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Research paper

Applying Zero Waste Management Concept in a City of Indonesia: A Literature Review

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Abstract

City waste management in Indonesia still faces loads of challenges, mainly in the case the ultimate disposal (landfill) availability. Only 60-70% of the waste can be transported and disposed of to landfill, while the rest are scattered in various places. Waste dumped in landfill emits leachate contaminating and greenhouse gases. Also, the discarded material is a waste of non-renewable natural resource. Holistic management is necessary, starting upstream to downstream waste management. The concept of Zero Waste offers waste management, initial from the avoiding of trash, recycling, reduction and recovery of second-hand material. Some cities in the world such as Canberra, Adelaide (Australia), Stockholm (Sweden), Nova-Scotia (Canada) and San Francisco (USA) has set a target of Zero Waste. Indonesia still implements management that emphasizes the waste management disposal in a landfill. This literature review examines to find out whether Indonesia can apply the concept of Zero Waste in the upcoming.

Keywords: *Peat Soil; Delignification; Acid Hydrolysis; Bioethanol.*

1. Introduction

The Indonesian government in early May 2008 passed Law Number 18 of 2008 concerning Waste Management as an umbrella for national law. The law says the regional government is obliged to close all landfills (TPA) that are operated as open dumping in a maximum period of 5 years (until 2013). In the same time frame, the new landfills will be built to replace them. The construction of new landfills must use the Sanitary Landfill system by applicable standards and regulations (Pemerintah Indonesia, 2008) [1]. Nationally it is estimated that only 60% -70% of the total urban waste can be transported to a landfill by authorized government agencies (Damanhuri, 2005) [2]. Most TPAs are operated as controlled open dumping landfill, even though the landfill is designed as a Sanitary Landfill. It was identified in the study conducted by Meidiana & Gamse (2011) [3] and Munawar & Fellner (2013) [4]. These practices will cause emissions and leachate containing organic pollutants, nitrogen content and greenhouse gases (GHG). Proper waste management can prevent environmental damage and depletion of natural resources. On the other hand, the issue of global warming and climate change and its various impacts on humans has triggered communities to think about sustainable natural resources. The limited availability of natural resources especially nonrenewable resources forces people to think hard how to save the remaining natural resources. Zero Waste Management (ZWM) system is one of the solutions that are holistic in managing waste and resources in a city in a sustainable manner (Zaman & Lehmann, 2011) [5].

Waste management is still a big challenge for the Indonesian government. These challenges include public awareness that is still relatively low because there are still many persons do throw litter, do not sort, the level of payment of retribution is low while the government itself is still lacking in providing facilities and conducting the waste promotion (Faisal, 2014) [6]. Even though Indonesia has had a Waste Law since 2008, there are still many waste concepts that have not been implemented optimally.

2. Research methodology

This literature review uses qualitative research methods which analyze as many as 35 articles relating to the keyword Zero Waste. These articles come from all over the world and use trusted reference sources, which the sources can be traced from the Google Scholar Index, for identifying relevant academic literature. The parameters used to assess the application of Zero Waste in Indonesia are waste avoidance, extended producer responsibility, paying retribution according to the amount of waste (pay as your throw), waste management by the community and providing incentives and disincentives to waste management.

3. Discussion

3.1. Waste generation in cities

The term of Municipal Solid Waste (MSW) in Asian countries usually refers to all waste produced by the community or household. MSW is defined in developing countries such as Indonesia

which is household waste or those originating from commercial activities, industry, particular areas, social facilities and other facilities (Ministry of Environment, 2008) [7]. This waste problem arises because of the rapid urbanization and the rapidly increasing population in urban areas (Bustos, Borregaard & Stilwell, 2004) [8].

Several factors influence the composition of MSW includes cultural norms, waste management policy, the area, but one of the main factors that influence is community income. Community income influences consumption habits and lifestyle.

Many developing countries and countries that are transitioning to developed countries have informal sectors that run waste recycling, reuse of used goods and repairs of used goods. This activity was driven by the need for cheap used goods by the community (Wilson, Rodic & Velis, 2013) [9].

Garbage is more often considered as an item that is useless by the community and even industry. This perspective is actually a wrong view if humans understand and realize how waste has prices and can also damage the environment. A universal understanding has developed, which extensively accepts the effects of climate change, including loss of biodiversity, increased air, water and soil pollution, deforestation and reduced resources and material, as a consequence of excessive consumption of unsustainable production processes. This includes minimizing waste strategies and the concept of "eliminating waste from the process production to creating products" (Zero Waste SA Strategy, 2010) [10].

It is estimated that every year the waste produced by the world reaches four billion metrics where only 20% can be recycled or restored (Chalmin & Gaillochet, 2009) [11]. Waste generation in cities continues to increase, so it is vital if we see the city as an ecosystem that lives with a "closed-loop" management cycle as shown in Figure 1.

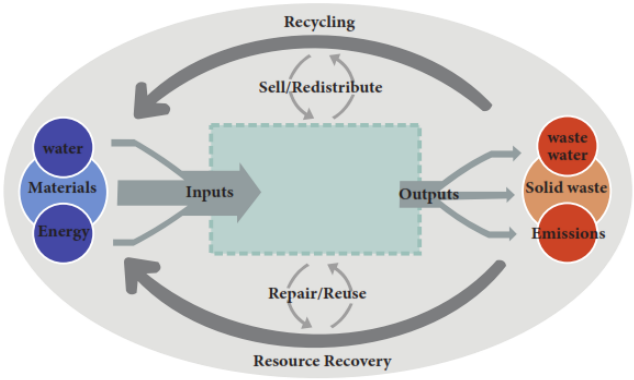

Fig. 1: Material Flow Rate in A Zero Waste City (An Adaptation of Girardet, 1992).

The ZW concept refuses incinerators, and landfills, and tries to bring an end to the throwaway society, instead of creating sustainable communities. This concept sounds like a very utopian concept, but Indonesia can make it happen for a particular time. In Indonesia, we do not expect to reach ZW next year, but we can a plan to be much closer to Zero Waste by 2020 (Connett, 2007) [12].

Managing waste is always one of the most challenging aspects to managing a city, and the quality of waste services is one of the indicators of good governance of the city. Avoidance of waste is a particularly high priority. However, despite this, in Indonesia, the waste management sector is getting less attention than other urban issues (Africa, 2010) [13]. Waste avoidance is a top priority, and then it is followed by recycling and material engineering towards minimizing the quantity of waste that is eventually dumped into landfills or burned in incinerators.

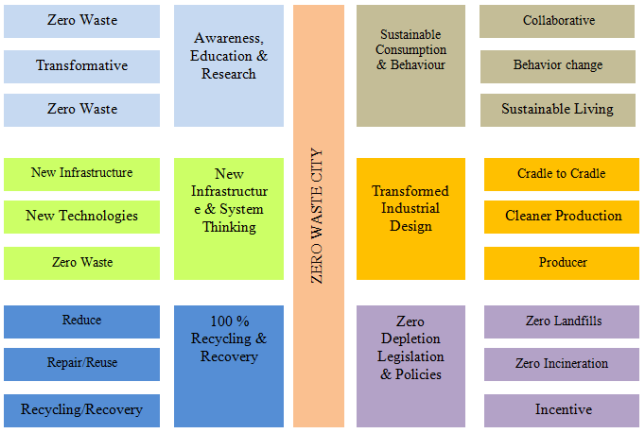

Fig. 2: The Principles for Transforming the City into Zero Waste. Source: Zaman & Lehmann (2013) [14].

Exploitation of limited natural resources on an ongoing basis will lead to future uncertainty. In order to prevent this, humans should engage in sustainable consumption and waste management strategies based on (1) waste avoidance, (2) material efficiency and (3) recovery of resources (Lehmann, 2011).

The size of the urban area only covers about 2% of the world's surface, but it consumes more than 75% of the world's natural resources and produces 70% of global waste (UN-MEA, 2006; Ramsar, 2012) [15]. Creating waste means depleting natural resources, using energy and water, pressure on land, polluting the environment and ultimately creating additional costs for managing waste. We must move to a position where there are no more things like garbage; everything must be changed; this is what is called Zero Waste.

Cities around the world produce approximately 1.3 billion tons of solid waste every year, and this volume is expected to increase to 2.2 billion tons by 2025. The rate of solid waste generation will more than double within 20 years in countries with low income (Hoornweg & Bhada-Tata, 2012) [16]. The Indonesian Ministry of Environment and Forestry said the total waste in Indonesia reached 64 million tons per year of which 14% was the plastic waste (Sudirman, 2016) [17].

ZW is one of the most visionary concepts in solving waste problems. Some major cities in the world such as Adelaide, San Francisco, and Stockholm have declared themselves as the city of Zero Waste, and they are trying to achieve the targets set and become the first cities to implement ZW. However, what is not less important is how to apply the ZW concept in a city and how to measure the performance of a city based on the ZW concept (Zaman & Lehmann, 2013) [18].

3.2. Development of zero waste

(Palmer, 2004) [19] was the first to use the term Zero Waste in 1973 as a term to recover resources from chemical waste. Some cities in the world in 1995 applied the No Waste law to achieve the 2010 target, and Canberra became the first city in the world to successfully achieve the ZW target (Connett, 2013) [20] (Snow et al., 2003) [21].

The emergence of the regulation on ZW in New Zealand in 1997 supported the initiative to minimize waste through the ZW movement in this country. This movement voiced intensely "a circular economic material system (closed loop materials economy) where a product is made to be reused, repaired and recycled, an economic system that minimizes and ultimately closes economic circle material; one where products are made to be reused, repaired and recycled, economies that minimize and ultimately eliminate waste "(Tennant-Wood, 2003) [22].

In 2000, Del Norte County in California became the first city and state in the USA to comprehensively implement the ZW plan, and in 2001 the California Integrated Waste Management Board

adopted the ZW goal as a strategic waste management plan (Connett, 2013) [24].
Achievements and events related to the development of ZW can be seen in Table 1.
Applying ZW means that it will eliminate all waste disposal in the soil, water or air which is a threat to the planet, human health, animals or plants (ZWIA, 2004) [25].
The San Francisco Department of Environment defines ZW as "Not sending anything to landfill or incinerators and making policies that reduce waste and increase access to recycling and compost" (SF Environment, 2011) [26] . The UK defines ZW as "a simple way to summarize targets as far as possible in reducing the effect of waste on the environment. This is a visionary goal that prevents garbage, conserves resources and restores material value. " (Phillips et al., 2011) [27].
ZW is also meant to eliminate unnecessary and unwanted garbage from every product and every stage of its life cycle. ZW consists of many concepts that can be developed for sustainable waste management systems including avoiding, reducing, reusing, redesigning, re-generating, recycling, repairing, re-manufacturing, reselling and redistributing waste resources.

Table 1: Achievements and Events Related to ZW

Year	Country	Milestone/event
The 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	CRAA 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	The Cradle-to-Cradle book was published
	USA	Zero Waste International Alliance (ZWIA) was formed
		The first Zero Waste Summit was held in New Zealand
2004	USA	ZWIA defines Zero Waste
		GRRN adopts Zero Waste business principles
	Australia	Zero Waste SA was established in South Australia
2008	USA	The Sierra Club took the Zero Waste producer responsibility policy
2012	USA	The documentary Trashed premiered at the Cannes film festival
		The Zero Waste Business Council was founded in the United States.

Sources: Zaman (2014) adaptation from Connett (2013).

The concept of ZW continues to grow, not stopping limited to recycling but also restructuring the product design to prevent the onset of garbage in the initial stages (United Nations Economic Commission for Europe, 2011) [28]. Figure 2. shows the principles of the city of ZW which if appropriately implemented the city can turn into a ZW city.

3.2. Measuring the performance of zero waste

Developing an idea of waste management into a Zero Waste system requires the integration of some parameters including geographic boundaries, waste prevention through design, behavior change, waste reduction through reuse and redesign and so on. Literature study conducted by Zaman (2014b) categorize indicators which are divided into seven main domains, namely geo-administrative, socio-cultural, management, environment, economy, organization, government and policy (see Figure 3.).
To understand and evaluate Zero Waste management, it is essential to develop a performance assessment tool in the form of a set of indicators. Solid waste management indicators have been developed by various stakeholders under their focus, for example social, economic, environmental or technological fields. Various studies were also carried out by researchers about indicators of sustainable waste management. A summary of the key findings of these indicators can be seen in Figure 3.
However, no particular approach can solve the current waste problem. A holistic approach to managing city waste and the concept of long-term sustainability is needed to design the city of Zero Waste. Understanding the local context and global market situation will provide a maximum adaptation of ZW. Identification of crucial priority areas is essential to design future ZW strategies. The city government will answer questions related to their plans to improve recovery performance (tested in terms of waste generation per capita, landfill per capita and rate of resource recovery - compared to internationally successful practices) such as what resource facilities are needed to meet various targets, how much investment is needed and where the Advanced Waste Treatment (AWT) facility is established? What can be done to improve performance? If the level of waste generation increases according to predictions, there will be much material that can be pulled from the waste stream to meet higher targets (Zaman, 2014) [29].
Many factors contribute to influence the amount of waste generated and the composition of urban solid waste. These include social norms and culture, waste management policy and the coverage area of waste collection services. One of the main factors affecting the generation of waste is the income of the community, as the higher the income, the more people consume and throw away.
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 collected, and a smaller amount than 50 percent of the inhabitants is served. In low-income countries, garbage collection alone takes for 80-90 percent of the waste management budget, while in middle-income countries; the cost of collecting waste is 50-80 percent of the total budget. In high-income countries, garbage collection takes up less than 10 percent of the waste budget, resulting in significant funds allocated to sewage treatment facilities. Upstream community participation in developed countries reduces collection costs, and the savings can be used to establish waste recycling and recovery facilities (Plan, 2009).

4. Zero waste initiatives across the world

4.1. Canberra

Canberra became the number one city in the earth to legislate Zero Waste in 1996. This law states that "The government does not

produce waste starting in 2010". In 2004, the city of Canberra had reached 70% of waste diversification;

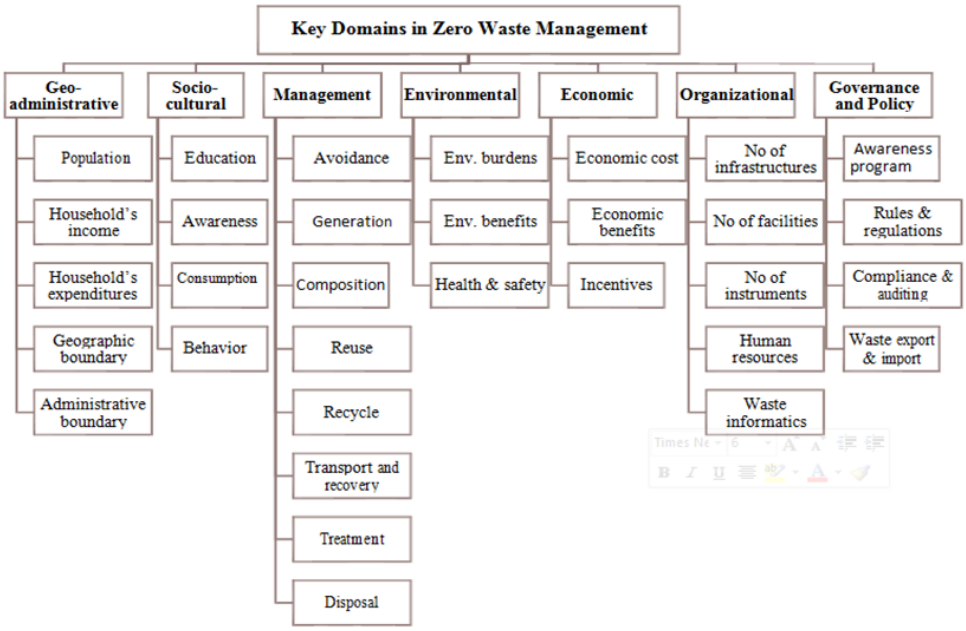

Fig. 3: Domain Scheme in Zero Waste Management System.

Source: Zaman (2014b).

This was due to the diversification of garden waste and building debris (Construction & Demolition). One of Canberra's city programs is set up a place called "Resource Recovery Park" to help the industry can make products from separate materials, and they can market reusable materials.

4.2. Adelaide

Adelaide, one of the cities in South Australia that has high consumption levels in the world, has been developing and implementing the Zero Waste strategy for recovery of excellent waste resources. Waste recycling and composting are the primary waste management programs in Adelaide. The waste composting program increases significantly, and they targeted in 2015, the volume of compost must be higher than the waste sent to landfills. For this reason, waste composting facilities continue to be built in Adelaide. The city has a high percentage of waste diversification, reaching 82%. The city has also been thriving in running the CDL scheme for decades.

4.3. Stockholm

Stockholm is one of the leading cities in Europe with high environmental standards and is very ambitious to improve environmental quality. The Stockholm City Government is responsible for waste management systems in the state capital. The Stockholm City Government initiated a project called "Vision Stockholm 2030" for the sustainable development of Stockholm in the future. Stockholm has implemented the goal as a fossil-fuel-free city in 2050 (Stockholm City, 2009) [30]. One of the key objectives of the 2030 vision is to transform Stockholm into a resource-efficient area (RUFS, 2010) [31].

4.4. Halifax-nova scotia

The city of Halifax-Nova Scotia, Canada, in the mid-1990s, tried to expand the landfill area. This plan caused protests from the public complaining of the foul odor of the site. Then the city government proposed a large incinerator with a capacity of 750 tons/day. Similarly, this plan caused protests that the incinerator project was stopped. Finally, the government handed over the problem of waste management to the community and said "You do not want landfills and don't want an incinerator, tells us what you want. Please design the program. "
Residents accept the challenge, and the government provides necessary assistance such as consultant reports. Residents choose one of the programs in the report given by Sound Resources out of Seattle. This program involves the separation and collection of waste that can be recycled, organic and others "door to door." Citizens make two paradigm changes in the report. 1) In the report always use the word "resources" to replace the word "garbage." 2) Due to previous bad experiences with landfills, residents requested that no garbage be dumped into landfills without prior processing. This request has led to the construction of waste filtering construction facilities.
Halifax alone reaches 60% rate of diversification. Also, this program created 1000 jobs in the field of waste collection and processing. A total of 2000 jobs were created in the used goods collection industry sector. Almost all items that can be separated (separated material) are reused by industry in Nova Scotia.

4.5. San fransisco

The most progressive city in implementing the zero waste concepts is San Francisco, with a population of 850,000 people. The city has reached 77% of waste diversification, the highest in the United States, with a three-field approach: enforcing a strict waste reduction law, partnering with waste management companies to innovate new programs, and working to create a culture of recycling and composting through incentives and collaborate with the community. The available land in this city is minimal so they are trying hard to adopt the Zero Waste goal that will be achieved in 2020 (Zaman & Lehmann, 2013) [32].

5. Waste management in Indonesia

The 2010 population census shows the population of Indonesia as much as 237.5 million people, when compared with

Table 2: Implementation of Aspects of Municipal Waste Management in Three Periods

Waste Management Aspect	Before Decentralization	1999 – 2004 (UNEP)	2005-2010
1. Integrated Waste Management Policy	NA	NA	NA
2. Solid waste management policy	NA	NA	NA
3. Institutional arrangements for managing waste	A	A	A
4. Framework for managing waste	NA	NA	NA
5. Budget support for managing waste	NA	NA	A
6. Training programs to manage waste	NA	NA	NA
7. Private sector participation	A	A	A
8. Community participation	NA	NA	NA
9. Information system	A	A	A
10. Economic instruments			

Source: Meidiana & Gamse (2010).

The population census in the year 2000 which amounted to 205.1 million people, then over the last ten years the population of Indonesia has increased by about 32.5 million people with a growth rate of 1, 49% per year (Soleh, 2011) [33]. Problems encountered arise at each stage of solid waste management such as container, collection, transfer, transportation and final processing where these problems tend to increase at the final point, namely landfill (Meidiana & Gamse, 2010) [34].

Table 3: Potentials and Challenges of Waste Management in Indonesia

Potential	Challenges
1. Waste Act. No. 18/2008 accommodates 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 one year and five 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 the law.	3. The target to achieve the MDGs in the community waste sector is 70% in the year 2015
3. Recycling policies in 3R can increase the potential for waste reduction, waste recovery, and profit	4. Low community awareness in separating waste
4. Waste with high organic content is the main source for composting.	5. The low priority in local authorities' allocation of annual finances.
5. The projected increase in plastic consumption has the potential to achieve the waste-added value as it may become the raw material for recycling plants and incinerators in the future.	6. Low participation from the non-public sector
	7. Lack of waste infrastructure 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: Meidiana & Gamse (2010).

Based on the waste management study conducted by UNEP in 2004, it shows that only 33% of solid waste management service indicators are met by the government. This means that the level of waste services implemented by the Indonesian government is still low. Many factors influence the low level of service. The existing waste management law was inadequate, causing waste management to be inefficient in Indonesia. This law does not explicitly regulate solid waste management.

Many cities face landfill problems because limited land availability and open dumping sites are not equipped with sanitation systems, such as overburden, leachate collection, and environmental pollution prevention systems from CH4 emissions and leachate intrusion into ground and surface water. Table 2. shows the development of several indicators of managing aspects of waste in Indonesia. Table shows that out of 10 indicators of aspects of city waste management, four aspects have been adequate since 1999 and only one aspect has improved after the evaluation of UNEP.

Efforts to improve indicators must begin by looking at existing conditions as challenges and using this potential to develop them. The potential and challenges in MWM in Indonesia are shown in Table 3.

6. Conclusions and Suggestions

From the literature review as described above, some conclusions can be drawn, namely:

1) The application of the Zero Waste concept has been very successful in various cities in the world, so this concept is not utopia
2) Zero Waste can be a better concept on handling waste in Indonesia because Zero Waste is a concept that starts from,

preventing the emergence of waste in the "upstream" to "downstream," not just handling garbage in the "end pipe."

3) Cities in Indonesia have experienced overcapacity in the ability to handle urban waste management so that new initiatives are needed.
4) It needs the involvement of all parties in implementing the concept of Zero Waste, from the private sector, government and education in campaigning for this concept.

Suggestions:

1) The cities government in Indonesia must apply the concept of Zero Waste in its waste management immediately where Zero Waste is also a mandate from Law No.18 of 2008 on Waste Management.
2) The Zero Waste management campaign can be implemented in the community to raise people awareness not to produce waste.

The waste management program must focus on increasing human capacity, not just adding garbage collection equipment or making landfills.

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