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Minimizing the increasing solid waste through zero waste strategy

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ABSTRACT

Increasing population, booming economy, rapid urbanization and the rise in community living standards have significantly accelerated the solid waste generation in the world. Solid waste has become one of the global environmental issues. Continuous depletion of natural finite resources is leading the globe to an uncertain future. To prevent further depletion of global resources, sustainable consumption and a strategic waste management system would be required. One approach that has been suggested as a means of addressing these concerns is that of the concepts of “Zero Waste”. However, transforming currently overconsuming activities into zero waste is still challenging. In this study, the challenges of solid waste (focusing on industrial waste e-waste, food waste and packaging waste), zero waste practices, and zero waste strategy were discussed to analyze the challenges and opportunities to transform traditional waste management toward zero waste vision. “Zero Waste” is a good solution to minimizing the increasing solid waste. However, in order to minimize the solid waste, there are still more endeavors need to be done in future.

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1. Introduction

Increasing population, booming economy, rapid urbanization and the rise in community living standards have greatly accelerated the solid waste generation in the world, especially in developing countries (Minghua et al., 2009; Guerrero et al., 2013). Solid waste has become one of the global environmental issues (Seng et al., 2010; Sharholy et al., 2007). Waste is the symbol of inefficiency of any modern society and a representation of misallocated resources. The global solid waste volume is estimated about 11 billion tons per year (using 2.5ton trucks can turn 300 circles around the equator) in 2011, and per capita solid waste generation is approximately 1.74 tons/year in the world. On the other hand, along with the large solid waste generation, an enormous amount of natural resources are depleted everyday due to the high demand for new product demand (Menikpura et al., 2013; Plaganyi et al., 2013). Globally, 120-130 billion tons of natural resources are consumed every year and produce around 3.4 to 4 billion tons of municipal solid waste (Giljum et al., 2008; Chalmin and Gaillochet, 2009). Creation of any waste depletes natural resources, uses energy and water, places pressure on land, pollutes the environment and, finally, creates an additional economic cost for managing the waste.

This large amount of waste has also created a huge pressure for the authority to manage waste in a more sustainable manner (Shekdar, 2009; Cheng and Hu, 2010). Solid waste management becomes necessary and relevant when the structure of the society changes from agricultural with low-density and widespread population to urban, high-density population. Furthermore, industrialization has introduced a large number of products which nature cannot, or can only very slowly, decompose or digest. Hence, certain industrial products contain substances which, due to low degradability or even toxic characteristics, may build up in nature to levels representing a threat to humanity's future use of the natural resources – that is, drinking water, agricultural soil, air and so on (Desmond, 2006; Menikpura et al., 2012; Troschinetz and Mihelcic, 2009). Waste management systems have not received as much attention in the city planning process as other sectors like water or energy. Therefore, many gaps of waste management can be observed in current planning. Global climate change and its various effects on human life drive current society toward more sustainability. Depletion of finite global resources also forces us to consider resource and product stewardship. One person's trash, the saying goes, is another person's treasure (Johnson et al., 2009; Boudreau et al., 2008). In recent years, one approach that has been suggested as a means of addressing these concerns is that of the concepts of “Zero Waste” (Bartl, 2011; Phillips et al., 2011). Zero waste is a philosophy that encourages the redesign of resource's life cycles so that all products are recycledhttp://en.wikipedia.org/wiki/Reused (Zaman, 2014; Zaman and Lehmann, 2011; Young et al., 2010).

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No trash is sent to landfills and incinerators. The process recommended is one similar to the way that resources are reused in nature.

The term "zero waste" was first used by Dr. Paul Palmer in 1973 for recovering resources from chemicals (Palmer, 2004). In a zero waste system, material flow is circular, which means the same materials are used again and again until the optimum level of consumption. No materials are wasted or underused in circular system (Murphy and Pincetl, 2013; Mason et al., 2003; Colon and Fawcett, 2006). Therefore, at the end of their lives products are reused, repaired, sold or redistributed within the system. If reuse or repairs are not possible, they can be recycled or recovered from the waste stream and used as inputs, substituting the demand for the extraction of natural resources. Fig. 1 shows the symbolic material flow of a circular waste system, where the end-of-life product or output waste are treated as resources and used as inputs in the metabolism process (Curran and Williams, 2012; Matete and Trois, 2008). Zero waste represents a shift from the traditional industrial model in which wastes are considered the norm, to integrated systems in which everything has its use. It advocates an industrial transformation, whereby businesses minimize the load they impose on the natural resource and learn to do more with what the Earth produces. From Fig. 1, it can also be known that the zero waste concept include the "3R rule"—"Reduce, Reuse, Recycling", which have been considered to be a base of environmental awareness and a way of promoting ecological balance through conscious behavior and choices. It is generally accepted that these patterns of behavior and consumer choices will lead to savings in materials and energy which will benefit the environment.

The concepts of 'Zero Waste' have been implemented in a number of countries (e.g. South Africa, New Zealand, China, India), provinces or states (Nova Scotia, California), as well as a range of companies (e.g. DuPont, Fuji Xerox and Toyota) (Greyson, 2007; Matete and Trois, 2008). But how to transform our existing situation into zero waste, and how to measure the performance of a zero waste city are the prime questions. This study focuses on industrial waste, electrical and electronic waste (e-waste), food waste and packaging waste to analyze the challenges and opportunities, achieving a shift from traditional waste management to zero waste.

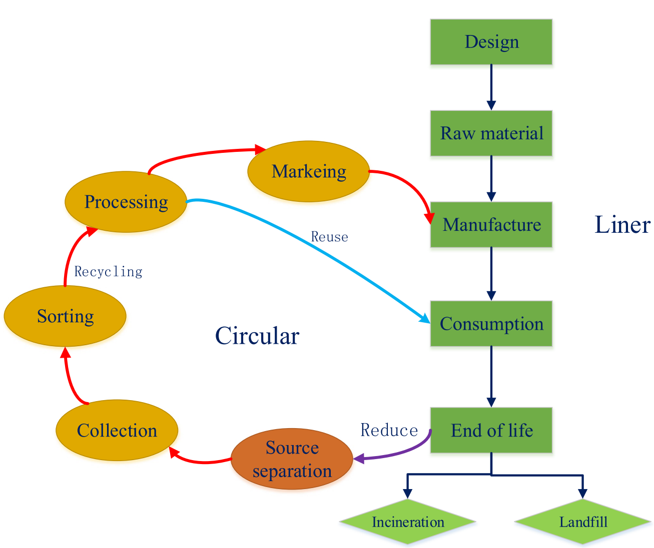

Fig. 1. Linear and cyclical resource flows.

2. The challenge of solid waste

2.1. Industrial waste

2.1.1. Industrial waste generation

Industrial waste is generated by industrial activity, such as that of factories, mills and mines. It is still often a significant portion of solid waste. In 2011, the global generation was about 9.2 billion tons (including construction waste) (See Table 1), and per capita industrial waste is approximately 1.74 tons/year in the world. As shown in Table 1, more than 50% was generated in Asia and the Pacific, especially in China (3.2 billion tons in 2011) (Frost and Sullivan, 2012; Wang et al., 2010).

As is indicated in Fig. 2, industrial waste in developing countries (such as China) has a fast increasing trend in the foreseeable future, while for the developed countries, industrial waste generation is tending to stability or will decrease slowly (such as in Spain) (NBSC, 2013; Frost and Sullivan, 2012). In addition, comparing with the developed countries (more than 90% collection rate), many developing countries remain at lower collection and recycling rate (China 67% in 2010; India less than 50% in 2010). Thus, the developing countries are facing with more challenges from industrial waste.

2.1.2. Environmental concerns

Regarding the industrial waste (especially for hazardous waste), illegal dumping and transboundary movement commonly attracts more attention due to their potential threats on environment and human health.

Illegal dumping is a persistent problem because it threatens human health and the environment, imposes significant costs on communities, and has an adverse effect on public welfare (Lega et al., 2012; Penelope et al., 2010). Illegal dumping often attracts more illegal dumping. Due to large generation of industrial waste, not all the waste can be collected and treated, therefore enormous industrial waste was illegally dumped, especially in the developing countries (Chartsbin, 2013).

Industrial waste producers are continuously faced with the problem of disposing of their waste and must choose from a number of different disposal and treatment options. Increasingly, they are choosing to export the waste to other countries (most are developing countries) (Huang et al., 2012; Kojima et al., 2013). It is very difficult to estimate how much hazardous waste is exported every year. The transboundary movement not only refers to the waste export, but also means environmental pollution transfer from the developed countries to developing countries. This is because most developing countries often own poor waste recycling and treatment facilities, and most waste was treated in the informal recycling sectors or directly dumped into the surrounding environment (Salihoglu, 2010; Thomas and Fannin, 2011).

Some serious environmental events occurred due to the illegal dumping and transboundary movement. In 2011, a chemical industrial company in Yunnan Province illegally dumped 5222.38 tons chromium slag (Peoples, 2011). In 2006, a ship registered in Panama, the *Probo Koala*, chartered by the Dutch-based oil and commodity shipping company Trafigura Beheer BV, offloaded toxic waste at the Ivorian port of Abidjan (Maantay and McLafferty, 2011).

The reasons, why illegal dumping and transboundary movement happened, mainly associated with the potential economic benefits (Havocscope, 2013), e.g., the cost to a European company to properly dispose of toxic waste can cost around $1000 per ton, if illegally dumping the materials, the cost would be about $2.50 for one ton; The cost to legally incinerate trash in the Netherlands is 4

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