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Assessing plastic waste management performance: Insights from the waste management performance index

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ABSTRACT

Background: In 2015, Indonesia was the second-largest contributor to marine debris worldwide, with an estimated 0.48-1.29 million metric tons of marine waste. In Jakarta, the marine waste generation reached 303.6 tons per day. Government programs such as JAKSTRADA and JAKSTRANAS aim to reduce plastic waste by 30% and manage 70% of waste by 2025. These policies promote circular economy-based waste management, but household participation remains low, with only 1.6% contributing to the 3R (reduce, reuse, recycle). **Methods:** This study employs both quantitative and qualitative approaches to measure the performance of circular economy-based plastic waste management in Jakarta. The population includes both formal and informal sectors, such as waste banks and waste pickers. Data is analyzed using the Waste Management Performance Index (IKPS) from SIPSN and BPS, comparing plastic waste management achievements with JAKSTRADA targets up to 2025. **Findings:** In Jakarta, per capita waste generation is 0.7 kg/day, mainly organic and plastic. Despite a decline in collected waste, plastic waste is rising. Management follows Law No. 18/2008 and Presidential Regulation No. 97/2017, involving formal (TPS 3R, waste banks) and informal (collectors, vendors) sectors. The informal sector aids recycling by collecting plastic from inaccessible areas. JAKSTRADA targets waste reduction, handling, and recycling until 2025. The Waste Management Performance Index (IKPS) evaluates policy, effectiveness, and efficiency. **Conclusion:** Waste management in Central Jakarta is still low with an index of 26% and a recycling rate of 12.6%, despite achieving 99.98% of the collaboration target. **Novelty/Originality of this article:** This study highlights the integration of formal and informal sectors in plastic waste management in Central Jakarta, emphasizing the use of the Waste Management Performance Index (IKPS) to assess policy effectiveness and recycling progress toward JAKSTRADA targets.

KEYWORDS: plastic waste; Waste Management Performance Index (IKPS); Central Jakarta.

1. Introduction

In 2015, Indonesia was declared the second-largest contributor of marine debris in the world after China, with an estimated total of 0.48–1.29 million metric tons of marine waste (Jambeck et al., 2015). Rapid development and urbanization have increased the accumulation of plastic and microplastic waste in Jakarta Bay (Takarina et al., 2022). The daily waste generated at the Emplacement Pluit in Jakarta can reach 230 m^3 or 303.6 tons, comprising food packaging, drinking cups, PET bottles, assorted packaging, plastic bags (PP), toy plastics (HDPE), metals, Styrofoam, and biodegradable waste (wood, branches, and leaves). The recycling potential of marine debris in Pluit is 67.86%, with a focus on composting and recycling PET plastics (Sari et al., 2021).

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Historically, communities have managed waste by burying, burning, or disposing of it in vacant lands, rivers, and other waterways, which eventually lead to seas, lakes, or swamps. The presence of macroplastics and microplastics in water bodies poses a serious issue (Chau et al., 2020; Cordova et al., 2020; Islam et al., 2021; Jambeck et al., 2015; Kuncoro et al., 2022). Direct disposal of waste into rivers often clogs urban drainage systems, leading to flooding, attracting rats, and spreading diseases (Schlehe & Yulianto, 2020). Additionally, the lack of facilities and community capacity to manage plastic waste contributes to environmental pollution. For instance, in rural households in Indonesia's outermost regions, limited disposal options and misconceptions about the relative importance of organic versus plastic waste often result in no waste sorting. Consequently, plastic waste is mixed with organic waste into a single pile. Although communities in these outermost regions are directly affected by plastic pollution, they continue to dispose of waste into the sea, believing their contribution to be insignificant compared to the existing waste volume (Phelan et al., 2020; Riani & Reza, 2022).

Ineffective waste management has resulted in a plastic leakage rate of up to 32% into the environment (Ellen MacArthur Foundation, 2016). Beyond packaging plastics, general plastic recycling rates are even lower. In Indonesia, 14.5% of waste is estimated to consist of plastic, including rubber and synthetic leather (World Bank Group et al., 2018). The province of DKI Jakarta has enacted Regional Regulation (Pergub) No. 108 of 2019 on Regional Policies and Strategies (JAKSTRADA) for Household Waste Management and Similar Waste. JAKSTRADA is derived from Presidential Regulation (Perpres) No. 97 of 2017 on National Policies and Strategies (JAKSTRANAS) for Household Waste Management and Similar Waste. Both JAKSTRANAS and JAKSTRADA aim to reduce plastic waste by 30% and manage up to 70% of plastic waste by 2025. These documents serve as master plans, both at the national and regional levels, with measurable and phased targets requiring collaboration from all stakeholders. The waste reduction policy, targeting a 30% reduction by 2025, includes programs such as waste generation limitation, recycling, and reuse. Meanwhile, the waste management policy, targeting 70% management by 2025, includes programs such as sorting, collection, transportation, processing, and final disposal. Achieving these ambitious targets requires the involvement and commitment of all parties, from producers upstream to downstream stakeholders, including the government, communities, and private sectors. A circular economy-based action partnership is becoming a new paradigm in plastic waste management in Indonesia. Based on this background, this study aims to evaluate the current performance of plastic waste management.

Waste is solid waste consisting of organic and inorganic materials that are no longer useful and require management to prevent environmental degradation and protect development investments (SNI 19-2454-2002, 2002). UNEP defines marine debris as solid materials discarded, transported, and accumulated in marine and coastal ecosystems (Purba et al., 2019; UNEP, 2005). As landfill capacities become increasingly limited, the government plans to reduce the amount of waste sent to landfills (Zakianis et al., 2017). These efforts involve strategies to enhance waste management and reduce the overall volume of waste. Indonesia's strategic plan to improve waste management relies on household participation to achieve a 30% reduction target through the 3R policies (reduce, reuse, recycle). With only 1.6% of households showing active participation in 3R activities—and less than 0.5% linked to plastic recycling and reuse—achieving the RPJMN targets will require significantly greater household engagement. To enhance household participation in waste sorting in developing countries without integrated waste management systems, various influencing factors must be considered. These factors include knowledge, situational aspects, government incentives, market incentives, awareness of the benefits of waste sorting, cost ratios, and the value of waste to be recycled (Rousta et al., 2020).

Waste generation is defined as the amount of waste produced by a community, measured in volume or weight per capita per day, or based on building expansion or road extension (SNI 19-2454-2002). The waste generated continues to increase in line with the rise in per capita consumption, influenced by economic growth and population numbers (Abdoli et al., 2016). Most residents are not yet accustomed to the habit of sorting waste.

Sorting waste and storing it temporarily at home until it accumulates to a certain amount is still considered unusual (Sekito et al., 2020). Currently, social awareness of the impacts of plastic pollution is growing, alongside global efforts to seek solutions. Public awareness of environmental issues and littering behavior serves as an indicator of high living condition scores (Brotosusilo & Handayani, 2020; Conlon, 2020).

Responsibility for certain stages of waste management services involves various entities. The collection and transportation of household waste to Temporary Disposal Sites (TPS) or Transfer Stations (TPST) is entrusted to local communities and organizations, such as neighborhood associations (RT/RW). Meanwhile, the transportation of waste from TPS or TPST to Final Disposal Sites (TPA) falls under the jurisdiction of local governments, which are also responsible for managing the collection and transportation of waste from public and social facilities. Government agencies, both at the national and local levels, play a crucial role as authorities in waste management. They initiate, facilitate, promote, and sustain the development of waste management material exchanges and services to ensure effective waste management systems (World Bank Group et al., 2018; Palm & Karolina, 2021).

Rivers serve as the main transportation route for plastic waste entering the ocean. Polluted rivers are the primary conveyors of plastic waste from land to sea, with the top 10 river basins (DAS) contributing 88% of plastic input to the ocean (Schmidt et al., 2017). The load and concentration of plastic in river flows are influenced by the characteristics of the river basin. Generally, urban land cover with high population density positively correlates with the high concentration of plastics entering river bodies (Kumar & Agrawal, 2020). Lebreton et al. (2017) estimated that 1.15-2.41 million tons of land-based plastic waste flow into the oceans from 122 rivers worldwide annually. Twenty of the most polluted rivers in Asia account for 74% of plastic leakage. Additionally, eight polluted rivers are located in Africa, another eight flow in South and Central America, and one river in Europe. China's Yangtze River contributes the highest plastic emissions, with a total discharge of approximately 0.33 million tons. Furthermore, rivers in Indonesia, particularly on the island of Java, significantly contribute to plastic mass flow, including the Ciliwung River (Cordova et al., 2020), the Citarum River (Honingh et al., 2020; Sembiring & Fareza, 2020), the Brantas River, the Bengawan Solo River, the Serayu River, and the Progo River. The Ciliwung River, as the most polluted river in Indonesia, flows through Jakarta, the capital and most populous city in the country. Flowing through industrial and densely populated areas, the Ciliwung River's plastic waste flow is influenced by the rainy and dry seasons. The monthly variation in waste discharge from the Ciliwung River is high in January and February, coinciding with the peak rainy season (Emmerik et al., 2019).

Urban waste refers to waste generated in cities (SNI 19-2454-2002, 2002). Urban solid waste, or municipal solid waste, is solid waste generated in urban areas. Plastic waste is a specific category of urban waste. Plastic waste collection is demonstrated through various alternative collection methods (curbside/drop-off) and separation methods (source or post-separation) (Bing et al., 2014). In Indonesia, various stakeholders, ranging from ministries to industries, are involved in urban waste management.

2. Methods

The approach employed in this study is quantitative. Additionally, a qualitative method is used to describe on-field conditions, providing support for the quantitative data. The population, or a set of data with shared characteristics, is associated with the study of circular economy-based plastic waste management. This subsection elaborates on the operational definition of the population, the target population, sample size, methods, and units of observation. The participation of the informal sector in urban solid waste management across several Asian cities, including Jakarta, serves as the livelihood foundation for those involved in this sector. This study focuses on evaluating the effectiveness of partnership performance in the interaction between plastic waste management partners, specifically in the midstream stage of urban plastic waste management. The process is divided into three stages: upstream (outstream) sources, such

as households, offices, and markets; midstream, representing the handling process; and downstream, where plastic waste is transported to final disposal sites (TPA/landfill).

The study's population consists of two groups of samples: the formal and informal sectors. The formal sector comprises institutions, agencies, or organizations officially engaged in urban plastic waste management. For the formal sector population, the study involves waste management facilities and institutions responsible for managing urban solid waste. The informal sector refers to unofficial entities managing urban solid waste, specifically in Central Jakarta. Based on data from the National Waste Management Information System (SIPSN, 2021), the informal sector in this study includes scavengers and waste collectors. Data calculations for this informal sector population use secondary data from SIPSN. The study focuses on plastic waste with economic value and high recyclability, such as plastic bottles, cups, and bottle caps.

The performance of waste management is measured using the Waste Management Performance Index (IKPS). The IKPS serves as a standard for assessing the waste management performance at both the central and local levels. It functions as an instrument for providing incentives, disincentives, and control mechanisms while encouraging continuous improvement processes (KLHK, 2020, 2021). The data analysis method used to assess the performance of plastic waste management follows the Guidelines for Calculating the Waste Management Performance Index (KLHK, 2020) and employs descriptive analysis. In this research, the analysis method for the waste management performance index utilizes secondary data from SIPSN and other accurate data sources, prioritizing government data. The analysis focuses on plastic waste generation, reduction efforts, and handling measures that have been implemented.

The waste management data available in SIPSN is general data for all types of waste. To determine the composition and percentage of waste in Central Jakarta, the researcher also uses data from the Central Statistics Agency (BPS) to analyze trends in plastic waste over three years (2020–2022). Consequently, the characteristics of waste in the Central Jakarta Administrative City can be analyzed using this data. Further data related to plastic waste is obtained from the Environmental Agency (DLH) of the DKI Jakarta Province. The achievements in plastic waste management are then compared with the Jakstrada targets. The purpose of this comparison is to identify performance levels or challenges/gaps in plastic waste management, considering that the time horizon set by Jakstrada extends until 2025. This first objective also examines the flow of plastic waste management conducted by both formal and informal sectors. The plastic waste flow in this study is derived from interviews and the analysis of available secondary data.

3. Results and Discussion

The amount of waste generated in a city is directly proportional to the level of urban activity and community activities within it. An increase in the amount of waste generated also has the potential to increase the waste disposed of in the environment (DLH DKI Jakarta Province, 2021). The characteristics of waste in DKI Jakarta and the performance of waste management are described in the following subsection.

3.1 Waste characteristics

According to the Environmental Agency of DKI Jakarta Province, the per capita waste generated by Jakarta residents is 0.7 kg per day. The daily volume of waste transported reached 7,233.82 tons in 2021. In terms of quantity, this transported waste volume decreased from the previous year, which was more than 7.5 tons. The waste volume is dominated by organic waste, totaling 3,888 tons (BPS DKI Jakarta Province, 2021; DLH DKI Jakarta Province, 2021). Based on data from SIPSN (2021), the solid waste management facilities in Kemayoran District consist of 33 waste bank units, 23 TPS 3R (Reduce, Reuse, Recycle) facilities, and 13 informal sectors managing plastic waste. Compared to other administrative cities in DKI Jakarta Province, Central Jakarta ranks second lowest in waste

generation after the Thousand Islands, with approximately 300,000 tons per year (SIPSN, 2022).

Table 1. Percentage of waste composition in DKI Jakarta Province from 2020-2022

Waste composition	Waste composition percentage in DKI Jakarta Province (%)		
	2020	2021	2022
Paper	14.92	14.92	17.24
Wood	0.87	0.87	3.18
Fabric	1.11	1.11	0.90
Rubber and synthetic leather	0.52	0.52	0.70
Plastic	14.02	14.02	22.95
Metal	1.82	1.82	1.08
Glass	2.45	2.45	1.48
Organic	53.75	53.75	49.87
Batteries	0	0	0
Others	10.54	10.54	2.60
Total	100.00	100.00	100.00

(BPS DKI Jakarta Province, 2023)

This is consistent with the lower population of Central Jakarta compared to other administrative cities, except for the Thousand Islands. From 2020 to 2022, the waste composition in DKI Jakarta was dominated by food waste, followed by paper waste and plastic waste. The data on the percentage of waste composition in DKI Jakarta Province from 2020 to 2022 is presented in Table 1. Unfortunately, the percentage of plastic waste increased from 14.02% in 2021 to 22.95% in 2022 (BPS DKI Jakarta Province, 2023). The main source of this waste composition mostly comes from household waste, followed by commercial centers and traditional markets. The waste composition by source is shown in Figure 1.

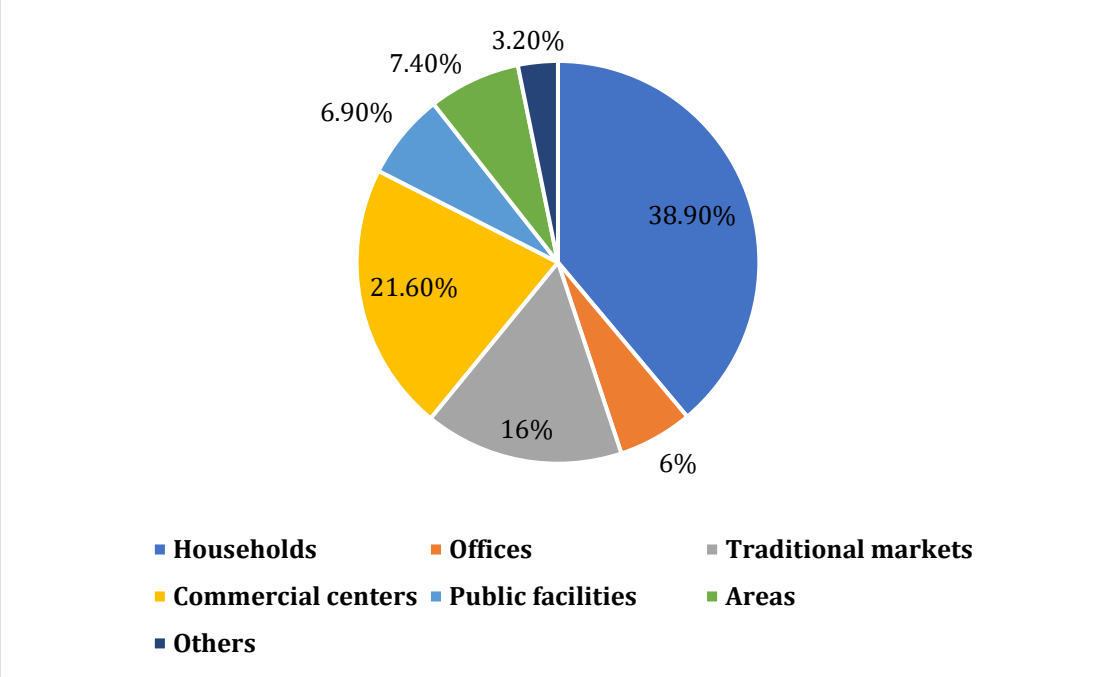

Fig. 1. Waste composition by source in DKI Jakarta Province in 2022
(SIPSN, 2023)

Waste generation undergoes a process before reaching the final disposal site. During this journey, there are still economically valuable wastes, including plastic waste, so the composition of generated waste can differ from the composition of waste entering the final processing site. In the waste management process in DKI Jakarta, both the generated waste

composition and the waste entering the Bantargebang Waste Processing and Final Disposal Site (TPST) show that organic waste, particularly food waste, is still the largest category, followed by plastic waste (Figure 2). The next category is textile waste. Paper waste has significantly decreased because it has economic value and can still be utilized. Although plastic waste has economic value, its quantity remains high at TPST Bantargebang. The lack of packaging waste management (e.g., sachets), single-use plastics such as plastic bags, and mixed waste that is not properly sorted could be the reasons for the high quantity of plastic waste at TPST Bantargebang.

In the 1987-2005 Waste Management Master Plan, it was stated that the waste generation in 1985-1986 was 4,930 tons/day. The Master Plan outlined five waste handling and disposal methods: open dumping, sanitary landfill, sea reclamation, incineration, and composting. The waste management system, initially centralized at Bantargebang, was transformed into a multi-nodal waste management system. This multi-nodal system allows for waste, including plastics, to be sorted and processed at temporary storage sites or other places like waste banks and TPS 3R (Waste Management and Recycling Stations), so that only non-recyclable waste is sent to Bantargebang. Law No. 18 of 2008 on Waste Management became the first law in Indonesia specifically addressing waste management. This law categorizes waste management based on the scope of management, namely: household waste, similar household waste, and specific waste. Waste management is further outlined in Presidential Regulation No. 97 of 2017 on the National Strategy and Policy for Household Waste Management (Jakstranas), with targets to reduce plastic waste at the source by 30% and increase plastic waste management by 70% by 2025. This strategy is then implemented at the regional level through the Regional Strategy (Jakstrada). To achieve the Jakstranas and Jakstrada targets, the Ministry of Environment and Forestry (KLHK) developed a standard instrument, the Waste Management Performance Index.

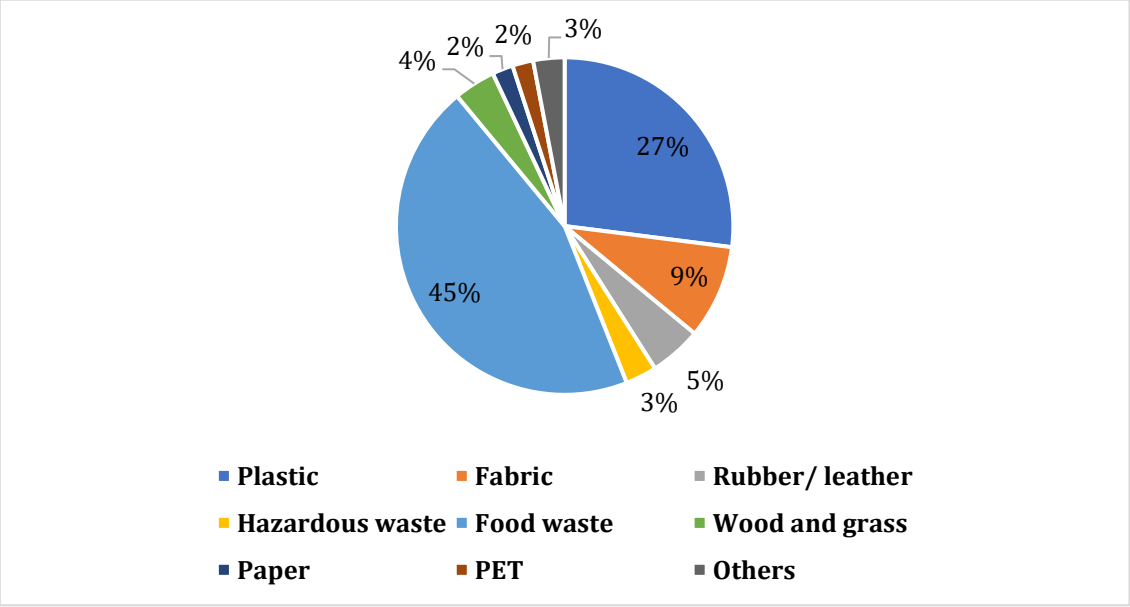

Fig. 2. Characteristics of waste at Bantargebang TPA
(SIPSN, 2023)

3.2 Plastic waste flow in Kemayoran Subdistrict, Central Jakarta Administrative City

Plastic waste management in Central Jakarta Administrative City consists of two sectors: the formal sector and the informal sector. The formal sector involves plastic waste management through partners, including government, private entities, or formal waste management facilities, such as TPS 3R (Waste Management and Recycling Stations) and Waste Banks. The flow of plastic waste in the formal and informal sectors is presented in Figure 3 below.

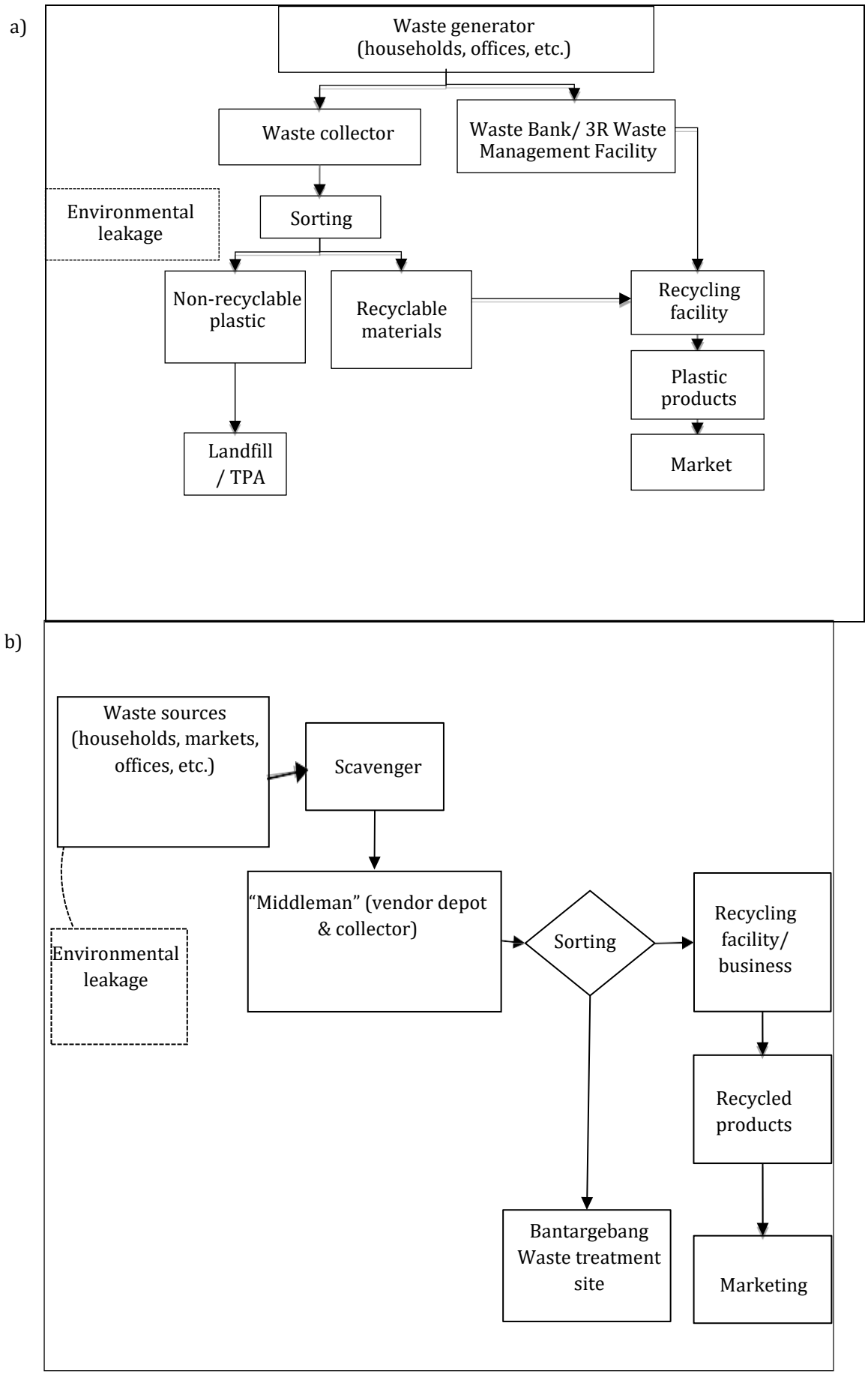

Fig. 3. Plastic waste flow: (a) Formal; (b) Informal

The formal sector in plastic waste management involves several parties, such as waste banks, TPS 3R (Waste Management and Recycling Stations), and waste processing service providers (waste collection and sorting services). These service providers may come from the private sector and are responsible for collecting the waste on a regular monthly basis from the waste sources, then sorting it into recyclable and non-recyclable materials. Materials that cannot be recycled are considered to have no economic value and are transported to the Integrated Waste Processing Site (TPST) Bantar Gebang. Recyclable materials are sent to recycling facilities, which are typically plastic processing companies located outside Jakarta, such as in Tangerang, Banten Province. The informal sector, in addition to influencing the level of plastic waste collection, also reaches places that are not facilitated by the formal sector. The informal sector collects plastic waste to prevent it from being discarded and polluting the environment.

The waste is then collected by street vendors (pelapak) and waste collectors (pengepul). These vendors and collectors consist of small vendors (also known as small stalls) who generally sell the collected waste with economic value to larger vendors/collectors. The larger vendors, which serve as the main hubs for small vendors, are typically located in Sunter, North Jakarta. However, some vendors and collectors have also established cooperative agreements for plastic waste transactions with other partners, including both larger vendors and recycling facilities/companies. The waste collected by the vendors and collectors is weighed and then sorted. Some larger vendors that have pressing machines will compress the plastic waste. Several partners work with the Central Jakarta Environmental Agency (Sudin LH), such as the TPS 3R Kemayoran, which sends the collected waste to Sudin LH. Vendors and collectors have generally established transactional relationships with other parties, both at the input and output levels.

The input partners (often referred to as lower partners) are sources of plastic waste, such as scavengers or small businesses that generate waste with economic value. The upper partners are recycling facilities/companies that act as buyers of the sorted, weighed, cleaned, and often compressed/plastic waste. These upper partners generally set the prices for various types of plastic waste. Plastic waste dominates all of the stalls that were interviewed, while other economically valuable waste types, such as paper, metal, electronics, and glass, are less common. Plastic waste is the most easily found material, easy to collect, and lightweight, although its price per kilogram is much lower than that of metal waste. The profit from the large quantity of plastic waste collected is used to fund the operational costs of the stalls, such as worker wages.

3.3 Waste management performance index

Jakstrada has set targets for waste reduction and management until 2025. In Jakstrada, there are projections for waste generation, as well as targets for waste reduction and management. Strategies for waste reduction and management include strengthening the commitment of both the central and regional governments in providing budgets, improving leadership capacity, institutional capacity, and human resources, establishing information systems, and strengthening the commitment of the business community (Governor Regulation of the Special Capital Region of Jakarta No. 108 of 2019 on the Policy and Strategy of the Special Capital Region of Jakarta in Household and Similar Household Waste Management/Jakstrada, 2019). The indicators and target achievements of Jakstrada are presented in Table 2.

Table 2. Jakstrada achievement targets for Central Jakarta Administrative City

Indicators	Target 2018	2019	2020	2021	2022	2023	2024	2025
Projection of plastic waste generation (Hundreds of thousands of tons/year)	3.06	3.07	3.08	3.09	3.10	3.11	3.12	3.13
Target for waste	55.16	61.47	67.83	74.23	80.67	84.03	87.42	93.96

Reduction (thousands of tons/year)	(18%)	(20%)	(22%)	(24%)	(26%)	(27%)	(28%)	(30%)
Target for waste management (hundreds of thousands of tons/year)	223.7 (73%)	245.9 (80%)	231.2 (75%)	228.9 (74%)	226.5 (73%)	224.1 (72%)	221.7 (71%)	219.2 (70%)

(Governor Regulation of the Special Capital Region of Jakarta No. 108 of 2019 on the Policy and Strategy of the Special Capital Region of Jakarta in Household and Similar Household Waste Management, 2019)

The Waste Management Performance Index (IKPS) is a key performance indicator for KLHK from 2020 to 2024. Waste management performance is defined as the comparison between the results and the targets to be achieved in the waste management system. The aspects evaluated in the IKPS include policy, institutional, financing, technical aspects, and community participation (KLHK, 2020). This index serves as a standard instrument for assessing waste management performance comprehensively, both at the central and regional levels. The results of this assessment can be compared between regions and facilitate the government in providing incentives (rewards) or disincentives (punishments). In addition to being an instrument for managing waste, the IKPS also aims to be a reference for the government to account for the achievement of waste management to the public. The quality of services in waste management becomes a measure of public satisfaction. The IKPS assessment criteria consist of two variables, namely governance and effectiveness & efficiency (KLHK, 2020, 2021). The assessment will be calculated with the final result in the form of points with a maximum score of 100. The IKPS formulation is presented in Table 3.

Table 3. Waste management performance index formulation for plastic

Variable	Parameter	Indicator	Maximum value	Total weight	Final value
Governance	Input	Policy	100	15%	15
		Human resources	100	5%	5
		Facilities and infrastructure	100	5%	5
		Budget	100	5%	5
	Process	Socialization and understanding	100	5%	5
		Acceptance and implementation	100	5%	5
Effectiveness and efficiency	Output	Achievement ratio against target and capacity	100	20%	20
		Budget efficiency (Ratio of incremental achievement and target per budget class)	100	20%	20
	Outcome	Clean city	100	10%	10
	Impact	Water Quality Index (IKA), a component of the Environmental Quality Index (IKLH)	100	10%	10

(KLHK, 2020)

Governance refers to the aspect of planning, regulating, and managing resources for plastic waste management. Resource management in this context involves managing inputs and processes. Inputs in waste management include policies, human resources, facilities and infrastructure, and budgeting. In this case, the policies are Jakstranas (National Waste

Strategy) and Jakstrada (Jakarta Waste Management Strategy). From these inputs, the process stage follows, which includes socialization and understanding, acceptance, and implementation. Effectiveness and efficiency consist of output, outcome, and impact. Output refers to the achievement of waste management (measured by the ratio of waste management targets to waste management achievements). Budget efficiency is also measured in this output, with the parameter being the ratio of improved waste management achievements to the target of waste management improvements, divided by the waste management budget class. The outcome in this variable is a clean city. A clean city serves as a parameter to measure participation in the Adipura (clean city) award. The impact refers to environmental quality. Environmental quality includes soil, water, and air parameters, with a particular focus on the Water Quality Index (IKA), as water is the most susceptible to contamination from waste (KLHK, 2020).

The calculation of IKPS (Waste Management Performance Index) results in the performance achievements of waste management, including the reduction and handling of household waste and similar waste. The waste management performance achievements in the Administrative City of Jakarta in 2022 are presented in Table 4. The Administrative City of Central Jakarta successfully managed 99.98% of the total waste generation, but the reduction rate only reached 26%. When compared to other regencies and cities in DKI Jakarta Province, the waste reduction rate in Central Jakarta is the lowest. Furthermore, the recycling rate is still low at 12.64%, slightly below the prediction by the Ellen MacArthur Foundation, which is 14% (Ellen MacArthur Foundation, 2016; SIPSN, 2023).

Table 4. Waste management performance achievements in Central Jakarta Administrative City in 2022

Aspect	Description	Achievement	Unit
Waste generation	Waste generation (A)	310,268.53	ton/year
Waste reduction	Annual waste reduction (ton/year) (B)	81,033.83	ton/year
	Waste reduction percentage (B/A) (%)	26.12	%
Waste management	Annual waste management (ton/year) (C)	229,159.32	ton/year
	Waste management percentage (C/A)	73.86	%
Managed waste	Annual managed waste (ton/year) (B+C)	310,193.15	ton/year
	Managed waste percentage (B+C)/A	99.98	%
Recycling rate	Annual recycling of waste (ton/year) (D)	39,212.13	ton/year
	Annual waste raw material (ton/year) (E)	0.14	%
	Recycling rate (D+E)/A	12.64	%

(SIPSN, 2023)

The still-low recycling rate must be a focus in plastic waste management to protect the environment, human health, and nature, as well as to enhance the economic potential within it. In focusing on this recycling program, other processes will follow, such as the process of collecting plastic waste, which will improve the collecting rate and involve many parties. The more parties involved, the higher the amount of plastic waste collected. Furthermore, involving many parties can increase positive perspectives and awareness of the importance of sustainable plastic waste management (Bianchini & Rossi, 2021). Indonesia, although the second-largest contributor to plastic waste after China, does not necessarily have a high plastic consumption rate. Although 16% of plastic waste in the oceans comes from Indonesia, the per capita plastic consumption in Indonesia is still below that of developed countries. The per capita plastic consumption in Indonesia is around 9 million kg per day. This figure is far below Singapore's plastic consumption, which is over 75 million kg per day (Minderoo Foundation, 2016; Purparisa, 2019). However, plastic waste management in Indonesia remains low, which also affects the low Environmental Performance Index (EPI) (Mutia, 2022).

The low recycling and reduction rates of plastic waste can be attributed to several factors, such as weak law enforcement, inadequate waste management budget allocation, lack of easily understandable guidelines for the general public, and insufficient infrastructure. Regarding laws and regulations, Indonesia has the Jakstranas and Jakstrada,

which serve as guidelines for both the central and regional governments to take strategic actions. Policies can have cross-border impacts, but local actions are also necessary, requiring a combination of global and local policy efforts. According to Alpizar et al. (2020), who conducted research on policy design to reduce plastic waste in developing countries, there are four types of policy instruments in waste management: price-based instruments, which change the relative price of plastic-related goods or inputs, such as by imposing taxes or subsidies on alternative goods, less-polluting products, or inputs; rights-based instruments, which determine the total allowed quantity of pollution and permit pollution rights trading to minimize pollution reduction costs; regulation, which directly determines the allowed pollution level; and behavioral instruments, which use public preferences or cognitive limitations to influence behavior and reduce pollution.

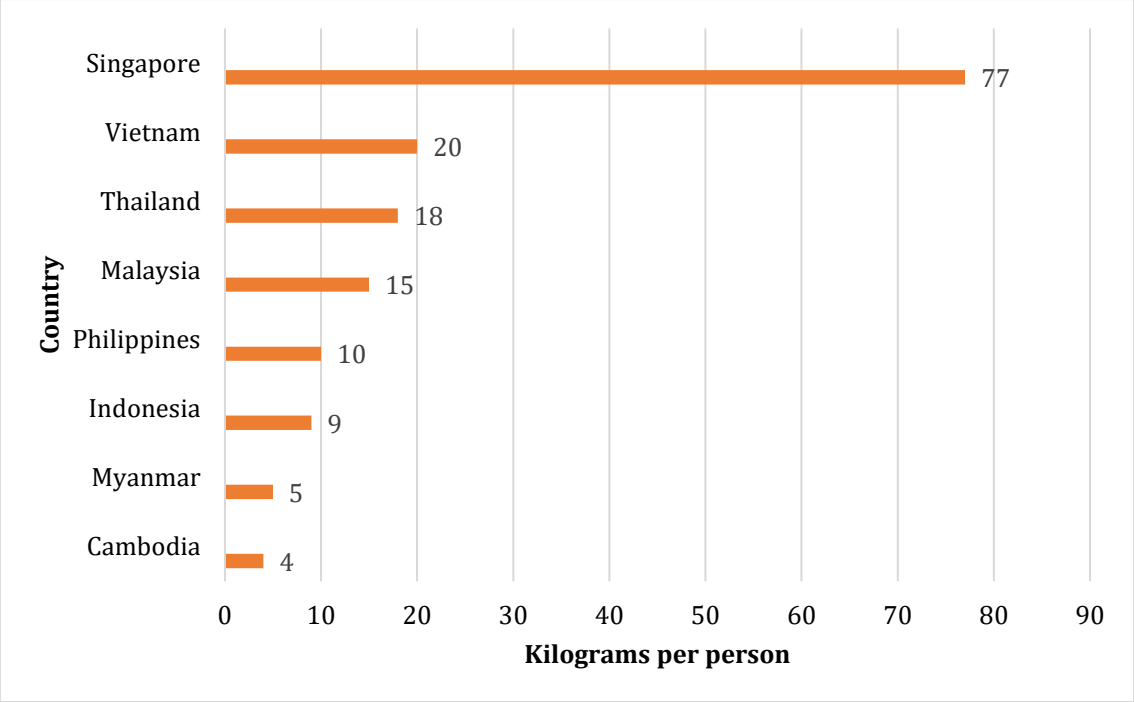

Fig. 4. Per capita single-use plastic consumption in Southeast Asia 2019
(Mutia, 2022; Purparisa, 2019)

Policy design can help reduce plastic waste pollution in the ocean. The implementation of policies and law enforcement related to single-use plastic bans, for example, can be reflected in the Caribbean Islands. Indonesia and the Caribbean are both archipelagic nations facing plastic waste problems in the ocean, most of which originate from "leakage" of plastic waste from land environments. The Caribbean is an archipelago with important ecosystem services, as it is a major tourist destination offering sand, sun, and sea. About 15.5% of the Caribbean's Gross Domestic Product (GDP) comes from tourism, which also employs 14% of the workforce (Clayton et al., 2021). Unfortunately, this sector has failed to raise awareness about the dependence on marine environmental quality, and that ocean waste not only affects the marine environment, coastal areas, and biodiversity but also impacts the local economy. Some beaches are filled with plastic waste due to weak policies and inadequate waste management practices (Acosta-Coley et al., 2019), with the Caribbean region being ranked among the top 10 countries contributing to per capita plastic waste (Clayton et al., 2021). In the Caribbean, local government focus is on individuals: policies, regulations, and laws to reduce single-use plastic waste (e.g., banning the production and use of plastic bags); market-based instruments (e.g., charges on single-use plastics) to minimize waste; and penalties for non-compliance. Legislative policies have been implemented in ten countries, which now have national strategies. Currently, 11 Caribbean countries have implemented national single-use plastic bans, including bans on plastic bags and styrofoam.

Some successes in the Caribbean include a 15.1% reduction in plastic waste in Barbuda and Antigua. In 2016, Antigua and Barbuda became the first Caribbean nation to successfully implement a ban on the import and use of single-use plastic bags commonly used for shopping. In Jamaica, regulations are enforced with fines for using single-use plastics, and in return, there are subsidies for using reusable alternatives (Clayton et al., 2021). Awareness campaigns are used to educate the public about the reasons behind the shift and to instill a sense of commitment. Moreover, after the ban was enacted, the public was given incentives to switch to reusable and biodegradable alternatives.

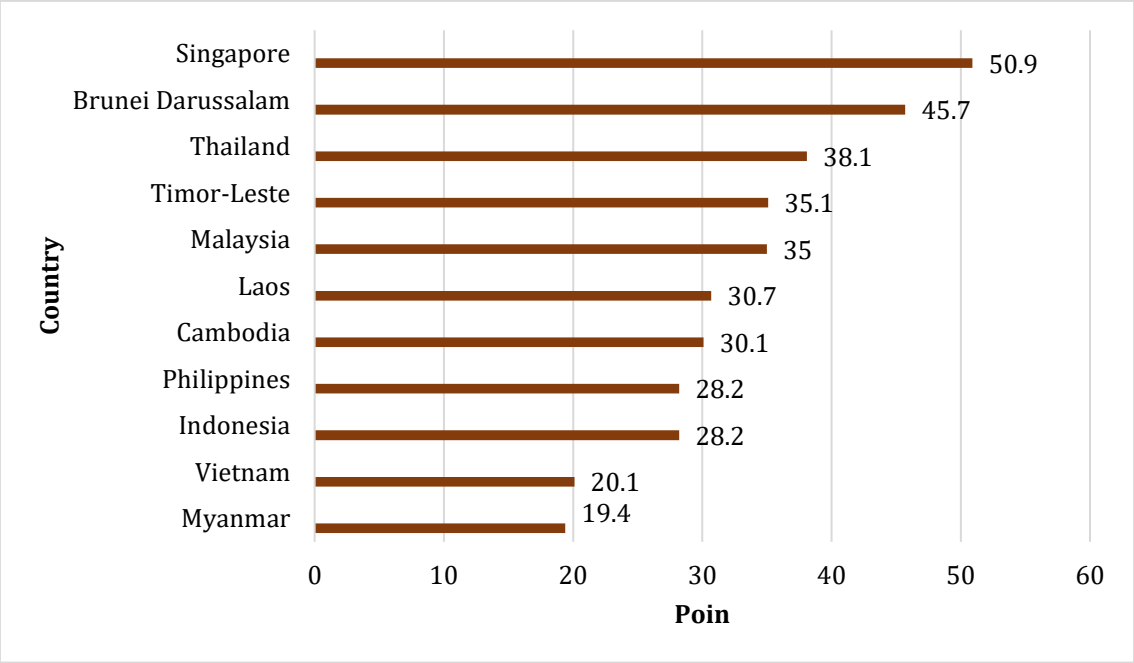

Fig. 5. The environmental performance index 2022
(Mutia, 2022; Purparisa, 2019)

Indonesia can adapt the UNEP guidelines (2018), originally aimed at Caribbean nations. The adaptation of these guidelines can be implemented by first assessing the initial condition of a region (at the provincial, district/city level) to evaluate possible policy actions. This requires mapping or creating a regulatory matrix for each region to determine whether the existing regulations meet the prerequisites or if new regulations are needed. The next step is to assess the sustainable development impact of various possible options. To initiate this phase, preparations involving stakeholders, public awareness activities (e.g., education, campaigns, and socialization), creating incentive policies for industries, and developing environmental programs aligned with international environmental programs are necessary.

The implementation of Jakstranas, Jakstrada, and Plastics Smart City (PSC) in Jakarta can be carried out effectively through an urban solid waste management approach. This concept has four basic principles: equity, meaning all citizens are entitled to an appropriate waste management system for environmental health reasons; effectiveness, meaning the waste management model applied should aim for safe waste disposal; efficiency, meaning waste management should maximize benefits, minimize costs and resource use, and lead to sustainability, equity, and effectiveness; and sustainability, meaning the waste management system should be suitable for local conditions and feasible technically, environmentally, socially, economically, financially, and from an institutional and political perspective (Klundert & Anschütz, 2001). To achieve Jakstranas goals, plastic waste management cannot be carried out with a business-as-usual (BAU) scheme. The BAU scheme will only increase the amount of plastic waste in the ocean. The circular economy paradigm is increasingly popular among researchers as a new approach to plastic waste management that sees value in plastic waste and restructures the linear supply chain to work in a

continuous cycle (Dijkstra et al., 2020; Payne et al., 2019). The Circular Economy model focuses on reuse, remanufacturing, and repair, which uses less energy and resources, making it more economical (Korhonen et al., 2018).

4. Conclusions

The performance in waste management in Central Jakarta Administrative City has not yet been able to reduce waste, as evidenced by the index score of 26% and a recycling rate of 12.6%. Despite the government issuing regulations on the ban of single-use plastics, the amount of plastic has actually tended to increase from 2021 to 2022. On the other hand, Central Jakarta Administrative City has been able to manage waste by involving partners for collaborative work, resulting in waste management achieving the Jakstranas and Jakstrada targets, with an index of 99.98%.

The management and reduction of plastic waste entail substantial costs, encompassing not only the technical aspects of waste treatment but also the pursuit of economic value generation from waste processing. Such value can be reinvested as capital for marketing activities or alternative waste management initiatives. An economy-oriented approach may therefore serve as a strategic pathway to accelerate the transition toward a circular economy, thereby fostering the advancement of sustainable development goals in Indonesia.

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Author Contribution
Both authors collaboratively contributed to the conception, design, data collection, analysis, and interpretation, as well as drafting, revising, and finalizing the manuscript.

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