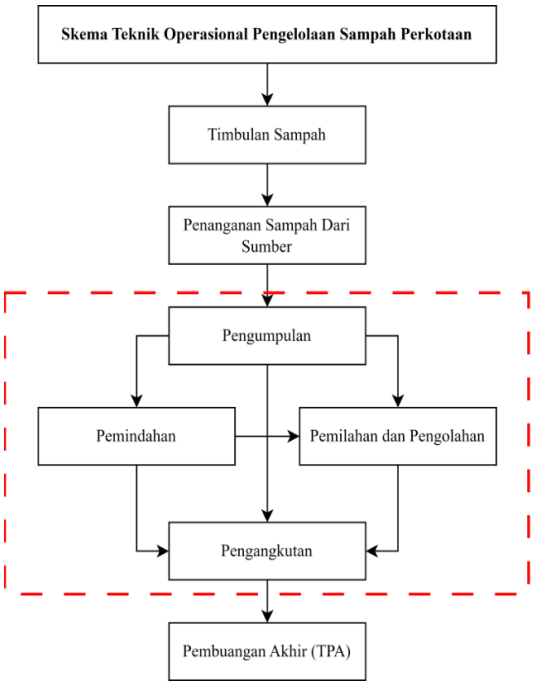
1. Operational Technical Subsystem, This subsystem includes patterns of containerization, collection, transfer, transportation, processing, and final disposal.
2. Organization and Management Subsystem, This subsystem includes parties responsible for waste management, such as the Department, Regional Technical Implementation Unit (RTIU), private sector, and community organizations.
3. Legal and Regulatory Subsystem, This subsystem includes the legal and regulatory framework that regulates waste management, including laws, government regulations, and regional policies relating to waste management.
4. Financial Subsystem, This subsystem includes program and development financing, as well as contributions and levies.

5. Community Role Subsystem, This subsystem includes programs for community roles and increased partnerships, as well as community empowerment.

In this research, a review and evaluation will be carried out on one of the components of the urban waste management system, namely the operational technical subsystem.

By INS 19-2454-2002 concerning Operational Technical Procedures for Urban Waste Management, operational technical subsystems include waste generation, handling from the source, collection, transfer, sorting and processing, transportation, and final disposal at Final Waste Processing Sites (FWPS). For more details, see Figure 1 as follows.

Figure 1. Waste Management Operational Technique Scheme.



Source: SNI 19-2454-2002

Based on the scheme in Figure 1, this research will discuss the operational technicalities of waste management at IWMS starting from collection to transportation using normative references in the form of SNI 19-2454-2002 concerning Operational Technical Procedures for Urban Waste Management and Regulations of the Minister of Public Works and Public Housing number 03/PRT/M/2013 concerning the Implementation of Waste Infrastructure and Facilities in Handling Household Waste and Similar Types of Household Waste.

RESEARCH METHODS

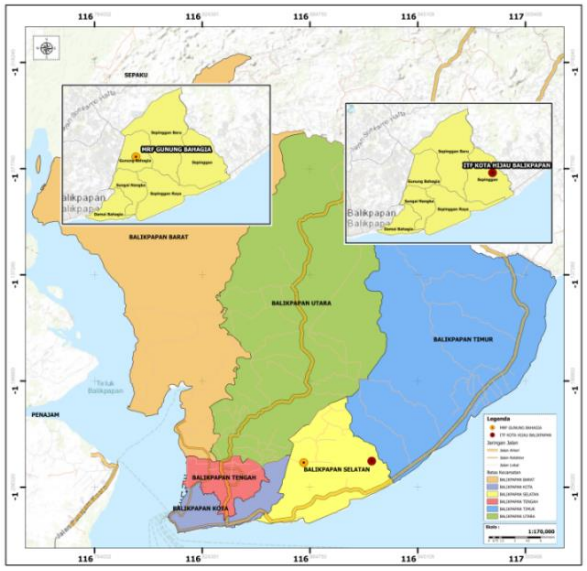
1. Research sites

This research was conducted at 2 (Integrated Waste Management Sites (IWMS)) of Balikpapan City, namely the Gunung Bahagia Material Recovery Facility (MRF) located in Gunung Bahagia Village and the Balikpapan Green City Intermediate Treatment Facility (ITF) located in Sepinggan Village.

This location selection was based on the National Water and Sanitation Information Service (NAWASIS) database belonging to the Directorate of Urban, Housing and Settlement, Ministry of National Development Planning (PPN)/Bappenas of the Republic of Indonesia.

This data shows that there are only 2 waste infrastructures in the form of IWMS in Balikpapan City, as has been confirmed by authorized stakeholders at the Balikpapan City IWMS. The research locations are shown in Figure 2 as follows.

Figure 2. Balikpapan City IWMS Location Map



Source: Author's Process, 2023

2. Data Collecting Method

This research uses primary data collection methods through observation and interviews with stakeholders at the Balikpapan City IWMS. First, interviews were conducted with supervisors at MRF Gunung Bahagia a waste processing facility that combines several waste processing techniques, such as separation, composting, or recycling processes. Moreover, interviews were also conducted with the field coordinator at ITF Green City Balikpapan a waste processing facility using an environmentally friendly incinerator machine so that only residual waste is disposed of in the landfill. This method aims to gain an in-depth understanding of waste management practices at the Balikpapan City IWMS.

3. Data analysis method

The following is the data analysis method used in this research.

a. Mass Balance Analysis

Calculation of waste reduction using mass balance analysis aims to determine the percentage of waste that can be reduced in the Balikpapan City IWMS, including calculating the total volume of waste, its composition, and the value recovery factor (Maulana & A, n.d.) . The calculation stages in mass balance analysis include:

1) Calculating the Volume of Balikpapan City IWMS Waste Generation
2) Calculating the Volume and Weight of Waste According to Type at the Balikpapan City IWMS by the assumed waste composition percentage in Table 1.

Table 1. Assumed waste composition percentage

No	Type of Waste Composition	Percentage (%)
1	Organic Waste	65.66
2	Inorganic Waste	34.33

Source: nawasis.org

3) Calculating the Recovery Factor Value of Balikpapan City IWMS Waste
4) Calculating Balikpapan City IWMS Waste Reduction and Residue
5) Calculating the Contribution of Balikpapan City IWMS Waste Reduction to Balikpapan City's Total Waste Generation

$$IWPS\ Contribution\ (\%) = \frac{Total\ of\ Average\ Reduction\ Waste}{The\ Amount\ of\ Waste\ in\ Balikpapan\ City} x\ 100\%$$

Table 2. Classification of IWPS Contributions Based on Waste Reduction.

No	Reduction Terms	Classification
1	Reducing	Suitable
2	Not Reducing	Suitable enough

Source: Author's Process, 2023

b. Analysis of IWMS Operational Conformity with Regulations

Analysis of the suitability of IWMS operations was carried out by comparing the existing conditions of waste management at

the Balikpapan City IWMS with normative references, including PUPR Ministerial Regulation Number 03 of 2013 concerning the Implementation of Waste Infrastructure and Facilities in Handling Household Waste and Similar Household Waste, as well as the Indonesian National Standards (INS) 19-2454-2002 concerning Management of Waste Management Sites. Several indicators used in the technical analysis of TPST operations can be seen in Table 3.

Table 3. IWMS Operational Technical Analysis Indicators.

Variable	Sub Variable	Indicator
Collection Techniques	Collection Method	(1) Direct and/or indirect individual waste collection (2) Direct and/or indirect communal waste collection (3) Street and park cleaning
	Operational Schedule	(1) The waste transportation schedule is between 1 and 4 times per day (2) The waste transportation schedule is less than once every 3 days (3) The waste transportation schedule is more than once every 3 days
	Other Technical	(1) Waste collection is carried out using trash cans, trash carts, pick-ups, and dump trucks (2) Has a designated service area (3) Has permanent officers and can be moved periodically
Technical Transfer	Transfer Location	(1) Easy access with an asphalt surface that can be passed by transport vehicles (2) The shortest distance between the IWMS and the nearest settlement is around 500 m (3) Availability of IWMS land >20,000 m2
	Transfer Facilities	(1) It does not have facilities such as container platforms, walled courtyards, or warehouses (2) Have one or both of the facilities such as a container platform, walled courtyard, or warehouse (3) Has facilities such as a container platform, walled courtyard, and warehouse
	Transfer Method	(1) The transfer of waste to the transport truck is carried out manually by the transport officer (2) The transfer of waste to the transport truck is carried out using a compactor machine (3) Filling containers is done manually by collection officers or the public while moving containers to transport trucks is done mechanically (load haul)
Technical Processing	Processing Facilities	(1) Does not provide a sorting place or composting place (2) Provide either a sorting area or a composting area (3) Providing a sorting place and composting place
	Processing Activities	(1) Does not provide processing activities (2) Provide waste sorting activities (3) Provide sorting and composting activities

	Processing Zone	(1) Available waste sorting room or waste processing installation (composting) (2) Environmental pollution control zones and buffer zones are available (3) Residue handling zone available
Technical Transportation	Transport Location	(1) All residual waste is transported to the landfill (2) The waste transportation schedule is carried out according to the schedule (21.00-05.00 / 06.00-13.00 / 13.00-18.00) (3) The ideal distance is 20 km
	Transport Facilities	(1) The waste carrier is equipped with a cover (2) The maximum height of the tub reaches 1.6 m (3) The size of the vehicle must be adjusted to the class of road being traveled
	Freight Intensity	(1) The intensity of transportation by trucks can transport waste to landfills < 80% of the population's waste production (2) The intensity of transportation by trucks can transport waste to landfills 80% of the population's waste production (3) The intensity of transportation by trucks can transport waste to landfills >80% of the population's waste production
	Transport Method	(1) The container model still uses a manual dump truck (2) The container model still uses trucks mechanically (3) The lifting container model uses an arm roll truck

Source: PUPR Minister Regulation No. 03, 2013; SNI 19-2454-2002; INS3242-2008

$$Classification\ Level = \frac{Maximum\ Value - Minimum\ Value}{Total\ Classes} = \frac{39 - 10}{3} = 9$$

Table 4. Score Range and Classification Level of Conformity of IWMS Operations with Regulations.

No	Score Range	Classification
1	30 – 39	Suitable
2	20 – 29	Suitable enough
3	10 – 19	Not Suitable

Source: Author's Process, 2023

RESULTS AND DISCUSSION

1. Characteristics of IWMS in Balikpapan City

The city of Balikpapan has 2 units of Integrated Waste Processing Sites or IWMS from a technical cooperation pilot project which aims to educate the public in managing waste based on 3R so that it can reduce waste generation at the Manggar FWPS. This collaboration was carried out between the Indonesian Government and the Japanese Government with the management of the Balikpapan City Environmental Service (BCES) under the auspices of the Japan International Cooperation Agency (JICA). JICA is a partnership program that aims to encourage the implementation of development projects in various developing countries. The characteristics of the 2 IWMS in Balikpapan City in Table 5 are as follows.

Table 5. Characteristics of Balikpapan City IWMS.

Characteristics of Balikpapan City IWMS	
Gunung Bahasgia MRF	**ITF Green City Balikpapan**
(1) MRF Gunung Bahagia was first established in 2015 on Jalan Rengganis, Gunung Bahagia Village, Balikpapan City, and began operating in 2016, as can be seen in Figure 3.	1) Balikpapan Green City ITF as a city-scale IWMS started operating in 2018, located right in the Daksa Housing Complex, Sepinggan Village, which can be seen in Figure 4.
(2) IWPS has expanded its area coverage to 57 RT from 59 RT in Gunung Bahagia Village through Balikpapan City APBD funding.	2) At that time, the IWMS with area coverage only served waste from Sepinggan Market, but currently, the area coverage has changed location to Pandan Sari Market.
(3) This MRF carries out waste collection activities from the source to the MRF every day except Sundays using the 4 GrandMax cars it owns, as well as transporting residual waste to the Manggar FWPS every day except Sundays using trucks belonging to the Manggar FWPS.	3) The ITF has a schedule for collecting waste from its source to the ITF every day except Sundays using 1 dump truck, as well as transporting residual waste to the Manggar FWPS every day except Sundays using an ITF dump truck.
(4) MRF Gunung Bahagia only sorts waste into 7 types of waste consisting of paper waste, plastic cups, plastic bottles, non-bottle plastic, cans/metal, glass bottles, and B3 waste and others, so there is no program for processing waste into compost.	4) Balikpapan Green City ITF carries out waste sorting activities to separate inorganic waste from organic waste, apart from that, ITF also carries out a waste processing program in the form of waste composting.
(5) The zoning owned by MRF Gunung Bahagia also only consists of a waste sorting zone and a storage zone for the sorted waste before it is sold to collectors.	5) The zoning owned by the Balikpapan Green City ITF consists of a sorting zone, a composting zone, and a storage zone for the results of sorting organic and inorganic waste.

Source: Processed Primary and Secondary Data, 2023

Figure 3. MRF Gunung Bahagia Balikpapan

Source: Author's Process, 2023

Figure 4. ITF Green City Balikpapan

Source: Author's Process, 2023

2. Mass Balance Analysis

Table 6. Calculation of Balikpapan City IWMS Mass Balance Analysis.

Calculation Stage		Balikpapan City IWPS	
		MRF	ITF
Waste Volume per day*secondary data from interviews	a	20.24 m3	6.65 m3
Assumed Percentage Composition of Organic Waste	b	65.66%	
Assumed Percentage Composition of Inorganic Waste	c	34.33%	
Composition of Organic Waste per day	d=a*b	13.29 m3	4.37 m3
Composition of Inorganic Waste per day	e=a*c	6.95 m3	2.28 m3
Assumed Specific Gravity of Waste	f	300 kg/m3	
Composition of Organic Waste per day	g=d*f	3,987 kg	1,311 kg
Composition of Inorganic Waste per day	h=e*f	2,085 kg	684 kg
Garbage Weight per day	i=g+h	6,072 kg	1,995 kg
Organic Waste Processed per day*secondary data from interviews	j	0	1,222 kg
Inorganic Waste Processed per day*secondary data from interviews	k	1,618 kg	0
Recovery Factor value per day	l=(j+k)/i	27%	61%
Weight Reduction per day	m=j+k	1,618 kg	1,222 kg
Residue Weight per day	n=im	4,454 kg	773 kg
Balikpapan City Waste Generation per day	o	514,730 kg	
Percentage of IWPS Waste Reduction per day	p=m/o	0.31%	0.24%
Total Reduction of Balikpapan City IWPS Waste per day		0.55%	
IWPS Classification		**Suitable**	

Source: Processed Primary and Secondary Data, 2023

Based on the mass balance analysis carried out in Table 6, the total waste reduction carried out at the Balikpapan City IWMS has contributed 0.55% of the total waste produced by Balikpapan City. The IWMS's contribution shows that the Balikpapan City IWMS is following the objectives of establishing the IWMS, namely to be a place for sorting and processing waste centrally so that the IWMS can be a viable way to achieve the goal of recycling materials in urban areas before (Lestari, Hardianto, & Hidayanto, 2014)being transported to the FWPS. In line with this, IWMS is also a waste handling center as a place for recycling and reusing waste, such as organic waste which is composted, and inorganic waste which is recycled into items that can be reused. So, by reducing waste at IWMS, the amount of waste that will be disposed of (residue) at the Final Waste Processing Site (FWPS) will decrease (Ratri et al., 2022).

3. Waste Management Operational Performance Assessment

The operational performance assessment of the Balikpapan City IWMS based on collection techniques, transfer techniques, processing techniques, and transportation techniques can be seen in Table 7 to Table 10 as follows.

Table 7. Assessment Based on Balikpapan City IWMS Waste Collection Techniques.

Collection Techniques			
Collection Method			
	Direct and/or indirect individual waste collection	Direct and/or indirect communal waste collection	Street and park cleaning
MRF		✓	
Existing Conditions	-	The waste collection carried out by MRF is indirect communal waste collection	-
ITF	✓		
Existing Conditions	The waste collection carried out by the ITF is an indirect individual collection	-	-
Collection Schedule			
	The waste transportation schedule is between 1 and 4 times per day	The waste transportation schedule is less than once every 3 days	The waste transportation schedule is more than once every 3 days
MRF	✓	✓	
Existing Conditions	MRF performs 3-4 cycles/day	MRF carries out waste transportation every day except Sundays	-
ITF	✓	✓	
Existing Conditions	The ITF carries out a rotation of 1 cycle/day	ITF carries out waste transportation every day except Sundays	-
Other Technical			
	Waste collection is carried out using trash cans, trash carts, pick-ups and dump trucks	Has a designated service area	Has permanent officers and can be moved periodically
MRF	✓	✓	✓
ITF	✓	✓	✓

Source: Processed Primary and Secondary Data, 2023

Table 8. Assessment Based on Balikpapan City IWPS Waste Transfer Techniques.

Transfer Techniques			
Transfer Location			
	Easy access with an asphalt surface that can be passed by transport vehicles	The shortest distance between the IWMS and the nearest settlement is around 500 m	Availability of IWMS land >20,000 m2
MRF	✓		
Existing Conditions	Asphalt pavement with a road width of 5 m	The closest distance between the IWPS and the settlement is 10 m	Land area 800 m2
ITF	✓		

Transfer Techniques			
Existing Conditions	Asphalt and cement pavement with a road width of 8 m	The closest distance between the IWPS and the settlement is 20 m	Land area 2,000 m2
Transfer Facilities			
	It does not have facilities such as container platforms, walled courtyards, or warehouses	Have one or both of the facilities such as a container platform, walled courtyard or warehouse	Has facilities such as a container platform, walled courtyard, and warehouse
MRF		✓	
Existing Conditions	-	Walled and has a warehouse	-
ITF			✓
Transfer Method			
	The transfer of waste to the transport truck is carried out manually by the transport officer	The transfer of waste to the transport truck is carried out using a compactor machine	Filling containers is done manually by collection officers or the public while moving containers to transport trucks is done mechanically (load haul)
MRF	✓		
ITF	✓		

Source: Processed Primary and Secondary Data, 2023

Table 9. Assessment Based on Balikpapan City IWMS Waste Processing Techniques.

Processing Techniques			
Processing Facilities			
	Does not provide a sorting place or composting place	Provide either a sorting area or a composting area	Providing a sorting place and composting place
MRF		✓	
Existing Conditions	-	There is a sorting area	-
ITF		✓	✓
Existing Conditions	-	There is a composting area	There are both
Processing Activities			
	Does not provide processing activities	Provide waste sorting activities	Provide sorting and composting activities
MRF		✓	
Existing Conditions	-	There are inorganic waste-sorting activities	-
ITF		✓	✓
Existing Conditions	-	-	There are activities for sorting organic and inorganic waste and composting organic

Processing Techniques			
			waste
Processing Zone			
	Available waste sorting room or waste processing installation (composting)	Environmental pollution control zones and buffer zones are available	Residue handling zone available
MRF	✓		
ITF	✓	✓	✓

Source: Processed Primary and Secondary Data, 2023

Table 10. Assessment Based on Balikpapan City IWMS Waste Transport Techniques.

Transportation Technical			
Transport Location			
	All residual waste is transported to the landfill	The waste transportation schedule is carried out according to the schedule (21.00-05.00 / 06.00-13.00 / 13.00-18.00)	The ideal distance is 20 km
MRF	✓	✓	✓
Existing Conditions	-	Transportation schedule 13.00-18.00	Distance 14 km
ITF	✓	✓	✓
Existing Conditions	-	Transport schedule 06.00-13.00	Distance 11 km
Transport Facilities			
	The waste carrier is equipped with a cover	The maximum height of the tub reaches 1.6 m	The size of the vehicle must be adjusted to the class of road being traveled
MRF		✓	✓
ITF		✓	✓
Freight Intensity			
	The intensity of transportation by trucks can transport waste to landfills < 80% of waste production	The intensity of transportation by trucks can transport 80% of waste from landfill to landfill	The intensity of transportation by trucks can transport waste to landfills >80% of waste production
MRF	✓		
ITF	✓		
Transport Method			
	The container model still uses a manual dump truck	The container model still uses trucks mechanically	The lifting container model uses an arm roll truck
MRF	✓		
ITF			✓

Source: Processed Primary and Secondary Data, 2023

The assessment results in Tables 7 to Table 10 can be seen in Table 11 as follows.

Table 11. Assessment of Operational Performance of Waste Management at Balikpapan City IWMS.

Operational Technical	Balikpapan City IWMS	
	MRF	ITF
Waste Collection Techniques		
Collection Method	1	1
Collection Schedule	2	2
Other Technical	3	3
Total	6	6
Waste Transfer Techniques		
Transfer Location	1	1
Transfer Facilities	1	1
Transfer Method	1	1
Total	3	3
Waste Processing Techniques		
Processing Facilities	1	2
Processing Activities	1	2
Processing Zone	1	3
Total	3	7
Waste Transportation Techniques		
Transport Location	3	3
Transport Facilities	2	2
Freight Intensity	1	1
Transport Method	1	1
Total	7	7
Total number of TPSTs	19	23
Classification	Not Suitable	Suitable enough

Source: Processed Primary and Secondary Data, 2023

Based on Table 11, the results of the operational performance assessment of IWMS in Balikpapan City compare the operational conditions of waste management in IWMS Balikpapan City based on normative references, including PUPR Ministerial Regulation Number 03 of 2013 and INS 19-2454-2002. The assessment results show that the Gunung Bahagia MRF is classified as not suitable with a score of 19, while the Balikpapan Green City ITF IWMS is included in the quite suitable category with a score of 23. This indicates that the Balikpapan Green City ITF fulfills compliance with applicable regulations by basic principles of waste management (PURNOMO, 2021). In this activity, Geographic Information System (GIS) plays a role in the process of digital data processing and simple spatial data visualization that is able to provide disaster information at the village (Ayuningtyas, 2022).

CONCLUSION

Based on the research results, it was concluded that waste management at the Balikpapan City Integrated Waste Management Site (IWMS) has shown progress in its operational technical aspects. This IWMS can reduce the amount of waste in Balikpapan City. However, it was found that the operational performance of waste management facilities, such as the Gunung Bahagia MRF, did not meet the standards set, especially in terms of the waste transfer and processing system, with a score of 19. On the other hand, the Balikpapan Green City ITF was assessed as being in sufficient compliance with the provisions of the Minister of PUPR Regulation Number 03 of 2013 and Indonesian National Standard (INS) 19-2454-2002 with a score of 23. This shows that the Balikpapan Green City ITF is in line with the basic principles of waste management, namely following established regulations. These findings provide important insights into the current conditions and challenges that need to be overcome to achieve more sustainable waste management

in Balikpapan City. The results show important and beneficial connections between social capital, community empowerment, social entrepreneurship projects, and waste management techniques (Burhanuddin, 2024). With the construction of this embankment, it can hold the river water from overflowing and the land on the banks of the river.Not overflow and the land on the riverbanks does not occur landslides (Bahrul Ilmi, Nasruddin, Rosalina Kumalawati, 2022).

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