City, Culture and Society 2 (2011) 177–187

Contents lists available at SciVerse ScienceDirect

City, Culture and Society

journal homepage: www.elsevier.com/locate/ccs

Urban growth and waste management optimization towards 'zero waste city'

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ARTICLE INFO

Article history:
Accepted 30 November 2011
Received in revised form date 10 November 2011
Accepted 30 November 2011
Available online 24 December 2011

Keywords:
Sustainable waste management
Zero waste concepts
Zero waste city
High consuming cities
Urban growth
Adelaide
Stockholm

ABSTRACT

Today, many developed cities such as Stockholm, and Adelaide are aiming to transform their current waste management practice into a more efficient and sustainable way, called zero waste practice. Increasingly people move from rural to urban environments due to the economic activities and quality of life provided to inhabitants, causing cities to expand. Over-crowded cities are compromising the quality of urban life due to their rapid growth and ever-increasing generation of waste. The concept of the "zero waste city" includes a 100% recycling rate and recovery of all resources from waste materials. However, transforming current over-consuming cities to zero waste cities is challenging. Therefore, this study aims to understand the key drivers of waste management and the challenges, threats, and opportunities in transforming traditional waste streams and optimizing practices toward zero waste practices. Part of this study is an in-depth case analysis of waste management systems in two cities, Adelaide and Stockholm. Cities from high consuming countries, such as Australia and Sweden, have been analyzed based on five waste management contexts: social, economic, political, technological, and environmental. In addition, key drivers are identified. Both Adelaide and Stockholm have the vision to become "zero waste cities". The study concludes that strategies based on tools, systems, and technologies can assist cities in their transformation into "zero waste cities"; however, they must also be affordable, practicable, and effective within their local regulatory framework.

Introduction

Currently, half the world's population lives in urban areas and almost all regions of the world will be predominantly urban by the middle of this century (UN-HABITAT, 2008, p. IX). Urbanization is higher in high-consuming counties compare to low-consuming countries, for instance in Australia, one of the highest consuming countries on earth, almost 89% of people live in urban areas (Lehmann, 2010a, p. 20). Cities that generate economic growth (Lehmann, 2010a, p. 20) create mega-regions, urban corridors, and city regions depending on various urban forms. However, people move from inner cities to "satellite" or dormitory cities and suburban neighborhoods because of more affordable housing and living conditions (UN-HABITAT, 2008, p. IX).

Designing sustainable cities is very challenging. Among all key challenges, waste management is one of the most important challenges for sustainable city design. In high consumption cities in the industrialized world, large amounts of paper waste, over-packaging, food waste, and e-waste are all causing particular problems. "Zero waste" means designing and managing products and processes systematically to avoid and eliminate the waste and materials, and to conserve and recover all resources from waste streams (ZWIA, 2004). Therefore, zero waste cities would recycle 100% of their waste or recover all possible resources from waste streams and produce no harmful waste for our environment. From the holistic point of view, designing zero waste cities is relatively hard to achieve.

Today's consumption-driven society produces an enormous amount of waste. This large amount of waste creates a huge pressure for the city authority to manage waste in a more sustainable manner. Waste management systems have not received as much attention in the city planning process as other sectors like water or energy. Therefore, gaps can be observed in waste management in current city planning.

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doi:10.1016/j.ccs.2011.11.007

Waste management systems include socio-economic, political, environmental, and technological aspects and have many stakeholders. All these aspects are inter-related and dynamic in nature. Therefore, waste management systems create a complex cluster of different aspects, and functions of this complex cluster are also dynamic and interdependent. Global climate change and its various effects on human life drive current society toward a more sustainable society. Depletion of finite global resources forces us to consider resource and product stewardship. Therefore, "zero waste" management is a holistic view of preventing and managing waste and resources in a sustainable city.

The aim of this study is to analyze the challenges, threats, and opportunities to transform traditional waste management practice toward zero waste practice. Part of this study has been done by case studies of waste management systems in Adelaide and Stockholm and lessons learnt from case studies to identify the key challenges, threats, and opportunities in city design. Waste management systems in Adelaide and Stockholm have been analyzed in the contexts of socio-political, economic, environmental, and technological contexts. Based on the case studies and findings, key recommendations are formulated and presented as guiding principles for zero waste cities.

This study focuses on municipal solid waste (MSW). Therefore, heavy industrial, clinical, agricultural, radioactive, and mining waste are excluded from this study.

Materials and methods

The study is based on a literature review and two case studies in Adelaide and Stockholm. Qualitative and quantitative data analysis has also been done and case studies have been conducted to identify five core aspects of sustainable waste management. This study has been conducted with a practice-based research methodology. Practice-based built environment research includes case-based, evidence-based, and performance-based research modes (Lee, 2011). In this study only case and evidenced-based research methodology has been considered to identify the key challenges, threats, and opportunities for designing zero waste cities.

Fig. 1 shows the contexts that have been analyzed during the case studies. Five different contexts, namely, (i) social (ii) economic, (iii) political, (iv) technological and (v) environmental aspects are explored in the case studies of municipal solid waste management systems in Adelaide and Stockholm.

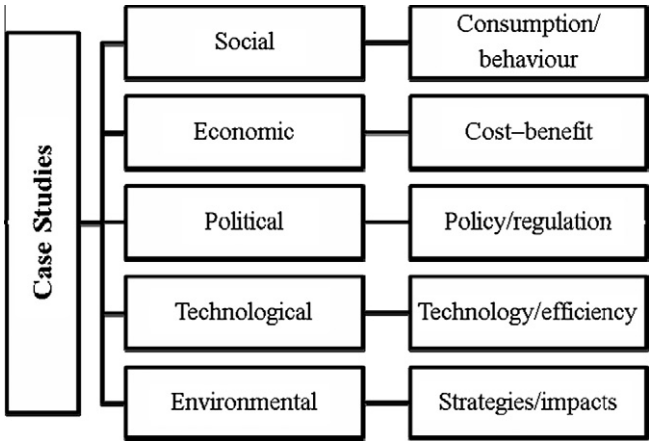

Fig. 1. Framework for case studies.

Municipal solid waste

Waste can be defined in different manners based on various perceptions. For instance, one person might discard something they see as waste; however, the same thing could be treated as a resource by another person. One such example is "e-waste": the "e-waste" of high-consuming counties is used as resources in low-consuming countries. Municipal solid waste includes different sources of generation such as residential, commercial, institutional, industrial, and municipal (Pichtel, 2005, p. 6). The composition of waste also varies depending on its source. Table 1 shows the common municipal solid waste generation as a function of source.

The concept of "zero waste city" from the 'eco-city'

The nature of the city is dynamic and ever changing. In the current over-consuming society per capita waste generation is relatively higher in high-consuming cities compare to low-consuming cities. Currently, many cities are designed or planned based on "eco-city" concepts and those cities are designed to deliver a high quality of life to their residents. Completed "eco-city" projects such as Vauban Freiberg (Germany), Hammarby Sjöstad (Sweden) and uncompleted projects for example Masdar City (UAE), Tianjin Eco-City (China) are designed to offer a good quality of life. All those eco cities are designed by considering sustainable city design practices. Population density of those completed and uncompleted "eco-cities" were between 50 and 150 people/ha (Lehmann, 2010a, p. 111). However, there can be argument on the definition of a true "eco-city"; for example a modern city built with a high ecological footprint is not an "eco-city"; moreover, it is not possible to accommodate all the world's people in the limited global land area in the same design criteria.

The concept of eco-city is generally used in broader sense. Philosopher and author Richard Register first coined the term 'eco-city'(Ekblaw, Johnson, & Malyak, 2009). Eco-city enhances the well-being of its citizens and of society through integrated urban planning and management that fully harness the benefits of ecological systems and renewable energies- aiming for zero-emissions and zero-waste (Lehmann, 2011, p. 853). Therefore, the concept of zero waste is a subset of the concept of eco-city. The concept of the "zero waste city" includes a 100% recycling rate and recovery of all resources from waste materials generated in the city. Cities attract people because of the economic and social activities and quality of life offered to their inhabitants. However, inadequate urban management, often based on inaccurate perceptions and information, can turn opportunity into disaster (UNFPA, 2007, p. 15).

Cities are not only over-populated and over-consuming in nature but also deplete global finite natural resources at a high rate. There is a positive relationship between urbanization and poverty (UN-HABITAT, 2008, p. 24) and the relationship indicates that expanding cities in a