Implementation of zero waste concept in waste management of Banda Aceh City

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Abstract. This study aims to find out how far the implementation of the concept of Zero Waste in waste management in Banda Aceh City. The problem of increasingly complex garbage due to the increasing amount of waste along with population growth. During this time generally waste is transported and disposed to the Final Processing Place (TPA) so that all garbage piled up in the landfill. Most of the waste handling is done after the garbage appears so it is difficult to manage it. Handling of garbage from scratch is still minimal so the TPA becomes full fast. The concept of Zero Waste is to minimize waste generation so that less waste is wasted to the landfill. This is so as not to waste resources and prevent environmental damage. Handling of waste from the beginning of waste avoidance, waste sorting, producer responsibility, waste levies according to the amount of disposal, waste management by the community and the provision of incentives and disincentives is the implementation parameter of Zero Waste. This concept should be integrated into local policy so it becomes an obligation for the government and the community to implement it. A number of cities around the world have implemented Zero Waste policies and set a target to reduce waste disposal to TPA as small as possible. Banda Aceh as a medium-sized city in Indonesia has integrated a number of Zero Waste concepts in its local regulations. Some of these concepts are difficult to implement due to a number of socio-political factors.

1. Introduction

Urban waste that can be transported and disposed to the landfill or TPA amounts to between 60\% - 70\% of the total urban trash and the remainder scattered in polluting the environment [6]. The Government of Indonesia mandates the closure of TPA using the open dumping system through Law No. 18/2008 on Waste Management as the legal basis. This mandate must be implemented by the district or city government within a maximum of 5 years (until 2013) since the law is ratified. Furthermore, it is required to build a new landfill that must use the Sanitary Landfill system in accordance with applicable standards and regulations [21].

However, the open dumping landfill rule did not work well because most of the landfill in Indonesia remained in operation as before, as the research findings conducted by [17]. Though the
landfill is planned to run the system Sanitary Landfill [19]. The open dumping disposal system implies that the amount of greenhouse gases produced by the landfill increases as well as the leachate water that is a toxic waste from the landfill.

On the other hand, the issue of global warming and climate change and its impacts on humans has led people to think about sustainable natural resources. Limited non-renewable resources allow people to think hard about how to save the remaining natural resources. Zero Waste management system (ZW) or "no of Waste" becomes one of the holistic solutions in managing waste and resources in a city on an ongoing basis [36].

Waste management is still a big challenge for the government of Banda Aceh. These challenges include community awareness is still relatively low, especially the people who trading in the market, the lack of garbage collection facilities, and the limited number of counseling workers so that the campaign intensity is still relatively low [11]. Several programs in the Banda Aceh Solid Waste Management Masterplan since 2007 have been implemented, such as the introduction of recycling of waste, the rehabilitation of the old TPA in KampungJawa, as well as the construction of a new Sanitary Landfill in Aceh Besar district [7]

TPA KampungJawa belonging to the Banda Aceh Government has now over capacity so it is time to move another place. The landfill can be longer if the concept of waste management from upstream applied. Banda Aceh's waste policy has included several principles of Zero Waste in the handling of municipal solid waste. This study was conducted to find out how far the concept of Zero Waste is implemented in the city of Banda Aceh for better handling of waste.

2. Discussion

2.1. The development of Zero Waste concept

Eliminating waste from production process to customer usage is a waste minimization strategy [38]. Waste is more often regarded as useless goods by society and even industry. This is actually a false view if humans understand and realize how waste has a price and can also harm environment. A global understanding has emerged, widely accepting the effects of climate change, including loss of biodiversity, increased air pollution, water and soil, deforestation and reduced resources and materials, as a consequence of excessive consumption of unsustainable production processes.

About 20% of the waste can be recycled or recovered annually where the world's waste generates four billion metric [3]. Increased waste generation is caused by linear material flow rate system where the waste ends in the landfill. Currently the world is more run a linear economic system where the product will end up just like that in the landfill. While the concept of Zero Waste (ZW) is the opposite of linear circular system is the flow rate of material is a circular system where the end of the product becomes the beginning of the another product as well (nothing is wasted). Figure 1 shows the comparison of the material flow rate between linear and circular systems.
[20] was the first to use the term Zero Waste in 1973 as a term to recover resources from chemical waste. A number of cities in the world in 1995 adopted No Waste legislation to achieve the 2010 targets and Canberra became the first city in the world to successfully achieve ZW targets [5, 26].

The emergence of ZW regulations in New Zealand in 1997 supported the initiative to minimize waste through the ZW movement in the country. This movement voiced intensive “closed loop material economy system in which a product is made for reuse, repair and recycling, an economic system that minimizes and ultimately closed circle of the economy; one in which products are made for reuse, repair and recycling, economies that minimize and ultimately eliminate waste” [31]. In 2000, Del Norte County, California became the first state in the USA to implement a comprehensive ZW plan and in 2001, the California Integrated Waste Management Board adopted the ZW goal as a strategic waste management plan [5]. Achievements and events related to ZW development can be seen in Table 2. Applying ZW means eliminating all disposal in soil, water or air which is a threat to the planet, human health, animals or plants [39].

Figure 1. Flow rate of material according to the concept of circular (Zero Waste) and linear
Source: [28]
Table 1. Achievements and events related to ZW

| Year | Country | Milestone/event |
|------|---------|-----------------|
| 1970s | USA | The term 'Zero Waste' was introduced by Paul Palmer |
| 1986 | USA | The National Coalition against Mass Burn Incineration was formed |
| 1988 | USA | Seattle introduced the Pay-As-You-Throw (PAYT) |
| 1989 | USA | The California Integrated Waste Management Act was passed to achieve the 25% target of waste diversification from landfills in 1995 and 50% in 2000 |
| 1990 | Sweden | Thomas Lindhqvist introduced 'Extended Producer Responsibility.' |
| 1995 | Australia | Canberra passes Act No Waste by 2010 |
| 1997 | New Zealand | The Zero Waste New Zealand Trust was established |
|       | USA | The California Resource Recovery Association (CRRA) held a Zero Waste conference |
| 1998 | USA | Zero Waste is included as a key principle of waste management in North Carolina, Seattle, Washington, & Washington DC |
| 1999 | USA | CRRA conducted a Zero Waste conference in San Francisco |
| 2000 | USA | The Global Alliance for Incinerator Alternatives was formed |
| 2001 | USA | GrassRoots Recycling Network published ‘A Citizen's Agenda for Zero Waste.’ |
| 2002 | New Zealand | The Cradle-to-Cradle book was published |
|       | USA | Zero Waste International Alliance (ZWIA) was formed |
|       | USA | The first Zero Waste Summit was held in New Zealand |
| 2004 | USA | ZWIA defines Zero Waste |
|       | Australia | GRRN adopts Zero Waste business principles |
|       | USA | Zero Waste SA was established in South Australia |
| 2008 | USA | The Sierra Club adopted the Zero Waste producer responsibility policy |
| 2012 | USA | The documentary Trashed premiered at the Cannes film festival |
|       | USA | The Zero Waste Business Council was founded in the United States. |

Source: [34] adaptation from [5].

Eliminating incinerators, landfills, throwaway societies and creating communities that manage sustainable waste are ideals of ZW. ZW implementation can not be expected to run in short time or for example within a year, but we can plan a situation that is very close to ZW in the next five or ten years [4]. Excessive exploitation causes the natural resources to become increasingly limited in number, creating uncertain future development. This should be prevented, therefore humans should engage in sustainable consumption and waste management strategies based on (1) waste avoidance, (2) material efficiency and (3) restoration of resources [15].

The ZW concept continues to grow, not stopping just as recycled but also restructuring the product design to prevent the issue of waste in the early stages [33]. Figure 2. shows the steps that can be done if the city implements ZW well then the city can be turned into a city of ZW.
2.2. Municipal Solid Waste

Waste sector gets the very less attention than other urban issues. Yet managing waste is always the most challenging thing in managing a city. The quality of waste services is one of the indicators good governance of the city [1]. Waste avoidance should be a top priority, followed by recycling and material engineering to minimize the amount of waste that is eventually disposed of into landfills or burned in incinerators.

Approximately 75% of natural resources are spent by urban areas covering only about 2% of the world's surface but generating 70% of waste globally [24, 32]. Creating waste means depleting natural resources, using energy and water, pressuring the land, polluting the environment and ultimately creating additional costs for managing waste. We have to move to a position where there is no more material to be waste, everything has to be converted into useful goods, this is called Zero Waste.

Total cities around the world produce approximately 1.3 billion tons of waste per year and this will increase to 2.2 billion tons by 2025. The rate of waste generation becomes doubled over a 20-year period in low-income countries [12].

The implementation of ZW requires a preliminary assessment preliminary step (it can be seen clockwise in Figure 2) to the ongoing solid waste conditions. Preliminary assessment and evaluation is very important to know the performance of municipal solid waste management. Identification of types of waste and problems is essential so that the goals of ZW can be achieved well in this step. After this step is the ZW framework can be applied in accordance with local conditions. Local governments
should prioritize and leverage ZW into a comprehensive strategic work plan. After implementing the ZW work plan, ZW performance evaluation is done to know the extent of its success [35].

A number of factors contribute to influence waste generation and composition of urban solid waste such as norms and culture, waste management policy and coverage area. One of the main factors affecting is the income of the community where the income of the community influences because the habit of consumptive and lifestyle is very dependent on income.

The World Bank estimates that in developing countries, municipalities typically spend 20-50 percent of their budgets on solid waste management, yet 30-60 percent of municipal solid waste is not transported and less than 50 percent of the population is served. In low-income countries, garbage collection alone accounts for 80-90 percent of the waste management budget. While in middle-income countries, the cost of collecting 50-80 percent of the total budget and in high-income countries, garbage collection takes up less than 10 percent of the waste budget, resulting in large funds allocated to sewage treatment facilities. Upstream community participation in developed countries reduces collection costs and can establish waste recycling and recovery facilities [23].

2.3 Zero Waste Initiative in the World

Canberra became the first city in the world to enact Zero Waste laws in 1996. In 2004, the city of Canberra has reached 70% of waste diversification. One of Canberra's programs is to establish a place called "Resource Recovery Park" to help industry creates products from separate materials and they can market reusable materials.

Adelaide, a city in South Australia has developed and implemented a Zero Zaste strategy. The waste composting program is increasing significantly and they are targeting by 2015, the compost volume must be higher than the waste sent to the landfills. The city has a high percentage of waste diversification, reaching 82 percentage.

Stockholm is one of Europe's leading cities and environmental standards are very high and have ambitions to improve the quality of the environment. Stockholm has already implemented its goal of being a fossil-free city in 2050 [29]. One of the key goals of this 2030 vision is to transform Stockholm city into a resource-efficient area [25].

The city of Halifax-Nova Scotia, Canada reaches 60 percentage of the rate of waste diversification. The ZW program creates 1000 jobs in garbage collection and processing. In addition 2000 jobs were created in the sector of used goods collection industry. Almost all separately-used goods are reused by industry in Nova Scotia.

The most progressive city is San Francisco, with a population of 850,000, has reached 77 percentage of waste diversification, the highest in the United States, with a three-pronged approach: enforcing strict waste reduction laws, partnering with waste management companies to innovate new programs, and work to create a culture of recycling and composting through incentives and working with communities. San Francisco strives to adopt the Zero Waste goal to be achieved by 2020 [37].

2.4. Waste Management in Indonesia

Population census in year 2010 shows the total population of Indonesia is 237.5 million people, when compared with year 2000 population census of 205.1 million people, then over the last ten years the population of Indonesia increased by about 32.5 million people with a growth rate of 1.49 percentage per year [27]. Problems encountered at every stage of solid waste management such as temporary disposal, collection, transportation and final disposal where these problems tend to increase in the end point of landfill [16]. Indonesia's Ministry of Environment and Forestry mentioned total waste in Indonesia reaches 64 million tons per year. A total of its 14 percentage is plastic waste [30].
Based on a waste management study conducted by the UNEP in 2004, it shows that only 33 percentage of solid waste management service indicators are met by the government. This means that the level of waste services carried out by the Indonesian government is still low. There are many factors that affect this low service. The existing waste management laws were inadequate, leading to inefficient waste management in Indonesia. This law does not specifically regulate solid waste management.

Many cities face landfill problems due to limited availability of land and open dumping sites with no sanitation systems, such as soil cover, leachate collection and environmental pollution treatment systems through CH4 emissions and leach intrusion into groundwater and surface. This situation is a challenge but it also offers the potential to better manage municipal solid waste. The potential and challenges in municipal solid waste in Indonesia are shown in Table 2.

| Potential | Challenges |
|-----------|------------|
| 1. Waste Act. No. 18/2008 accommodate a greater role for local government. | 1. Enactment of Law No. 18/2008, forces local governments to propose plans and implementations to close open dumping no later than 1 year and 5 years from the enactment of the Waste Law (May 2008) |
| 2. Community participation has been indirect. This can be improved through direct involvement, for example in waste separation. | 2. Developers of Landfill are required to build waste separation facilities |
| 3. Incentive and disincentive scheme which is included in the Waste Act could encourage the enforcement of | |
| 4. Recycling policies in 3R can increase the potential for waste reduction, waste recovery and profit. | 3. The target to achieve the MDGs in the community waste sector is 70% in year 2015 |
| 5. Waste with high organic content is a main source for composting. | 4. Low community awareness in separating waste |
| 6. The projected increase in plastic consumption has the potential to achieve waste-added value as it may become the raw material for recycling plants and | 5. Low priority in local authorities allocation annual finances. |
| 7. Lack of waste infrastructure | 6. Low participation from the non-public sector |
| 8. Despite the enactment of the Waste Act, there is no policy on solid waste management and most of the municipal waste is solid waste. | |

Source: [16]
3. Implementasi Zero Waste di Banda Aceh

3.1. Kebijakan Persampahan Nasional dan Banda Aceh

The percentage of organic waste, paper and plastic produced by Banda Aceh were 89.1%; 2.5%; 0.74%. The weight of garbage produced by Banda Aceh City is 86057.64 ton / month and produce carbon emission of 83726.6 ton / month. While the amount of waste generated by the population of the city of Banda Aceh 0.58 kg / person / day with the population of Banda Aceh as many as 242,943 inhabitants [11].

The following Table 3 shows the comparison of structures between the Law of the Republic of Indonesia Number 18 Year 2008 on Waste Management and Qanun Banda Aceh No. 1 of 2017 on Waste Management.

| No. | Description | UU No.18 | Qanun No. 1 |
|-----|-------------|----------|-------------|
| 1.  | Chapter     | 18       | 19          |
| 2.  | Article     | 49       | 42          |
| 3.  | Clause      | 99       | 117         |
| 4.  | Applied     | May 7, 2008 | July 3, 2018 |

The compilation of the national waste law itself was triggered by the occurrence of landslides at the final waste processing site located in BantarGebang which had killed thousands [2].

3.2. Waste Avoidance

Waste avoidance is to prevent waste generation starting from the beginning of a product or activity takes place. Qanun Banda Aceh No.1/2017 is more advanced than national waste law because it has explicitly mentioned the handling of plastic waste sources. Qanun cites restrictions on the use of plastic bags in supermarkets, malls, stores and other waste sources; and restrictions on paper waste generation in offices both public and private offices. While for supermarkets, malls, shops, and other business places that provide plastic bags to consumers must use environmentally friendly plastic bags.

Qanun Banda Aceh No.1/2017 is authorized in 2017 which previously has been published also Circular Letter from Directorate General of Waste Management, Waste and Hazardous and Toxic Substances, the Ministry of Environment and Forestry, Number: S.1230 / PSLB3-PS / 2016 on Pricing and Mechanism of Implementation of Paid Plastic Bags. This letter contains the restrictions on the use of plastic bags by consumers where they must pay a minimum of Rp.200 for each use of plastic bags [14].

Unfortunately, the practice of plastic bag restrictions has ceased since the beginning of 2016. There are several reasons for the cessation of these restrictive practices, such as the lack of a legal basis (only the Minister's Circular Letter), the objections of a number of retail entrepreneurs resulting in less effectiveness. Banda Aceh City Government can not force entrepreneurs to carry out this Circular Letter so that the program of plastic bag restrictions stop until now.

3.3. Extended Produsen Responsibility

Extended Produsen Responsibility (EPR) requires producer or person in charge of the area participate in managing the waste they produce in a sustainable program. This is very important in order to reduce waste generation and as evidence of corporate responsibility that has contributed to reduce waste generation. The Qanun of Banda Aceh does not mention EPR specifically but only the Qanun charges the producers (factories) and / or the distributors based in Banda Aceh. Large industries are responsible for the distribution of products in Banda Aceh.
This EPR practice has never been implemented in Banda Aceh even at the national level. Instruments reinforcing EPR policy have not yet been established but 28 large companies in Indonesia have voluntarily implemented EPR [10]. Local companies in Banda Aceh have not implemented this rule at all.

### 3.4. Pay as You Throw Retribution

Retribution is very important to finance waste management of a city. In addition to funding management, user charges can also be a factor in waste disposal control. Ideally, the more waste generated, the more retribution must be paid by people. Unfortunately, the policy at both national level and Banda Aceh does not include this formula either explicitly or implicitly.

The Municipal Government of Banda Aceh obligates people who receiving waste services pay retribution based on the size or type of home or building in accordance with Qanun Kota Banda Aceh Number 5 Year 2017 on the Retribution Waste Service [9]. Table 4 shows the fees for recipients of the Banda Aceh City waste service.

| Table 4. Tarif for recipients Banda Aceh waste service |
|---------------------------------|-----------------|-----------------|-----------------|
| No    | Retribution Object type | Building/unit size | Main road & downtown | Sub main road & village area |
|-------|------------------------|--------------------|----------------------|-------------------------------|
| 1     | House                  | >150 m²            | 20,000,-             |                               |
|       |                        | 36–150 m²          | 15,000,-             |                               |
|       |                        | <36                | 10,000,-             |                               |
| 2     | Shop                   | >64m²              | 25,000,-             | 20,000,-                      |
|       |                        | 48-64m²            | 20,000,-             | 15,000,-                      |
|       |                        | <48m²              | 15,000,-             | 10,000,-                      |
| 3     | Restaurant/ Café shop  | >200m2             | 80,000,-             |                               |
|       |                        | 100 - 200m²        | 60,000,-             |                               |
|       |                        | 65 – 100 m²        | 45,000,-             |                               |
|       |                        | 48 – 64 m²         | 35,000,-             |                               |
|       |                        | <48 m²             | 30,000,-             |                               |
| 4     | Hotel /motel / Boarding| 5 stars            | 800,000,-            |                               |
|       |                        | 4 stars            | 650,000,-            |                               |
|       |                        | 3 stars            | 450,000,-            |                               |
|       |                        | 2 stars            | 350,000,-            |                               |
|       |                        | 1 stars            | 300,000,-            |                               |
|       |                        | MelatimotelBoarding| 250,000,-            |                               |
|       |                        | g                  | 150,000,-            |                               |
|       |                        |                    | 100,000,-            |                               |
| 5     | School / Madrasah      | >1000students      | 250,000,-            |                               |
|       |                        | 500-1000students   | 200,000,-            |                               |
|       |                        | 200-500students    | 150,000,-            |                               |
|       |                        | 100- 200 students  | 75,000,-             |                               |
|       |                        | <100students       | 40,000,-             |                               |

Source: [9]

Payments as regulated by Qanun above do not consider the amount of waste disposed of which is less consideration of the principle of fairness. It could be that the service recipient pays cheaper even though the garbage is more than the other party who pays more for the money even though the garbage is less. This EPR scheme, when combined with good infrastructure to separate different waste and
good citizens awareness, can improve the recycling [18]. Banda Aceh government can not apply this rule due to the lack of support from the legislative and the low willingness of the community to pay retribution [13].

3.5. Community Waste Management

Waste management by community plays an important role in waste management based on Zero Waste concept. The existence of waste management can prevent the material to end up in the landfill because the actual material is not waste but can still be processed into other useful objects. An easy-to-reach community garbage management site provides people with the opportunity to utilize their "junk" into useful objects again. Banda Aceh has 3 community waste management sites in the villages of AlueDeyahTengoh Village, DeyahGeulumpang Village (this system is called Waste Collecting Point / WCP) and Lambung Village (TPS3R), 4 rural garbage banks and 35 school waste banks [8]. The government of Banda Aceh has a legal basis for establishing the WCP, namely the Mayor Regulation of Banda Aceh Number 7 of 2017 on Guidelines for Community-Based Waste Management with Waste Collecting Point System [22].

3.6. Incentives and Disincentives

Awarding in the form of incentives or sanctions (disincentives) in the Zero Waste concept is commonplace. This effort is done to encourage people to do their own waste processing so that it can reduce waste disposed to the landfill. In addition, this also shows government support to waste management. Rewards and sanctions are given not only in the form of money but also in terms of granting facilities, tax deductibility and so on. The principle of incentive given first to the community then if people violate the rules of waste management then the incentives are revoked or turned into a disincentive. However, from the results of interviews with a number of parties, this scheme has not been fully applied by the Banda Aceh Government [13]. In some waste management community, municipal gives regular fee to the managers but not systematic, while the disincentive has never been applied.

4. Conclusion

1. Zero Waste can be an alternative concept in waste management in Indonesia because Zero Waste is a concept that starts from, prevents waste in "upstream" to "downstream", not just handling waste by dumping it to the landfill.
2. Require the involvement of all parties in implementing the concept of Zero Waste, ranging from private parties, governments and communities in the implementation of this concept.
3. Policy support from the national government in the form of a firmer regulation is required for ZW to be implemented properly.
4. The Municipal Government of Banda Aceh has included a number of ZW principles and implemented some of them. The implementation of ZW still needs to be improved again in order to really reduce waste.

Suggestion

1. The municipal government in Indonesia should immediately apply the concept of Zero Waste in waste management where it is also a mandate of Law No.18 Year 2008 on Persampahann.
2. Zero Waste management campaigns can be implemented in the community so that awareness appears to not create waste.
3. The waste management program should focus on increasing the role of the community in handling waste, not just adding garbage collection equipment.
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