

## Waste Management Optimization in Banda Aceh: Towards a Zero-Waste City

Muhammad Nizar<sup>1,2\*</sup>, Erman Munir<sup>3</sup>, Edi Munawar<sup>4</sup>, Irvan<sup>5\*</sup>

<sup>1</sup> Department of Natural Resource Management and Environment, Universitas Sumatera Utara, Medan, Indonesia

<sup>2</sup> Environmental Engineering Department, Universitas Serambi Mekkah, Banda Aceh, Indonesia

<sup>3</sup> Biology Department, Faculty of Mathematics and Natural Sciences, Universitas Sumatera Utara, Medan, Indonesia

<sup>4</sup> Chemical Engineering Department, Universitas Syiah Kuala, Banda Aceh, Indonesia

<sup>5</sup> Chemical Engineering Department, Universitas Sumatera Utara, Medan, Indonesia

\* Corresponding author's e-mail: [mnizar.abdurrani@gmail.com](mailto:mnizar.abdurrani@gmail.com), [irvan@usu.ac.id](mailto:irvan@usu.ac.id)

### ABSTRACT

Nowadays, many developed cities in Indonesia such as Banda Aceh intend to change their existing waste management systems to be more efficient and sustainable to achieve what can be called zero-waste practice. Recycling rates of up to 100% and recovery of all resources from waste materials are some of the elements embedded in the zero-waste city concept. However, to change from the cities that generate too much waste to the cities that are garbage-free is a tough challenge. Therefore, this research aimed to find out the opportunities, threats, and challenges in order to optimise and transform conventional waste management into zero waste principles. This research used in-depth interviews with waste experts, literature studies on waste management in other cities in Indonesia and other countries as well as examined government policies. The result of this research shows the challenges of turning a city into a zero waste one, such as how to design a product that generates less waste, what kind of zero waste city looks like, how to conduct the recycling process and what the responsibility of producers are, and how to optimize the rate of materials and waste recovery. However, its implementation should be affordable, practical, and effective within the framework of regional regulations.

**Keywords:** zero-waste city, zero-waste concept, waste in banda aceh, sustainable waste management.

### INTRODUCTION

Nowadays, urban areas represent half of the world's population. Additionally, these areas are spreading and increasingly growing in all regions of the world (UN-Habitat, 2010). Such districts have a higher level of consumption for urbanization compared to the cities in the countries with lower consumption. Australia is one of the countries in the world with the highest level of consumption, where around 89% people live in urban areas (Buck, 2014; Lehmann, 2010). The economic growth produced in urban areas can create urban mega-regions and corridors that can disrupt these areas in various forms of urban governance (Lehmann, 2010). However, nowadays

many people tend to move from the deepest part of cities to "satellite" or regions with suburban environments. This displacement is due to better housing conditions and more affordable living compared to the urban areas (Humains, 2008; UN-Habitat, 2010).

Designing a city with a sustainable zero-waste city concept is very challenging. High consumption of products such as paper waste, food scraps, over packaging, and large amounts of electronic waste in developed cities in the world cause special problems that are difficult to handle. The "zero-waste" concept is designed to manage products and processes to systematically avoid and eliminate both waste and materials so that all of the resources originating from

waste streams can be conserved and restored in a sustainable manner (Nizar et al., 2019 ; Zaman and Lehmann, 2011). Therefore, recycling up to 100% of waste can turn a city into *sans* waste. Instead, all resources can be recovered, and this in turn prevents waste from harming the environment. The concept of “zero-waste cities” is complicated to achieve based on a holistic perspective. The increase in the amount of waste generated in a city is due to growing public consumption. The community has yet to pay serious attention to sustainable waste management systems. Therefore, there are still many gaps in the waste management system yet to be addressed through urban planning as of today.

Banda Aceh is the capital of the Aceh Province with an area of 61.36 km<sup>2</sup> and a population of 254,904 people (density of 4154.23 people/km<sup>2</sup>). The city received an average rainfall of 209.1 mm yearly, while the average temperature is 27.6°C with an average height of 0.8 meters above sea level. Banda Aceh is bordered by the Malacca Strait in the north, the Aceh Besar District in the south and east, and the Indonesian Ocean in the west (Badan Pusat Statistik Banda Aceh, 2018).

Banda Aceh has a population size categorized as a medium city (Kementerian Pekerjaan Umum, 2013). Its territory is divided into several regions as shown in Figure 1.

There are 74,534 households in Banda Aceh City, and most families in Banda Aceh live in individual homes. Few residents inhabit shop houses as dwellings which only consist of two or three floors. Banda Aceh consists of flat areas; thus, many residential areas are on flat land. There

are no settlements built at elevation or hilly areas. However, there are still many small roads or so-called aisles in the villages, while large roads (width +6 meters) are located on protocol roads. The types of housing and residency are essential for the garbage collection system and recycling efficiency. For example, housing types will influence how temporary dumpsite is placed, the construction of recycling centres and planning of transportation modes so as to create efficiency in municipal waste management (Cole et al., 2014; Hoornweg & Bhada-Tata, 2012; Cole, 2013). Large industries or factories do not exist in Banda Aceh; only small-scale household industries such as tofu or tempeh factory, etc. are available, so all wastes are generated from household wastes.

The residents of Banda Aceh can be categorized as urban people who still shop in traditional markets which generate a lot of organic wastes that are not transported to landfills. There are seven conventional market centres in Banda Aceh, namely Kampung Baru/Aceh Market, Rukoh Market, Lamnyong Market, Peunayong Market, Seutui Market, Ulee Kareng Market, and Kampung Ateuk Market (Dinas Koperasi UKM & Perdagangan Banda Aceh, 2016). In addition to traditional markets, other trade centres are supermarkets, malls, and shops that are scattered throughout the city of Banda Aceh. The income of the Banda Aceh population is IDR 26 million/capita which is below the national average of IDR 42 million per capita (Rafie, 2018). Meanwhile, the percentage of poor people in Banda Aceh was 7.41% in 2016 (Badan Pusat Statistik, 2018). The level of population welfare affects

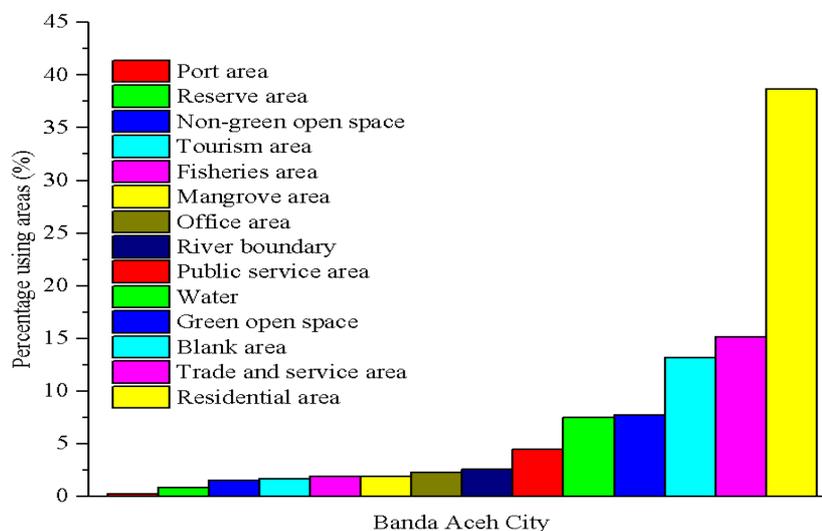


Figure 1. Percentage of Banda Aceh city area according to land use (Badan Pusat Statistik, 2018)

people’s purchasing power where the higher the purchasing powers of the people, the greater the potential for waste generation. However, this is not the only thing that determines the amount of waste produced by a city.

This study aimed to analyse the hazards, challenges, and opportunities to change the conventional waste management into the zero-waste city concept. In conventional waste management, people produce waste, place it at a certain point, then waste is transported to be disposed of in landfills. There is no action to reduce waste from the source. The waste management system implemented in the city of Banda Aceh must be dynamic, as it includes several contexts such as the environment, socio-political, technological, and economic elements in its strategy. The novelty in this research is to obtain a holistic waste management concept for medium cities in developing countries. So far, waste management in the city relies only on the concept of “end pipe”, which has implications for the waste of natural resources and pollution of landfills. The findings from this case study can be formulated and recommended as principles or guidelines to building a zero-waste city.

**Municipal solid waste**

Waste can be defined in different behaviours based on various perceptions. For example, one person’s garbage can be disposed of, depending on what they see as waste. However, other people can treat this disposed waste as a resource. For instance, e-waste which is defined as waste from the cities with higher technology that can be used as resources in the cities with

lower technology. The sources of municipal solid waste include institutional, industrial, urban, commercial and residential activities (Bennett, 2007; Pichtel, 2005; Irfan & Muh, 2020). Waste has a composition that varies depending on the source. The composition of landfills based on the source of waste is shown in Table 1.

**An eco-friendly city with the concept of a zero-waste city**

A city that continuously changes is considered dynamic. Today’s people consume too much; thus, the per capita waste produced is relatively higher in the areas with high levels of consumption compared to the regions with low levels of consumption. At present, many cities plan to adopt the “eco-city” concept which aims to provide a high quality of life for each of its residents. Completed projects such as Hammarby Sjöstad (Sweden) and Vauban Freiberg (Germany) as well as projects such as Masdar City (UAE) and Tianjin Eco-City (China) which are yet to be designed, are considered as “eco-cities” that offer a better quality of life to its people. Eco-friendly cities are designed based on the considerations for sustainable urban design practices. These cities have lower population densities ranging from 50 to 150 people per hectare (Lehmann, 2010). However, there are several arguments about the definition of a correct eco-friendly city; for example, a modern city the development of which follows high ecological footprints is not considered an “eco-city”. Additionally, not everyone in the world can be accommodated in these kinds of limited areas.

**Table 1.** Urban solid waste generation as a source function

Generation sources	Residential	Industrial	Institutional	Municipal	Commercial
Types of composition	Meal scraps, food packaging, cartons, plastic cups, newspapers, clothes and shoes, garbage, old electronics	Department paper, corrugated boxes, cardboard boxes, lunchroom waste	Office waste, used boxes, toilet waste, room waste and cafeteria waste.	Road waste, construction debris, demolition, e-waste and used cars.	Office waste, used boxes, napkins, wooden pallets, disposable tableware, food scraps, yard waste, demolition, and construction waste.
The excluded waste fractions in this study	Hazardous waste, i.e. chargers, prints etc.	Commonly managed by industry itself, massive industrial waste	The clinical and hazardous waste is generally explicitly managed by management.	Generally, waste from management results by construction companies.	Dangerous waste

Generally, the use of the eco-city concept is broadly defined. The eco-city concept was first created by Ekblaw et al. (2009). The well-being of eco-city citizens can be enhanced through several integrated urban planning and management plans that fully utilize ecological and renewable energy systems to create zero emissions and zero waste (Lehmann, 2011; Song et al., 2015). Therefore, the zero-waste concept is part of the eco-city concept. The idea of a zero-waste city includes a recycling rate of up to 100%, as well as recovery from various resources derived from waste materials produced in reliable waste cities. The social and economic activities that come with the quality of life offered in this kind of city have sparked the interest in people to keep coming to these cities.

However, the information and perceptions are often not accurate, and poor city management may cause undesirable disasters to happen (Growth, 2007; Nations et al., 2008). In addition to the increasing population and excessive consumption found in cities, these areas have brought about the higher level of natural resource depletion globally. The positive relationship between urbanization and poverty (UN-Habitat, 2010) demonstrates the importance of sustainable urban expansion at the global level. Thus, problems such as designing new products for the consumption system, developing new scenarios, and redesigning existing systems (Vezzoli, C., & Manzini, 2008) weigh on the current quality of life in these cities. This dilemma provides the main question for planners and researchers.

### **Consumption and waste generation**

The reason behind cities producing huge amounts of waste is essential in the understanding and devising the strategies to develop and transform cities into areas without waste. Environmental ethics, community behaviour, assessment of resources, social and individual perceptions of waste and resources, economic development, environmental and social welfare, global conservation of resources, and technical improvement, as well as its relevance are critical to improve understanding when building and developing a holistic zero-waste management system. However, in previous literature, very few researchers have established the relationship between these aspects from a holistic perspective. Resource consumption has a direct link with the generation of waste. Nowadays, consumers

generate high consumption levels in the efforts of mobilizing the society to achieve some recognition that is treated as a society's identity.

On the contrary, kind nature is derived from the opposite of consumption as mentioned by Aristotle. Consumption has two concepts as mentioned by Sagoff, where both ideas of consumption include "getting and spending resources" and "spending limited resources" (Jamieson, 2008). Therefore, the acquisition and use of resources for consumption lead to the depletion of minimal earth resources. Human behaviour is clearly significant in understanding the context of waste generation and consumption. Natural and environmental resources that have very different values have made it difficult to place monetary benefits according to the desires and tendencies also included in human culture (Beckerman, 2000).

Non-anthropocentric assessment is very consistent and analysis of costs as well as benefits used, the value of existence, contingent valuation and hedonic price cannot be assessed. However, there are different principles of ethics, commitment, values and so on (Moh & Abd Manaf, 2017). Therefore, there are gaps in knowledge pertaining to the philosophy of the environment and the assessment of environmental resources. The degree of change in individual and consumer behaviour is influenced by various people's attitudes and views on the topics of household goods, use of household appliances, purchasing, energy habits, and behaviour towards transportation. However, to change values and influence others, trust and attitude related to people's preferences as well as consumptive patterns must be factored in. Initiatives for policy are therefore essential in focusing these efforts towards facilitating sustainable behaviour.

Effective waste management systems have been designed and tested in various cities aiming to be zero-waste cities (Clay et al., 2007; Colon & Fawcett, 2006; Morlok et al., 2017; Nader, 2009; Phillips et al., 2011; Snyman & Vorster, 2011; Willis et al., 2018; Young et al., 2010; Zotos et al., 2009). Every developing country faces a great challenge of how to carry out recycling so that waste has economic value. A country that has similarities with Indonesia is Sri Lanka. Indonesia and Sri Lanka need improvement through awareness creation, capacity building, infrastructure and technology investment, law and policy enforcement, international collaboration, private-public partnerships, and fiscal support. These

improvements require a multi-faceted and multi-stakeholder approach (Gunarathne et al., 2019).

Solution to the current waste problem cannot be done using a single strategy. Therefore, material flows in the city as well as the concept of long-term sustainability are significant in the holistic design and application of zero-waste cities. The plans to improve performance in resource recovery need to be addressed in advance by city governments (assessed in terms of per capita waste generation, resource recovery rates, and landfill disposal per capita compared to international best practice benchmarks). If the rate of waste generation continues to increase (as expected), more material needs to be withdrawn from waste streams to achieve a higher recovery target.

## MATERIALS AND METHODS

This study used a descriptive method which aimed to obtain the information about the current situation of waste management. Descriptive research tries to observe the existing conditions and document the solid waste phenomena that have occurred in Banda Aceh. Researchers conducted in-depth interviews with a number of waste experts or practitioners in Banda Aceh. Researchers used a snowball sampling strategy, because it was not known exactly who and how many experts or practitioners were available in the study area (Rahi, 2017).

This research is based on a review of previous literature and data collected from in-depth interviews with experts. The experts interviewed were selected from academicians, practitioners and government employees who have been involved in waste management in Banda Aceh for at least 2 years. The waste experts were given in-depth questions such as “what additional facilities are needed for the recovery of resources in order to achieve the target?”, “what level of capital investment as well as development facilities are required for the implementation of the new Advanced Waste Management (AWT)?”, and “what kind of performance will be improved?”. These data were processed and analysed before the findings were compiled into a report. The environmental research that was built on practice included the research methods based on performance, cases and evidence as applied (Lee & Cabinet, 2011).

## RESULT AND DISCUSSION

### Management of MSW in Banda Aceh

Waste management in Banda Aceh uses the technology that is almost the same as that used in other cities in the world such as the city of Adelaide. However, most MSWs in Banda Aceh are flammable waste including plastic and paper processed through incineration. Meanwhile, organic waste is still treated using anaerobic digestive system and composting. The city government of Banda Aceh has promised to monitor the extended producer’s responsibility (EPR) scheme who generate the most major waste, such as hazardous waste, electronic waste, car waste, etc. However, the waste coming from industry must be disposed of by the industry itself. In Banda Aceh’s current EPR programme, only packaging for vehicles that have not been used is collected and managed, as shown in Table 2. The food waste collected from households weighs around 2,500 tons/month. The most extensive collection of waste is from the recycling centre at 43,300 tons/month and waste collected by contractors at 29,500 tons/month.

A total of 7 recycling and waste management facilities in Banda Aceh are responsible for the management of commercial and municipal solid waste. All waste treatment facilities in the city of Banda Aceh are owned by the government. In 2018, these facilities processed 316,522 tons of waste. The waste management system operated in Banda Aceh is shown in Figure 2. A diagram of the waste management system in Banda Aceh for 2017 shows that 65% of waste was burned, while 27% was recycled, and the remaining 8% was used as stockpiling waste. However, the data on the waste produced by the city of Banda Aceh is national data. This is due to the unavailability of local data, so the numbers are made up by making

**Table 2.** Waste recycled and collected from extended producer Responsibility tools in Banda Aceh, 2018

Type of waste	Tons/month
Glass	9,325
Plastic	550
Newspaper	320,302
Metal	403
Lead batteries more massive than 3 kg	725
Cardboard and packaging	2600
End-of-life vehicles	8,600

**Table 3.** Features of waste management systems in Banda Aceh

Sectors	Indicators	
Social	Consumption	High consumption
	Generation of waste kg/person/year in 2015	480 kg
Economic	Purchasing power parity	IDR 24 billion
	GDP per capita in 2015	IDR 43,4 Million
	Landfill tax/ton	IDR 17 Juta (2014)
	Landfill disposal cost	IDR 130.000 per ton
Technical	Waste technologies	Composting, thermal treatment and landfill
	Priority methods	Recycling, EPR
Environmental	GHG emissions 2010	2.72% (1.05MT/year)
	Environmental targets	Zero waste by 2025 Vision Banda Aceh 2030
Political	Key waste regulations	Landfill tax in 2017
		Ban combustible waste to landfill in 2017

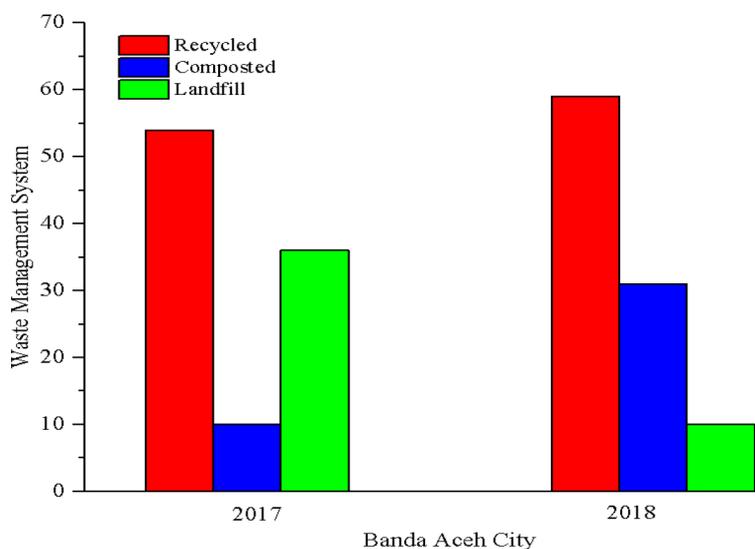
assumptions using the national waste data from the main capital of Banda Aceh. Findings in terms of the social, economic, technological, political, and environmental contexts of the city of Banda Aceh are shown in Table 3.

**Improper designs in production cause depletion of resources and materials**

People need to rethink the concept of zero-waste city and find more effective and efficient ways to produce and design the system in order to operate, maintain, and recycle all waste products generated by the city. A city’s future energy resources and consumption levels are among the defining elements in designing the physical infrastructure of a zero-waste city. The challenge

lies on how to build and design cities that are ready to overcome the challenges of urbanization so that all of its residents can have full access and benefits of urban life. Throughout history, many cities have existed as lessons in terms of urban planning. These cities stand testament to how cities can be more resilient in facing extreme challenges and situations, as well as how cities can be built and expanded with ecosystems as thought (Lehmann, 2011; Unnisa & Rav, 2012). In the past two decades, many cities have been marked by rapid urbanization.

Several cities in Asia have experienced many changes during this short period, e.g. Bangkok, Shanghai, Jakarta, Hong Kong, Singapore, and many others. In China, some new laws have been passed to be impressive and had everyone’s energy



**Figure 2.** Waste management systems in Banda Aceh City

consumption to make up only half of the current levels in the European Union for the same level of GDP in 2050. The same target has been adopted by other countries. However, the path to achieve it is yet to be clear in the little time left now.

The main problem happening now is excessive global consumption. Even, various developing countries are experiencing a rapid increase in the consumption levels. The consumption of resources is increasingly evident nowadays, as it is widely enjoyed by rich countries; however, this trend is unlikely to be maintained throughout the world. Lower consumption levels and smaller ecologies hold greater advantages for developing countries. Developing cities nowadays cannot grow in the same way as some unsustainable cities which depended on cars (e.g. developments in Australia and the US) in the past.

### **Sector waste management and recycling**

The disposal of consumer products has increased; thus, this resource is considered increasingly valuable. For example, e-waste and former landfill sites that are frequently hidden continue to be investigated. Hyper-consumption is becoming a standard; laptops and the latest cell phones are introduced in increasingly shorter cycles, while volume of electronic equipment continues to grow from year to year. This very high consumption level has resulted in the rare increase of demand for land and the use of precious metals to make electronic goods. However, supply from several countries helps control the unavailability of land and metals. Metals such as dysprosium, neodymium and palladium in particular, are essential to the production of high technology gadgets.

However, over the years, these metals have become increasingly scarce, making them valuable items. The electronics industry is aimed at finding new sources. The most effective solution is to recycle electronic waste as one way to reduce the dependence on imports of rare metals or city mining. Support for this issue comes in the form of the recently discovered hidden value of electronic waste in landfills (Brunner, 2011; Mining, 2015). Electronic waste contains all types of metals. Computers have boards, monitors and photocopiers which contain copper, lithium, rhodium, and many other precious metals. Recycling e-waste extracts about 20 or more types of metals that are at least similar to gold. Recycling experts have estimated this as city

mining; the final disposal site can become a large form of business in the future. The recycling of unused e-waste has enormous potential.

The landfill is a resource that has yet to be utilised. This type of landfill is likely to contain a lot of precious metals that were dumped during the days when the concept of recycling was still mostly unknown. For example, the metal content of stairs found in the dumps of people's homes was estimated to be able to meet the demand for metal in Germany for a year. However, until now, the cost of extracting valuable electronic waste from unexpected places has remained unknown. The United Nations Environment Program (Wilson et al., 2015) is a study centre that has reached zero waste in 32 out of 37 special metals recycled. Of the 60 metals, one third has a recycling rate above 50%, while only 1% of 34 metals is below. This study concludes that the potential for recycling metals for reuse is low. Therefore, Banda Aceh that has substantial quantities of electronic wastes must radically change the level of waste to optimize the usage of their resources.

### **Extended producer responsibility (EPR)**

The producer's responsibility or more commonly known as the Extended Producer Responsibility (EPR) is applied to producers of goods so that they are partially responsible for the waste generated from their products. Strong support from the central government is needed for the enforcement of the EPR system. It is difficult for districts or cities to implement the EPR system because their products are spread all across the nation or globe. For example, it is difficult to force packaging companies that operate on a national scale without any clear regulations from the central government regulating the responsibility for the packaging waste they cause. In solid waste law, producers are required to manage packaging and goods, meaning that they have to take back the products that have the potential to become waste. However, the fact is that sellers are rarely willing to take back their unused items.

EPR is more challenging to implement in Banda Aceh because the national company is based in Jakarta. Local producers in Banda Aceh have never been found to install warnings on their packaging related to waste reduction or waste handling. However, this action can be implemented if there is commitment from the local government to turn this measure into a policy or regulation. For example, the city of Banjarmasin has created regulations on

paid plastic bags. The Mayor of Bandung has also issued a regulation prohibiting the use of Styro-foam. The EPR system can work if there are strong and firm policies from the government. Both regulations and action are needed at once. EPR is very important to be included in solid waste policies at the national and local levels.

From Table 4, it can be seen that Qanun No. 5/2003 does not mention anything related to EPR. This is understandable, because the concept of EPR is still relatively new, thus when the Qanun was set out, the idea of EPR had yet to exist. The next regulations including Qanun 1/2017 and Law No.18/2008 do include EPR, but both laws are significantly different. The Solid Waste Management Law states the obligation of producers to provide labels or codes relating to the reduction of waste and how to handle the packaging or product. Qanun No. 1, however, does not mention the obligation to include the label, but asks producers to manufacture products with packaging that are to decompose, contribute to the provision of waste collection and waste processing facilities, and participate in waste recycling campaigns. This contribution can be charged directly to producers (factories) by a sole distributor based in Banda Aceh. The major industries that are responsible for distributing their products generally do not have branches in Banda Aceh, making it very difficult to force them to comply with the EPR rules in Qanun No.1/2017. The EPR rules stipulated in the National Solid Waste Law still need other legal regulations as guidelines for carrying out activities in the field.

### Lessons learned to optimize material flow and resource recovery

The current level of public consumption is very high. The concept of transforming cities into zero-waste cities is difficult to realize with the current high levels of consumption. However, this can be done if people can first change their lifestyles to a relatively sustainable level. The changes in individual behaviour have the potential to lower consumption levels. However, lack

of information and services can hamper the interest of more active recycling communities.

The cities that have zero-waste city planning are susceptible to the amount of pure waste. Therefore, the main challenge that must be solved is to minimize, avoid or prevent the creation of waste in urban areas. Continuous product supervision designed to reduce the waste volume must be included in the waste cycle. Processing waste with technology poses a potential threat to the basic waste reduction system for particular wastes. For example, a minimum amount of waste is needed to continuously operate incinerators that in turn produce energy. Therefore, the incineration technology can be threatened with a significant reduction in waste volume.

Policies and levies do influence regulations and waste management systems. For example, landfill taxes that were applied throughout the city of Banda Aceh in 2019 saw the flow of waste transferred to landfills targeted much less. Likewise, organic waste that is prohibited from being discharged into landfills in 2019 has brought about a more effective digestive and anaerobic system. Since monetary and tax incentives are given to recycling of storage containers, the percentage of recycling has significantly increased to about 75% to date (84% of glass bottles and cans were recovered in Banda Aceh City).

Recovery of the resources from waste requires innovative technology for restoration so that the depletion of resources globally can be reduced. The atmosphere of a place is very influential in the application of technology, time, and efficiency. For example, in Sweden, extensive combustion is needed to produce district heating and electricity.

A sustainable city model must have an integrated waste management system, as shown in Figure 3. Therefore, embedded and holistic cradle-to-cradle approaches are needed so that the goal of eliminating or avoiding waste from the entire life cycle from one place to another up to the final disposal of waste (TPA) can be achieved. Banda Aceh has the vision of becoming a “zero-waste city”.

**Table 4.** EPR policies in national regulations and Banda Aceh

No.	Regulation	Extended producer responsibility (EPR)
1.	Qanun Banda Aceh No.5/2003	NA
2.	Waste Act No.18/2008	Article 13, 14 and 15
3.	Qanun Banda Aceh No.1/2017	Article 24 and 25

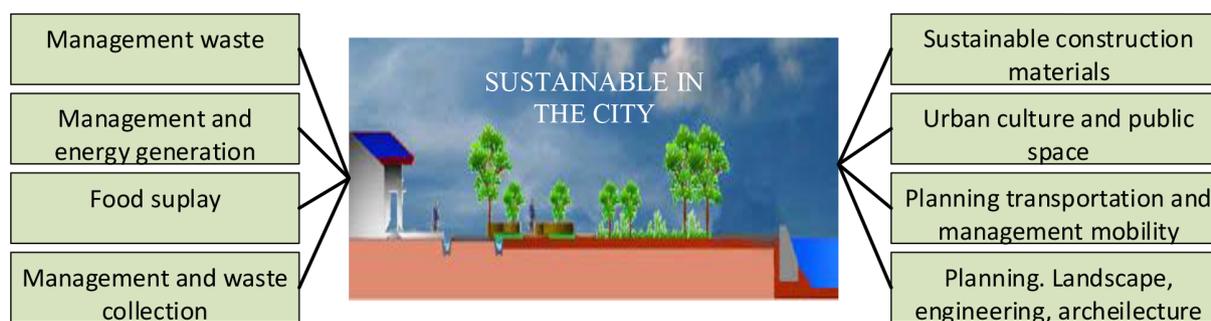


Figure 3. Zero-waste city according to holistic system thinking and integration

However, this is very difficult to implement without clear plans and actions and well-coordinated implementation.

## CONCLUSIONS

The government and society need to make major changes in waste management so that Banda Aceh can become a Zero-Waste city. This significant change begins with the community by avoiding the emergence of waste and on the government side by providing supporting facilities and policies. However, at present, more educational programs and behavioural changes are needed to raise awareness and make the dream of a sustainable economy a reality. Consumers are aware of the fact that waste is a precious resource; for example, people acknowledge the value of packaging cardboard waste, plastic, food scraps, glass, and e-waste. This study is the starting point in achieving a better understanding of the community about the complexity of city dynamics in the context of urban waste management. More comprehensive follow-up research on the different aspects of waste management including the changes in community behaviour, recycling and avoidance of waste is still needed. The most critical challenge in the context of zero-waste is inducing changes in people's lifestyle and economic restrictions for all cities around the world. As citizens of the world community, especially the city of Banda Aceh, people must be aware that the planet where humans live today has limited resources.

A city that can stand on its own by generating its own energy, creating its own food, regulating and using its own water, managing its own system efficiently, creating jobs for its own people, creating economic activities, and restoring all resources sourced from the waste stream can truly create "a zero-waste city".

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