CIRCULAR ECONOMY POTENTIAL OF PLASTIC WASTE IN TARAKAN CITY: CHALLENGES AND OPPORTUNITIES

Hairunisa[1], Ahyahudin Sodri[2], Wahyu Purwanta[3]
hairunisaJA@gmail.com[1], ahyahudin.sodri@ui.ac.id[2], purwantowahyu012@gmail.com[3]
Universitas Indonesia[12], Badan Riset dan Inovasi Nasional[3]

ABSTRACT

The Circular Economy is one of the sustainable development strategies that are being implemented to overcome the problem of environmental degradation and resource scarcity. The circular principle of economics is 3R to reduce, reuse, and recycle materials. The principle describes a circular system in which all materials are recycled and produced products, activities support and rebuild ecosystems support public health, and have resources used to generate economic value. This research is a literature review, field observation, and in-depth interviews with several stakeholders closely related to waste management issues in Tarakan City, especially about the circular economy of plastic waste into renewable energy alternatives that include current concepts and practices, and assess the extent to which its implementation has an impact on local communities. This review also serves as an assessment of the design, implementation, and effectiveness of policies related to plastic waste. This article attempts to identify the challenges and opportunities underlying the circular plastic waste economy. Conclusions on the current circular development of the plastic waste economy and provide policy advice for its future development and achieving sustainable development.

Keywords: *circular economy; plastic waste; sustainable development; waste management; Tarakan City.*

INTRODUCTION

The waste problem is still a challenge for most regions in Indonesia, especially related to waste management in the Final Processing Site (TPA). Based on recorded data, there are approximately 250 landfills scattered throughout Indonesia, but not all landfills have a good waste management system according to current regulations and legislation. (KLHK, 2016; KLHK et al., 2021). Good waste management involves all components in an area, including legal aspects or policies implemented by an area, existing institutional cooperation, adequate budget, technical operations, and participation from the community itself, so that the management system implemented will be sustainable. (Hadiwardoyo et al., 2020; Nizar et al., 2016; Rosana, 2018). This can be seen in the quality of the Aki Babu Landfill in Tarakan City which is getting worse because it is no longer able to accommodate the waste generated by the community. Waste management through waste depots, TPS3R, and communities in Tarakan City is expected to reduce waste disposed of in landfills (DLH Kota Tarakan, 2021).

The increase in population is accompanied by the growth of small and medium enterprises in Tarakan City which ultimately has an environmental impact, one of which is the generation of plastic waste generated from the economic activities of these business actors. (Thaha et al., 2014; Bappeda Kota Tarakan, 2019; DLH Kota Tarakan, 2021). At this stage, the participation of all parties is needed, especially government policies that can involve Regional-Owned Enterprises (BUMD) and State-Owned Enterprises (BUMN) through funding and increasing the capacity of human resources that can open circular economy opportunities in plastic waste by reducing waste at the point where the product is distributed to the process of recycling it is the best way to stop the wave of increasing waste production at all levels. This article discusses the opportunities and challenges of implementing a circular economy of plastic waste on a small island in managing the sustainability of its natural environment.

Circular Economy and its implementation

In the 1990s, various opinions in European countries regarding the changes taking place in the relationship between the state and the market, or the state and civil society, as well as actions taken for realignment influenced the future development path. Through processes and patterns of fundamental realignment between the state, civil society, and the market in an integrated manner as it relates to the provision of basic services such as water, sanitation, and solid waste management have been considered by the state to be the responsibility of local or national governments. In the last twenty years, various debates have continued to take place, where the government should also be part of the realignment between the state, the private sector, and civil society organizations. (Yamaguchi et al., 2012). Various environmental problems, such as loss of biodiversity, water, air, and soil pollution, resource depletion, and excessive land use are increasingly jeopardizing the life support system on Earth. (Tun et al., 2020). People's expectations are not being met due to issues such as high unemployment, poor working conditions, social vulnerability, poverty traps, intergenerational equity, and widening inequality caused by these environmental problems. Economic challenges, such as energy and food supply risks, problematic land tenure structures, deregulated stock markets, and flawed incentive structures are causing financial and economic instability that companies, individuals, and entire economies are increasingly facing. To address these and other sustainability issues, the concept of a circular economy (Circular Economy) is needed.

In 1990 D. W. Pearce and R.K. Turner who are environmentalists from the UK put forward the concept of a circular economy, they explained that the traditional economy was developed by not building a tendency to recycle and treating the environment as a waste repository. (Su et al., 2013). According to Boulding (1966) who stated that the economy and the environment are not characterized by a linear linkage, but by a circular relationship, To achieve a win-win situation or a win-win solution for the economy and the environment, they proposed a materially closed loop in the economy.

According to some economists, the circular economy is described as one that does not have a net effect on the environment but rather restores the damage done in acquiring resources and monitoring the waste generated during the production process. (Murray et al., 2017). The word circular means descriptively, circular economy is described as a process related to the concept of cycles, namely biogeochemical cycles and the idea of product recycling.

According to Murray (2017), Product recycling is an important process in the implementation of the circular economy and plays an important role in the process of sustainable development. The Circular Economy is often associated with resource cycling and has been developed within the scope of industry and the symbiotic relationship between companies in using the waste they produce as a resource. The goal of the circular economy in the service economy is that the work done by a company is done to slow down the cycle of use and delay waste output. This is expected to increase the product lifetime through better manufacturing and maintenance so that the replacement rate decreases and resource use decreases, and the 3Rs concept is key to the implementation of the circular economy.

The origin of the term Circular Economy is still debated to this day. As early as 1848, R.W. Hofman, the first President of the Royal Society of Chemistry stated that the better factories are, the better they utilize their waste, the closer the company gets to its goal, and the greater the profit they make. (Murray et al., 2017). Many scholars argue that Kenneth Boulding (1966) was the first originator when he wrote about how Humans must find their place in the ecological cycle system to be able to reproduce material forms continuously even though humans are never separated from the energy input process. (Liu et al., 2021).

The circular economy model began to be implemented in China in 2002, as it was considered capable of addressing environmental and resource management issues. In addition, the circular economy in China was able to achieve eco-efficiency and increased resource productivity as well as overcoming the environmental degradation that was largely the result of economic industrialization. (Geng & Doberstein, 2008). Several countries have introduced legislation to establish circular economy recycling principles. This is accompanied by the enactment of the Closed Substance Cycle and Waste Management Act. The Act provides a framework for implementing closed-cycle waste management and ensuring environmentally appropriate waste disposal and assimilation waste capacity. (Heshmati, 2015). According to Wang in 2014, the circular economy in China is adapted from the concept of Germany, Sweden, and Japan which have a desire to form a more closed society with an economic system that can and must operate according to the material and energy cycle principles that encourage natural systems that have the nature of self-sustaining ecosystems through the recycling of materials and energy. (Geng et al., 2009; Geng & Doberstein, 2008).

The most famous definition was put forward by the Ellen MacArthur Foundation (Tun et al., 2020), which describes the Circular Economy as a restorative or regenerative industrial economy with intentions and designs that aim to keep products, components, and materials at their highest utility and value at all times. It can be concluded that the Circular economy is a circular (closed) flow of materials and the use of raw materials and energy through various phases. The Circular Economy is a regenerative system in which resource inputs and waste, emissions, and energy leakage are minimized by slowing, closing, and narrowing the material and energy loop. This can be achieved through durable design, maintenance, repair, reuse, remanufacture, refurbishment, and recycling. Many experts researching the circular economy emphasize the importance of better integrating environmental and social aspects with economic progress and setting system-level change at its core. Sustainable development is more open-ended than the circular economy and is used to justify various institutional commitments and characterize a broader set of risks and opportunities. (Brundtland & Khalid, 1987). Brundtland's (1987) definition of sustainable development is widely accepted as a concept of development that meets the needs of the present without compromising the ability of future generations to meet their needs.

A report issued by UNEP in 2006 explained that the circular economy originated from two interconnected concepts, namely closed-loop economy and design to re-design thinking. Based on these concepts, some of the elements contained in the circular economy include low energy consumption, low pollutant emissions, and high efficiency. (Kementerian Lingkungan Hidup dan Kehutanan, 2020). A general term used to explain the definition of a circular economy for an industrial economy that aims to redesign or restorative material flows that are divided into two cycles, one is biological nutrition designed so that production flows that enter back into the biosphere are safe and the other is technical nutrition designed so that production flows circulate with high quality without entering the biosphere. The goal of this concept is to design waste to restore nutrients and recycle goods to make them last longer, and to use renewable energy to drive the economy.

Circular economy is a concept that describes systems, economics, values, production, and consumption that lead to sustainable economic, environmental, and societal development. (Chen & Huang, 2007; Tejaswini et al., 2022). This approach aims to achieve economic growth while avoiding natural resource depletion and environmental degradation. (Geng et al., 2009, 2012; Luo et al., 2010). The concept of circular economy can be defined as a process that includes all activities that seek to reduce, reuse, and recycle materials in the process of production, distribution, and consumption by explaining that circular

economy is a model of economic development based on ecological cycles with compliance with ecological laws and resource utilization. (Zhijun & Nai-ling, 2007). The circular economy also explains that there is a feedback process from resources to products and renewable resources to achieve the ultimate goal of optimal production, optimal consumption, and minimizing waste in production. The main focus of the circular economy is on improving resource productivity and eco-efficiency, as well as implementing reduce, reuse, recycle, and recover known as the 4Rs. (McDowall et al., 2017; Zhijun & Nai-ling, 2007).

The circular economy is one of the priorities of the Government of Indonesia as an effort to improve the quality of waste management that enters the environment by optimizing restoration value. According to the Ministry of Environment and Forestry (2021), an upstream-to-downstream approach is very important so that synergy can be carried out by stakeholders. Coordination and cross-sectoral involvement is one of the strategic steps to achieve common goals in environmental management. There are 6 main pillars in implementing circular economy according to KLHK (2021), namely the existence of recycling technology, the establishment of waste banks, TPS3R, the existence of recycling centers, the participation of the informal sector (scavengers and vendors), and social entrepreneurs.

Waste management in Indonesia

Waste is one of the environmental problems that has always been a concern. Increasingly, the waste problem is getting more complex, especially regarding the implementation of management carried out by the government. The increasing quantity of waste generation, the increasingly varied composition of waste, limited funds in the management of public services, and the increasing economic activities in society are a series of waste problems that exist today. The increasing population growth makes the diversity in society also wider, such as social activities, economic activities, and lifestyle. This leads to the emergence of new problems in society related to facilities and infrastructure in an area, one of which is waste. (Damanhuri & Padmi, 2019). Population growth is directly proportional to the increase in waste generation in the community. The amount and composition of waste generation can be seen from the consumption patterns of the community itself. (Damanhuri & Padmi, 2019).

Waste management that used to have a collect, transport, dispose paradigm is now viewing waste as an economically valuable raw material. The circular economy aims to preserve the value of products, materials, and resources for as long as possible by returning them to the product cycle at the end of their use, and minimizing the generation of waste, whether using a centralized or decentralized waste management system. (KLHK et al., 2021; Mulasari et al., 2014). Based on BPS Susenas data in 2016, the level of waste management achievements that have been realized is 59.08% in the handling process and 1.55% in the waste reduction process. Meanwhile, in the RPJMN 2020-2024, it has been mandated that waste management is 100%, where the division is 80% for waste handling and 20% for waste reduction. To achieve this goal, synergy and collaboration from various stakeholders are needed, from the government to the community. The role of the government is from preparing regulations that become a reference in waste management both at the national and regional levels to the provision of waste management infrastructure. (KLHK et al., 2021).

Much research on municipal solid waste management (SWM) has also been conducted in developing countries based on two main issues: concern for the increasing complexity and cost of waste management, which is proving difficult to manage efficiently and effectively by local governments, and concern for the environmental impact of growing waste streams. The latter perspective covers three areas: issues for environmental health or

public health, health and safety hazards for those working with solid waste, and sustainable development issues in terms of resource recovery and recycling of waste materials. (Yamaguchi et al., 2012). Waste is the result of consumption and production processes accompanied by the need to manage it, reduce its amount, and avoid pollution problems that lead to public health problems and or environmental damage. (Sabata et al., 2005). Countries in Asia and Europe are the continents that produce the most waste in the world, accounting for 22% of the total waste produced that year. (Damanhuri & Padmi, 2019). Based on the data, the largest contributing source of waste in Indonesia is household waste, which is 32.48% followed by market waste at 20.86%. from this data, it can be concluded that the largest contributor to waste is the type of organic waste. Inorganic waste is waste or waste that is not easily rotten and decomposed, such as plastic food wrapping containers, paper, plastic toys, bottles and glasses of drinks, cans, and wood. (SIPSN, 2020).

Law No. 18/2018 regulates waste management in Indonesia, which aims to improve public health and environmental quality and make waste a resource. Waste management is explained as a systematic, comprehensive, and sustainable activity that includes waste reduction and handling. There are 3 (three) types of landfill operations in Indonesia (Damanhuri & Padmi, 2019), which are Open Dumping, Controlled Landfills, and Sanitary Landfills. In Indonesia, it is recorded that 57% of landfills use a control system in their management (SIPSN, 2020), where waste is stockpiled with a layer of soil every 7 days to improve land use efficiency and landfill surface stability, then flattening and compaction of waste is carried out.

Good waste management involves all components in an area. Based on the condition of waste management in Indonesia, there are fundamental issues that become important problems (KLHK et al., 2021), among others:

1. Low level of government capacity in waste management issues.
2. Low level of public awareness of waste issues.
3. The trend of plastic waste composition mixed with other waste.
4. Lack of law enforcement related to violations in waste management.
5. Lack of role and responsibility of producers of goods and services related to environmental issues.

Municipal waste management currently carried out by local governments usually involves the collection of domestic solid waste, either through door-to-door or neighborhood collection, transportation at temporary disposal sites (TPS), and disposal at landfills. A more environmentally-oriented view of municipal plastic waste management includes reuse, recycling, and recovery activities, and waste disposal which is considered more environmentally friendly.

Various studies have been conducted on waste, contributing to the management of both organic and inorganic waste. There is an Integrated Sustainable Waste Management (ISWM) model that describes 3 important integrated elements (Kuncoro sejati, 2013; Parente & Usp, 2016), That is:

1. stakeholders or stakeholders involved in waste management;
2. the flow of waste disposal, starting from the point of waste generation (upstream) to final treatment or disposal (downstream); and
3. the perception of the stakeholders who undergo this management process.

Waste management that is carried out from source to landfill with the generation & separation, collection & transfer, treatment, recycling, and final disposal method is considered insufficient. It requires a supportive environment and stakeholder involvement to be able to influence each other so that all existing elements play an important role in providing results in integrated waste management. A good waste management system must

have 5 important aspects in achieving community welfare, improving environmental quality, and making waste a resource. (Lestari et al., 2019; Nadia, 2020), That is:

1. Legal aspects, there is a legal basis that serves as a reference in implementing waste management at various levels.
2. Institutionalization is a forum that has responsibility for technical assistance related to existing waste management.
3. Financing is one of the important elements expected to improve the quality of waste management infrastructure and also increase the capacity of human resources.
4. Technology, namely various innovations developed to reduce waste disposal.
5. Socio-cultural, i.e. public awareness to participate in waste management.

The involvement of various parties in waste management is expected to provide economic value to the waste generated by the community. Collaboration plays an important role in developing integrated waste management. This is an alternative scenario provided to policymakers, community-based organizations, and local public agencies as well as private companies. Stakeholder engagement shows the types of contributions that can be made across a range of activities toward greener development.

Waste Management Policy in Indonesia

The National Policy and Strategy (Jakstranas) has officially been enacted for the period 2017-2025, this is because the policy is in line with the National Long-Term Development Plan (RPJPN) and the National Medium-Term Development Plan (RPJMN). The policy direction contained in Jakstranas is aimed at waste management which includes activities to reduce waste by 30% and handle Household Waste and household-specific waste by 70%. (KLHK, 2017; Nadia, 2020).

Waste reduction as stipulated in the Jakstranas 2017-2025 is carried out by limiting waste generation, recycling waste, and reusing existing waste. Meanwhile, waste handling is carried out by sorting, collecting, transporting, processing, and final processing. With the enactment of Presidential Regulation number 97 of 2017 regarding Jakstranas, Article 16 states that governors, regents, and mayors are obliged to follow up on Jakstranas by compiling and stipulating Regional Policies and Strategies (Jakstrada) for provincial waste management (no later than six months after Jakstranas takes effect) and district or city waste management Jakstrada (no later than one year after Jakstranas takes effect). However, until now there are still many local governments that have not completed the formulation of their Jakstrada. As a result, the implementation of waste management by Jakstranas has not yet been realized.

Based on Law No. 18/2008 on Waste Management, the authority to implement waste management is almost entirely under the responsibility of local governments (District/City). The local government as the spearhead of waste management is expected to be able to immediately improve its role and capacity as an institution responsible for carrying out law enforcement and technical assistance to the community. Regulatory and policy arrangements must continue to be developed in Indonesia, considering that most of the waste in this country is still not properly sorted. This is due to the lack of recycling industry spread in various regions. So that the output generated from this is the creation of a roadmap for the fulfillment of raw materials for the domestic recycling industry. (KLHK, Kementerian PUPR, & Yayasan Dana Mitra Lingkungan, 2021).

Several important things must be done regarding waste management, The first is to limit, which requires factors that encourage massive behavioral changes in society, thus encouraging local governments to prepare regulations, for example, policies related to the use of plastic bags. The second is a circular economy that processes waste as raw material. In realizing this, it is necessary to build a complete ecosystem from upstream to downstream:

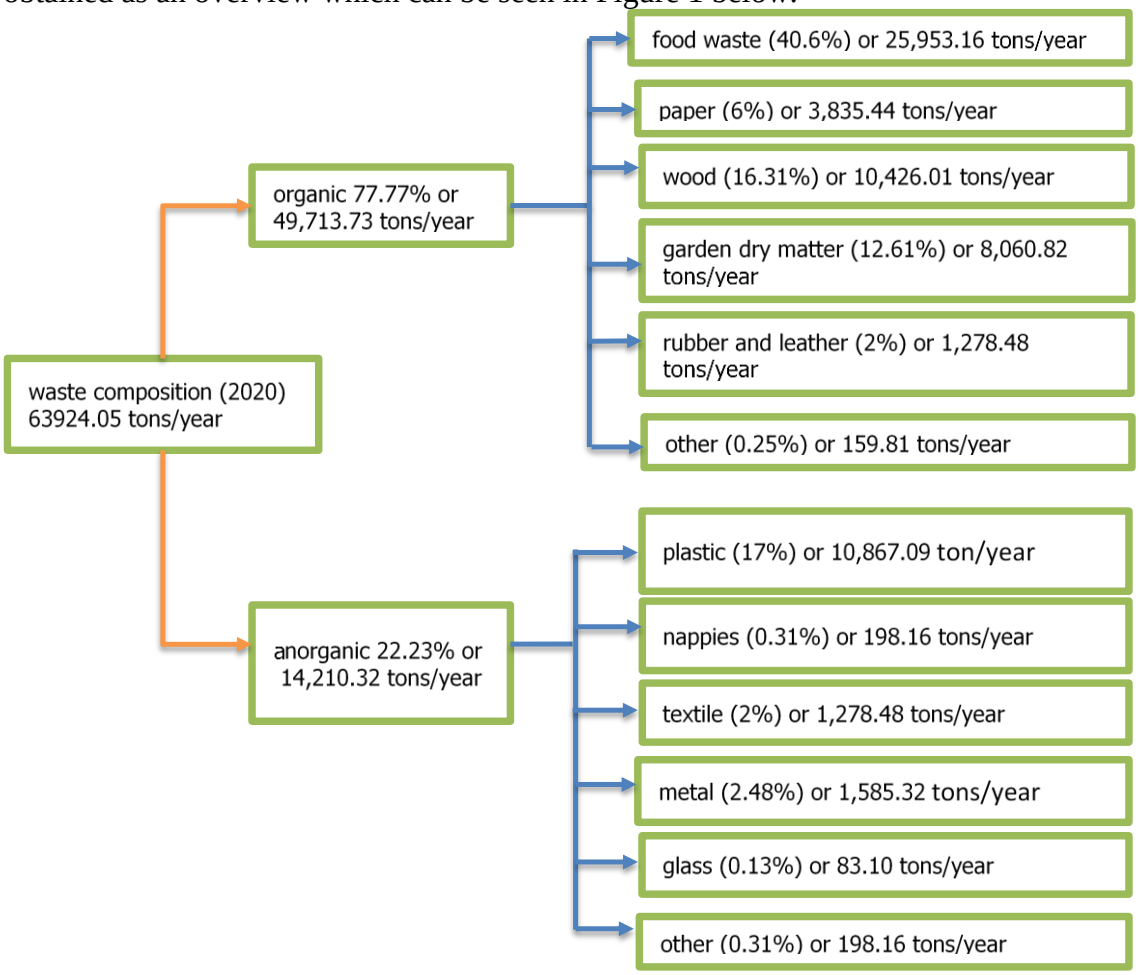
starting from producers carrying out their responsibilities, the community sorting, and collecting systems (waste banks, TPS3R, social entrepreneurs, informal sector, startup business, recycling industry), to returning to the industry (KLHK, Kementerian PUPR, & Yayasan Dana Mitra Lingkungan, 2021).

METHODS

The research location is Tarakan City, a small island with a population of approximately 270,000 people a land area of 250.80 km2, and a sea area of 406.53 km2. This type of research is qualitative with a case study design. This research seeks to provide knowledge about phenomena in individuals, organizations, and society. The concept of triangulation is used to respond positively to existing weaknesses, using multiple methods and data sources. This research is a literature study related to the concept and theory of circular economy which is the main variable. To strengthen the desk review, the next step is to conduct interviews with the Tarakan City Environmental Agency, the Aki Babu Landfill Technical Implementation Unit, and the Lestari Community Social Group engaged in environmental care activities related to policy implementation, as well as field observations starting in March 2021 to October 2021 in Tarakan City.

RESULTS AND DISCUSSION

Based on secondary data analysis, Tarakan City waste composition data in 2020 is obtained as an overview which can be seen in Figure 1 below.



Picture 1: Waste composition of Tarakan City in 2020
(Source: DLH Tarakan City, 2022 (reprocessed: Author, 2023))

In the figure above, it can be seen that plastic waste occupies the second highest position after food waste in the composition of waste generated at the urban scale. Based on previous research, data obtained that since 2011, the Tarakan City Government along with 62 other districts/cities in Indonesia have played an active role in the Acceleration of Settlement Sanitation Development Program (PPSP) which is divided into 2 stages, namely 2010 - 2014 for the first stage and 2015 - 2019 for the second stage. Despite having participated in the 2 stages, it has not made any changes to the reduction and handling of municipal waste. This causes waste to be poorly managed. In this research, several things cause waste to not be managed properly and correctly in Tarakan City, including:

1. Programs and activities that imitate or copy from other regions, especially from Java, do not consider the geographical conditions of Tarakan City which is an archipelago, and the socio-economic background of the local population.
2. The lack of human resources who can adapt to advances in science, technology, and innovation that are increasingly developing related to waste management.
3. The lack of intensity of policymakers on environmental issues in Tarakan City.

Sustainability of Tarakan City's plastic waste management system

Urban waste management, especially plastic waste, is the responsibility of consumers and producers, both of which are inseparable and an issue that involves various aspects of society. Several factors affect the sustainability of waste management, including population density, socio-economic characteristics of a city, as well as the physical, social, and cultural environmental characteristics of the local community by considering important aspects that can affect the success of the system, such as:

1. Financial aspects or budgeting of the necessary costs;
2. Environmental aspects include the process of reducing the amount of waste and the system of protection for the environment;
3. Social aspects that involve involving the community in the system to be run;
4. Technological aspects that will be developed;
5. Institutional and legal aspects involving regulations and stakeholder policies.

Problems in the waste sector are multi-linear and require the involvement of the community and various stakeholders to solve. The level of public awareness and involvement in waste management is still low. Based on Law Number 18 of 2008 related to waste management has divided the authority of implementation by the central government, provincial government, and district/city government which shows that most of the arrangements are with the central government while local governments have full authority regarding the implementation of waste management which is strengthened by legal products such as Regional Regulations (Perda), Jakstrada, feasibility studies of household waste management.

In addition, there is an imbalance in the waste management facilities provided by the City Government. The number of existing facilities does not match the amount of waste generated in each sub-district. This can be seen in Table 1 below.

Table 1: Tarakan City Waste Management Facilities in 2021

Description	Tarakan Barat	Tarakan Tengah	Tarakan Timur	Tarakan Utara
TPA	1	-	-	-
Waste Bank	3	4	4	-

TPST/TPS3R/Depo	9	11	6	1
Production Waste (ton)	54.569,10	4.959,55	3.359,4	1.038

(Source: Author, 2023)

Challenges and Opportunities in Plastic Waste Management

New thinking about the relationship between local government and other actors in providing public services initially focused mostly on privatization but has gradually suggested a new permanent role for government as one actor capable of becoming a direct provider of services. It became the main foundation of the idea of partnership as an important method to provide services not only efficiently and effectively but also fairly. Partnership in terms of waste management is defined as a relationship of various aspects that have functions, on the political aspect as a government institution, the planning aspect as an instrument in making public policy, sociological as a social form, ecological as a way to mitigate impacts and economically as a strategy to reduce costs.

The geographical location of Tarakan City, which is an archipelago, causes waste transportation routes to experience significant obstacles related to waste management so the city government is expected to be able to overcome the gap through an integrated system from upstream to downstream independently. So this encourages the City Government to manage urban waste within the City or island area itself to minimize the transportation costs of transporting waste between islands.

The implementation of waste management in Tarakan City is still inadequate, this can be seen in the condition of infrastructure, facilities, and infrastructure that are not well maintained and not on target. In optimizing regional waste management, the role of waste management implementers does not yet have full authority from structural, political, and bureaucratic, to determine budget allocations. Sustainable waste management requires legal, institutional, financial, technical, operational, and community participation aspects that must go hand in hand.

Based on the results of the study, one alternative that can be done by the City Government in dealing with plastic waste management problems is through community empowerment in the small and medium industry sectors. This can be seen from how the IKM community spread throughout the corner has the right technological knowledge to utilize existing resources to produce something that has value and benefits. Socio-cultural factors also cannot be separated from the mindset and creativity of the community in utilizing existing resources. This is in line with the considerations contained in the Presidential Instruction of the Republic of Indonesia Number 3 of 2001 concerning the Application and Development of Appropriate Technology to Accelerate National Economic Recovery, Accelerate Village Progress, and Face Global Competition so that it is considered necessary to accelerate rural development through community empowerment in various fields supported by the application and development of appropriate technology. The application and development of appropriate technology are expected to be able to improve the quality of people's lives from a social aspect. Based on data from the Ministry of Industry (2019), plastic recycling raw materials in Indonesia are 29% to meet the needs of domestic industries and increase the PCR rate which encourages a circular economy because it reduces post-consumption waste through the recycling process and becomes raw materials. In reducing waste generation, management is not only charged to local governments or social groups but there is cooperation that must be built with various parties, such as

producers, retail, BUMD, and also SOEs (Wardhana, 2020), So that the waste management budget carried out by local governments can be reduced. Based on observations and interviews, many derivative products can be produced by social groups in Tarakan, ranging from the management of used cooking oil into biodiesel, coconut shells into briquettes, to plastic waste into fuel oil (Tarakan 2021, Oktober 22).

The results of the analysis conducted in one of the communities, namely the Sustainable Social Community Group (KSM), obtained data related to the potential for waste reduction on the KSM scale which can be seen in Table 2 below.

Table 2: Potential Reduction of Plastic Waste in Communal (KSM Lestari)

no	type of plastic	Kg/week	Description
1	OPP	4	Plastic packs, clothes packaging (clear plastic)
2	PET	6	soft drink bottles and bottled water
3	HDPE	5	milk bottles, detergent bottles, shampoo bottles, moisturizer bottles, oil bottles, toys, juice bottles, medicine packaging bottles
4	PVC	2	water pipes, tiles, electric cables, wrapping
5	LDPE	5	garbage bags, pastry bags, milk cartons, and glass beverage packaging.
6	PP	2	baby water bottle, food storage
7	PS	3	Styrofoam
total		27	kg/week
		108	kg/month
		1296	kg/year
		1,30	ton/year

(Source: author's data processing results, 2022)

In experimental tests, the plastic waste used is the type of OPP, which is the easiest and most widely produced in the coastal environment of KSM Lestari because it is adjacent to traditional markets and shopping centers. In addition, OPP plastic waste is one type of plastic that is very easy to find and there has never been any previous research related to the management of OPP-type plastic into fuel. The amount of OPP plastic waste that can be managed by KSM Lestari is 12 kg/month, overall the type of waste that can be managed is 108 kg/month.

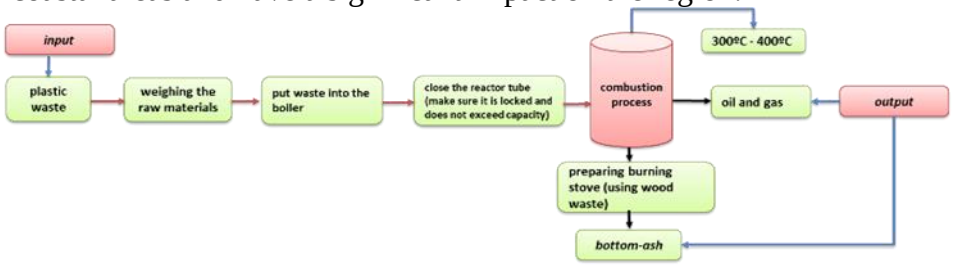
Evaluation of the sustainability of plastic waste management

In general, waste management starts from generating waste at the source, carrying out containers, and collecting waste from the source to temporary shelters or TPS / TPS3R / depot, and then transporting and distributing in the landfill. Management of waste generation from sources can come from individuals, communal or regional, and urban on a large scale. This research focuses on the communal scale in KSM Lestari which is located in a coastal area of the sea that has a lot of potential for plastic and wood waste. Waste management from communal sources has significant characteristics, namely community involvement in the selection process to the processing process, using simple and easy-to-apply technology, the amount of waste managed is relatively small, and operational costs

are cheap. Plastic waste processed at KSM Lestari comes from one of the shopping centers and traditional markets located in the same village so it does not require any mode of transportation for the process of transporting plastic waste collected voluntarily by supermarkets.

The concept of plastic waste management carried out at KSM Lestari puts forward the pattern of reducing as little waste as possible that ends up in the sea, utilizing wood waste on the sea coast, and processing plastic waste into fuel oil using simple pyrolysis technology so that the results can be reused by the surrounding community. This is done to reduce waste that ends up in the sea and is transported and ends up in landfill. Almost all plastic waste processed at KSM Lestari is a type of plastic that no longer has a selling value or has no price unless processed or recycled again, so the technology used in waste processing is the only option for reducing accumulated plastic waste.

In Tarakan City, there is only 1 TPS3R and 1 KSM that can process plastic waste, TPS3R Lestari located in East Tarakan District processes plastic waste into paving blocks and KSM Lestari located in West Tarakan District processes plastic waste into fuel. TPS3R is currently only capable as a TPS because operations are very dependent on the help of third parties and the City Government, while KSM Lestari processes waste independently and is still operational today because there is no dependence on any party. This can be a comparison, of how communities can move and process waste based on environmental issues in coastal areas and have a significant impact on the region.



Gambar 2: The flow of plastic waste processing process at KSM Lestari
(Source:Purwanta, 2022(reprocessed: author, 2023))

Research and development of plastic waste recycling, especially to prevent pollution that extends to the sea, has been widely carried out in various countries, such as research in China which showed that China had an amount of plastic waste that was not managed properly in 2010, similar to previously reported trends. By 2025, the South Asian region, for example, is India which is predicted to experience a huge increase in the amount of poorly managed plastic waste. In the oceans, 95% of plastic waste eventually disintegrates into visually unrecognizable forms and is no longer a problem. However, plastic particles remain in the environment for hundreds of years and are absorbed or digested by marine life. Based on research conducted by the World Bank in 2019, an estimated 8 million tons of plastic enter the oceans every year, posing risks to the entire global marine ecosystem, fishing industry, and human health, and Indonesia is the second largest contributor of plastic waste in the world after China. One of the problems that became the background of this study was plastic waste pollution that ended up in the marine environment, plus the geographical location of Tarakan City which is an archipelago where the majority of transportation used between islands are ships.

Pyrolysis technology is considered by most studies as one of the plastic waste management alternatives that is quite effective in reducing waste generation because it has a simple process. The costs involved depend on the scale of management and also the intervention of third parties in assisting. This is proven by the plastic waste management that has been carried out by KSM Lestari to this day.

Currently, waste management is very necessary to move towards a circular economy. The circular economy aims to preserve the value of products, materials, and resources for as long as possible by returning them to the product cycle at the end of use and minimizing waste generation. The concept of waste management has changed from adhering to the paradigm of collecting, transporting, and disposing of, to now viewing waste as a raw material with economic value. From an economic perspective, pyrolysis is still a viable option despite the seemingly high initial costs involved in procuring equipment. In addition, this technology has long-term environmental benefits that will undoubtedly outweigh the initial costs, especially given the current economic, energy, and environmental crisis. In this study, the author recommends that the government apply this pyrolysis method to other institutions in Tarakan City that are burdened with the responsibility of managing plastic waste.

Strategic capacity building is the task of developing enabling conditions for the private sector and greater public participation in decision-making, as well as more efficient and effective multi-agency cooperation according to research conducted by Turok and Bailey in 2004. Leadership from the political aspect is also an important aspect in this strategic capacity building because it contributes to the vision, confidence, and dynamism of the environment needed in a stable economic scope. In the political aspect, leaders play an important role in the direction of the policy to be implemented and the way of law enforcement of the regulations made, so that the main factor of strategic success that is prepared is at the top of each stakeholder.

Plastic Waste Management Strategy

Garbage pollution that occurs in the Tarakan City area is increasingly widespread due to the increasing population, littering, and changing land use patterns. There are several obstacles faced by Tarakan City in the waste management system, including:

1. Inadequate infrastructure, from the neighborhood level to the city level.
2. Human resource capacity is still minimal towards environmental management.
3. The geographical condition of Tarakan City, which is an archipelago, makes it difficult to access transportation between islands or other districts/cities, and has no alternative to handling and reducing waste other than managing itself in the city.
4. The economic and social background of the people of the region who are still less willing to participate in waste management.
5. Lack of information and socialization obtained by the community regarding programs and activities owned by policymakers.

The various variables that have been analyzed in evaluating plastic waste management models show that the involvement of stakeholders plays an important role in integrating all elements involved.

Suggestions and policies

Recommendations for policy strategies towards a circular economy in plastic waste include:

1. Accelerate collection capacity in less accessible areas to increase the distribution of waste and recycling collection.
2. Having adequate waste management facilities.
3. There is an effort to carry out the sorting process correctly so that the quality of plastic waste collected is clean.
4. The encouragement of policies made by the government related to recycling standardization and incentives given to the community, thus raising awareness of various parties related to good waste management.
5. There is innovation and also an increase in the technology used in processing plastic

waste recycling.

6. The informal sector, in this case, community social groups and waste pickers can synergize to become a solid community in collecting and processing waste as well as mediating the social and cultural aspects of society.
7. Having an accountable data system, both from waste generation data to the level of waste recycling, so that it is easy to supervise and evidence of traceability is an important aspect of the recycling process.
8. From the producer side, it carries out its obligation to manage the packaging and/or goods it produces by Law Number 18 of 2008 Article 15 and Minister of Environment and Forestry Regulation Number 75 of 2019 concerning the Roadmap for waste reduction by producers. Producers are asked to re-collect the products they produce as a form of implementation of Extended Producer Responsibility (EPR).

CONCLUSION

The involvement of various parties in waste management is expected to provide economic value to the waste generated by the community. Collaboration plays an important role in developing integrated waste management. /Alternative scenarios to policymakers, community-based organizations, NGOs, local communities, and private companies, showing the kind of contribution that different activities can make towards more environmentally sustainable development in this sector.

REFERENCE

Brundtland, G., & Khalid, M. (1987). Our common future. https://doi.org/10.1016/B978-0-7506-1049-0.50009-5

Chen, J. C., & Huang, J. S. (2007). Theoretical and experimental study on the emission characteristics of waste plastics incineration by modified O2/RFG combustion technology. Fuel, 86(17–18), 2824–2832. https://doi.org/10.1016/j.fuel.2007.03.008

Damanhuri, E., & Padmi, T. (2019). Pengelolaan Sampah Terpadu (Kedua). ITB Press.

Geng, Y., & Doberstein, B. (2008). Developing the circular economy in China: Challenges and opportunities for achieving "leapfrog development." International Journal of Sustainable Development & World Ecology, 15, 231–239. https://doi.org/10.3843/SusDev.15.3:6

Geng, Y., Fu, J.-Y., Sarkis, J., & Xue, B. (2012). Towards a national circular economy indicator system in China: an evaluation and critical analysis. Journal of Cleaner Production, 23, 216–224. https://doi.org/10.1016/J.JCLEPRO.2011.07.005

Geng, Y., Zhu, Q., Doberstein, B., & Fujita, T. (2009). Implementing China's circular economy concept at the regional level: a review of progress in Dalian, China. Waste Management, 29 2, 996–1002. https://doi.org/10.1016/j.wasman.2008.06.036

Hadiwardoyo, W., Implikasi, C.-, Usaha, B., Martono, M., Antin, T., Wahyuni, H. I., Partini, P., Fansuri, H., Fansuri, H., Fansuri, H., Fansuri, H., Fansuri, H., Fakultas, D., Iain, U., Intan, R., Mahyudin, R. P., Yenti Sumarni, Rosana, M., Susila Wibawa, K. C., … Tujuan, S. (2020). Kebijakan Pembangunan Berkelanjutan Yang Berwawasan Lingkungan di Indonesia. Jurnal Ekonomi Dan Perbankan Syariah, 2(2), 59–64. https://doi.org/10.24853/baskara.2.2.83-92

Heshmati, A. (2015). A Review of the Circular Economy and its Implementation. https://doi.org/10.1504/ijge.2017.10010876

Kementerian Lingkungan Hidup dan Kehutanan. (2020). National Plastic Waste Reduction Strategic Actions for Indonesia. Ministry of Environment and Forestry, Republic of Indonesia, 1–46. https://wedocs.unep.org/bitstream/handle/20.500.11822/32898/NPWRSI.pdf

KLHK. (2016). Baku Mutu Lindi Bagi Usaha dan/ Atau kegiatan Tempat Pemprosesan Akhir Sampah.

KLHK. (2017). Rapat Kerja Nasional KLHK 2017: Sumber Daya Alam Untuk Keadilan Melalui Agenda nasional Pembangunan Ekonomi Berkeadilan.

KLHK, Kementerian PUPR, & Yayasan Dana Mitra Lingkungan. (2021). Tata Kelola Persampahan

di Indonesia (Rangkuman Hasil Webinar). In N. M. Rizal (Ed.), Teknologi Persampahan Juni-November 2020. KLHK, Kementerian PUPR, Yayasan Dana Mitra Lingkungan.
Kuncoro sejati. (2013). Pengolahan Sampah Terpadu (P. Penta (ed.)). Kanisius.
Lestari, A. P., Bijaksana, A. F., & Ibrahim, R. M. (2019). Tata Kelola Persampahan Indonesia.
Liu, X., Kong, H., & Zhang, S. (2021). Can urbanization, renewable energy, and economic growth make environment more eco-friendly in Northeast Asia? Renewable Energy, 169, 23–33. https://doi.org/10.1016/j.renene.2021.01.024
Luo, S., Xiao, B., Hu, Z., & Liu, S. (2010). Effect of particle size on pyrolysis of single-component municipal solid waste in fixed bed reactor. International Journal of Hydrogen Energy, 35, 93–97. https://doi.org/10.1016/J.IJHYDENE.2009.10.048
McDowall, W., Geng, Y., Huang, B., Barteková, E., Bleischwitz, R., Türkeli, S., & Kemp, R. (2017). Circular Economy Policies in China and Europe. https://doi.org/10.1111/jiec.12597
Mulasari, S. A., Husodo, A. H., & Muhadjir, N. (2014). Kebijakan Pemerintah dalam Pengelolaan Sampah Domestik. Kesmas: National Public Health Journal, 8(8), 404. https://doi.org/10.21109/kesmas.v8i8.412
Murray, A., Skene, K. R., & Haynes, K. (2017). The Circular Economy: An Interdisciplinary Exploration of the Concept and Application in a Global Context. https://doi.org/10.1007/S10551-015-2693-2
Nadia, R. . Ni. (2020). Policy brief: Pengelolaan sampah di Indonesia, studi kasus pengelolaan sampah berbasis masyarakat.
Nizar, M., Munir, E., & Munawar, E. (2016). Manajemen Pengelolaan Sampah Kota Berdasarkan Konsep Zero Waste : Studi Literatur. Pengabdian Kepada Masyarakat, 7(2011), 93–102.
Parente, V., & Usp, P. (2016). Organic municipal solid waste (MSW) as feedstock for biodiesel production : A fi nancial feasibility analysis. 86. https://doi.org/10.1016/j.renene.2015.08.025
Purwanta, W. (2022). Pengantar ‘ Waste-to-Energy .’
Rosana, M. (2018). Kebijakan Pembangunan Berkelanjutan Yang Berwawasan Lingkungan di Indonesia. KELOLA Jurnal Ilmu Sosial, 1(1), 148–163.
Sabata, J. maria C., Torras, A., Elies, E. G., & Martell, M. (2005). URBAN SOLID WASTE MANAGEMENT Municipal Waste and its Management. Metropolis.
Su, B., Heshmati, A., Geng, Y., & Yu, X. (2013). A review of the circular economy in China : Moving from rhetoric to implementation. https://doi.org/10.1016/J.JCLEPRO.2012.11.020
Tejaswini, M. S. S. R., Pathak, P., Ramkrishna, S., & Ganesh, P. S. (2022). A comprehensive review on integrative approach for sustainable management of plastic waste and its associated externalities. Science of the Total Environment, 825, 153973. https://doi.org/10.1016/j.scitotenv.2022.153973
Thaha, A. F., Sugiri, D., Aditya, B., Mulasari, S. A., Husodo, A. H., Muhadjir, N., Peraturan Pemerintah Republik Indonesia, Nizar, M., Munir, E., Munawar, E., Rahmiyati, N., Andayani, S., Panjaitan, H., Lingkungan, H., & Lingkungan, D. I. (2014). Menyelamatkan Usaha Mikro, Kecil dan Menengah dari Dampak Pandemi Covid-19. Jurnal Administrasi Publik Mahasiswa Universitas Brawijaya, 2(1), 404. https://doi.org/10.32639/fokusbisnis.v19i1.575
Tun, M. M., Juchelkova, D., Palacky, P., & Sitar, V. (2020). applied sciences Renewable Waste-to-Energy in Southeast Asia : Status , Challenges , Opportunities , and Selection of Waste-to-Energy Technologies. October. https://doi.org/10.3390/app10207312
Wardhana, Y. M. . (2020, November 18). Investor Daily: Indeks Kepedulian Pengelolaan Sampah Plastik Produsen. 0100364007(8), 5479837.
Yamaguchi, K., Tobita, M., & Tsuchida, I. (2012). 11 Waste Management and Recycling. In I. Baud, J. Post, & C. Furedy (Eds.), Integrated Sustainable Design of Buildings (Vol. 17, Issue 1, pp. 329–336). Routledge. https://doi.org/10.4324/9781849775335-31
Zhijun, F., & Nai-ling, Y. (2007). Putting a circular economy into practice in China. Sustainability Science, 2, 95–101. https://doi.org/10.1007/S11625-006-0018-1
Peraturan Presiden No. 97 Tahun 2017 tentang Kebijakan dan Strategi Nasional (Jakstranas) Pengelolaan Sampah Rumah Tangga dan Sampah Sejenis Sampah Rumah Tangga
Bappeda Kota Tarakan. 2019. “Rencana Pembangunan Jangka Menengah Daerah (RPJMD).” Kota Tarakan. Tarakan.

Undang-undang Nomor 18 Tahun 2008 tentang Pengelolaan Sampah.

Peraturan Menteri Lingkungan Hidup Dan Kehutanan Republik Indonesia Nomor P.59/Menlhk/Setjen/Kum.1/7/2016 Tentang Baku Mutu Lindi Bagi Usaha Dan/Atau Kegiatan Tempat Pemrosesan Akhir Sampah.

Peraturan Pemerintah Republik Indonesia Nomor 27 Tahun 2o2o Tentang Pengelolaan Sampah Spesifik.

https://sipsn.menlhk.go.id/sipsn/