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Sustainable management of municipal solid waste in Asia

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Abstract
Considering the importance of sustainability in urban communities, solid waste management is one of the modern sciences in the world that if it is achieved, the effects and injuries of consumption in various dimensions can be significantly reduced; Because the abundance of solid waste is an inevitable result of development and consumption and the lack of proper management in line with current knowledge is one of the important factors of environmental pollution. The world tends to limit the diversion of solid waste management systems towards sustainability. Asian countries are deeply involved in this development. The study assesses several Asian countries to identify issues related to solid waste management and presents a strategy for improving sustainability as a roadmap.

Keywords: Management, Sustainability, Environmental, Economic, Social

Introduction and Goal

The production of solid waste is a natural result of human life. Eliminating these wastes improves the quality of life. Initially, solid waste management (SWM) techniques were simply used to remove waste from adjacent residential areas as a way to maintain public health. After understanding the dangers of uncontrolled disposal, measures have been taken and implemented mainly through sanitary landfill. In recent years, a variety of materials and energy recycling technologies have been designed and are now incorporated into modern systems.The importance of sustainable development and sustainability in energy systems for policy makers and decision makers around the world is increasingly growing. The main goals of global politics include economic growth, security of energy resources, and mitigation of the effects of climate change. In order to meet these goals, the policy needs to examine and integrate all three dimensions of sustainability.Various studies have been conducted in the field of sustainability. In a study, Maxim evaluated the sustainability of power generation technologies with a life cycle approach. He examined 10 indicators of sustainability, of which 2 are environmental indicators, 4 are technological-economic indicators and 4 are social indicators. It should be noted that Maxim did not analyze the scenarios in this study (Maxim, 2014).

In 2011, Keles et al. Examined important scenarios for electricity generation in Germany with a 2030 time horizon. They also analyzed four scenarios and did not include the study of sustainability indicators in their study (Keles et al, 2011).

In 2011, Jaswani et al. Evaluated options for generating electricity from biomass. They conducted their studies using life cycle assessment as well as review of 7 sustainability indicators which include 5 environmental indicators and 2 economic indicators. It should be noted that they did not analyze the scenarios in this study (Jeswani et al, 2011).

In 2010, Rovere et al. Proposed a method for analyzing the expansion of electrical stability. In their study, they examined 15 sustainability indicators, which include 5 environmental indicators, 3 economic indicators, 3 social indicators and 4 technology indicators. It should be noted that their view in the research was not to evaluate the life cycle and also not to analyze the scenarios (Rovere et al, 2010)

In 2009, Roth et al. Evaluated the sustainability of several examples of power supply technologies. Their goal is to find the best available business options and future technologies and their time horizons in this 2030 study. In this study, they have conducted this research by considering life cycle assessment and also considering 75 sustainability indicators which include 11 environmental indicators, 31 economic indicators and 33 social indicators (Roth et al, 2009).

Global efforts are now underway to limit the diversion of SWM systems towards sustainability. Asian countries are deeply involved in this development. However, the degree of attention to stability varies from country to country and is directly related to the economic situation. The study evaluates several Asian countries to identify SWM-related issues and proposes a strategy to improve the sustainability of SWM Asia.

Research Method

Situation analysis

Asia is a vast and heterogeneous region, with many developed economies such as South Korea and Japan, as well as developing economies such as India, China, and Indonesia. In most cases, solid waste is generated in cities and managed by municipal institutions. These services are provided for the scattered urban population in most Asian countries (Othman et al, 2013).

Urbanization in Asia

Over the past 50 years, many Asian countries have experienced rapid economic development and social change, which significantly affects urban life. Six of the world's 10 most populous countries are in Asia, including China, India, Indonesia, Pakistan, Bangladesh and Japan. The continent has a population of 7.3 billion, or about three-fifths of the world's population. Of these 7.3 billion people, 1.38 billion are urban dwellers, and this figure represents about half of the world's urban population. In the Sino-Indian-dominated region, it has more than 200 cities with a population of more than 1 million and 21 cities with a population of more than 5 million (Othman et al, 2013).

In 1950 the population was 4.1 billion, in 1975 the population was 4.2 billion and in 2002 it was 7.3 billion. During the same period, the urban population increased more than 5.5 times, from 244 million in 1950 to 38.1 billion, and by 2030, 54% of Asia's population (approximately 7.2 billion) is expected to live in urban areas (Othman et al, 2013).

The list of world regions includes Hong Kong, Singapore, Seoul, Taipei, Tokyo, Osaka, Bangkok, Mumbai, Delhi, Shanghai and Beijing. These areas are sometimes named as global cities due to their increasing participation in international trade. In most countries, efforts are being made to improve infrastructure and services, including SWM (Othman et al, 2013).

Solid waste management

Asia is known for its mixed culture as far as climate, economy, food and topography are concerned. This is reflected in SWM systems. SWM is important for a variety of reasons, including population concentration in urban areas, legal interventions, the emergence of new technologies, and the importance of health care. A typical SWM system is shown in Figure 1 (Ambulkar and Shekdar, 2004).

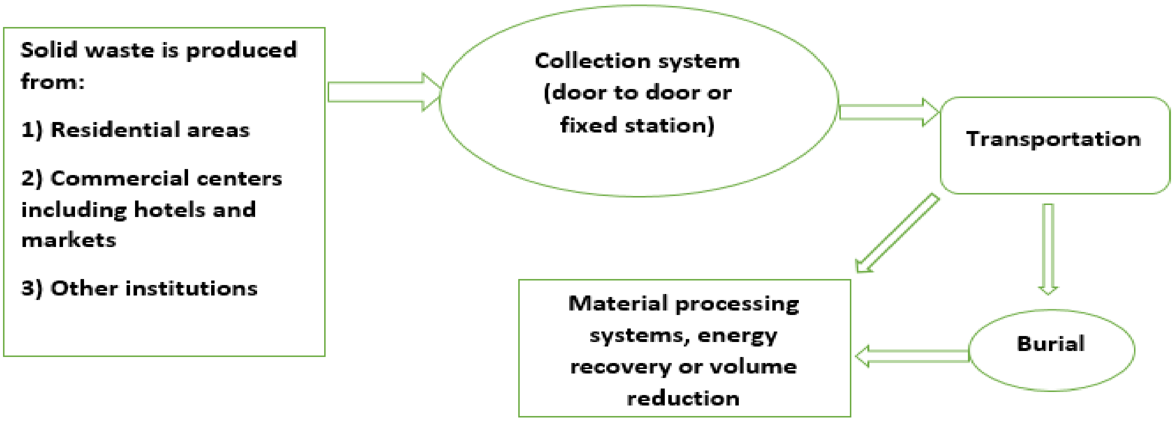

Figure 1. Conventional systems for solid waste management

Solid waste generation

There are many different sources of solid waste in cities. Waste is generated from residential areas, commercial establishments, public and private institutions, and private entities. In many Asian countries, solid waste is defined by law according to certain categories. However, in fact, everything or everything that is thrown away by the citizens should eventually be managed by the municipalities (Chung and Poon, 1998).

Municipal solid waste (MSW) includes all household and non-hazardous waste including commercial and organizational waste, street waste and construction waste (Hui et al, 2006).In some countries, the SWM system also uses waste generated by disposal processes such as incinerators, reservoir sludge, and sewage sludge. If these wastes have obvious hazardous properties, they should be treated as hazardous wastes. Table 1 shows the main sources of MSW, waste generators, and types of solid waste generated (Hui et al, 2006). The amount of solid waste production is mainly proportional to the economic situation of a society.

Table 1- Sources and types of municipal solid waste

Resources	Waste producers	Types of solid waste
Residential	Single and multi-person houses	Food waste, paper, cardboard, plastic, textiles, glass, metals, ash, special wastes (large items, consumer electronics,

		batteries, oil and rubber) and hazardous household waste
Commercial	Shops, hotels, restaurants, markets, offices, buildings	Paper, cardboard, wood, food waste, glass, metals, special wastes, hazardous wastes
Organizational	Schools, government center, hospitals, prison	Paper, cardboard, wood, food waste, glass, metals, special wastes, hazardous wastes
City Services	Street cleaning, landscaping of parks, beaches, recreational areas	Street roads, tree restoration, public waste from parks, beaches and other recreational areas.

Solid waste collection

Solid waste generated in urban areas is collected by fixed stations or door-to-door collection systems. In developed countries, in the case of the fixed station system, citizens collect waste at a location designated by the municipalities on a specific day of the week at a specific time. Instead, in door-to-door collection, vehicles go to individual homes at a specific time to collect waste. Public participation, awareness and cooperation in developed countries is satisfactory, and therefore urban areas in general are often clean (Othman et al, 2013).

In developing countries, a social location (bin) installed or is set to a specific station and local residents. Elsewhere, an improvised form of house-to-house gathering involves a worker with a wheelbarrow crossing every street. He rings a bell so that the locals notice that he is coming, after which they throw their waste in the cart. When the cart fills, the worker dumps it either in large bins or in a garbage truck. In most cases, public participation is limited. As a result, it is not uncommon to see scattered debris around bins (Othman et al, 2013).

Processing and retrieving resources

Solid waste is processed for recycling or to reduce its volume, and its contamination potential is reduced for landfills. The sustainability of the recycling sector depends on its cost, and this is largely determined by the economic situation of a society. In developing economies, where the percentage of recyclable particles such as paper, glass and metal is low, their recovery and recycling is mainly done by small industries (Othman et al, 2013).

Incineration has also been developed as a heat treatment method for the combustible parts of solid waste. The goal is to reduce the amount of waste required for final disposal and to recover the heat released during combustion. This process is expensive due to the sophisticated technology required for large-scale combustion and air pollution control (Dong, 2006).

Final disposal

Solid waste that is not processed by other processes and remains, and other materials left after processing, are eventually disposed of by sanitary landfill. In developed economies, aggressive preventive measures are taken to separate discarded materials from the environment. However, these practices greatly increase the cost and technology of the sanitary landfill process. Many efforts are being made to maintain control or implement landfilling of sanitary waste to minimize environmental pollution (Kathirvale et al, 2003).

Factors influencing the poor performance of developing economies

Inadequate resource management

Solid waste management is less of a priority for local authorities, resulting in lower funding. In some cases, there is a common budget for municipal wastewater collection and treatment and solid waste management, with solid waste management receiving a small share of the total budget (Pasang et al, 2007).

Inadequate technology

The equipment and machinery recently used in the system are usually designed and developed for general purposes or adopted from other industries. The use of such equipment for solid waste reduces its effectiveness (Lu et al, 2006).

Factors affecting developed economies

Higher economic standards

This factor increases the amount of waste production and excessive use of plastic and paper in daily life (Pasang et al, 2007).

Sustainable solid waste management and strategy-based urban planning

Worn-out countries provide significant financial and regulatory resources for the recycling of waste particles such as glass, metals, paper and plastics. These countries can provide such investments even if there is no license for recyclable materials.

In contrast, in developing economies, recycling is an economic activity for a particular segment of society. In addition, spending money on expensive recycling systems may not be possible, even if there is a growing awareness of the need for sustainable development. Environmental standards and enforcement mechanisms can be set to align with society's expectations for waste management efficiency. Technology-driven developments and operating conditions determine the types of systems that can be installed. Public awareness also plays an important role (Pasang et al, 2007).

An integrated approach to sustainable solid waste management

SWM can be considered as a material management system that is distributed throughout the city to collect a collection of solid waste and then transport around the city for processing and disposal. In addition, the system provides services to the public, employs a significant number of people, and requires significant resources in a variety of forms (Pasang et al, 2007).

The concept of integrated solid waste management systems is accepted. Under this model, all system components are selected simultaneously for rational planning and effective execution. The result of the system configuration ensures component compatibility, thus improving overall performance. However, solid waste management is not only a technology-driven system but also facilitates the management and disposal of solid waste. Solid waste management also depends on other factors such as socio-economic conditions, work environment and urban government actions (Othman et al, 2013).

Appropriate technology

All types of management equipment, including vehicles for transportation, processing machinery and disposal equipment must be appropriately designed in accordance with the characteristics of the waste. For example, in low-income countries where waste is low in calories, heat treatment may not be appropriate. Technology must be developed in accordance with local conditions. Sanitary landfilling technology should be widely used to allow landfill space for longer periods (Pasang et al, 2007).

operation management

Operating systems include material handling and refining processes that use waste to generate, transport, process, and dispose of waste from various sources on a regular basis. Methods and procedures for each component of the system must be clearly defined and there must be integrated mechanisms for monitoring and controlling operations (Othman et al, 2013).

Findings

Sustainability is a popular word today. Everyone, from manufacturers and service providers to international policymakers, uses the term in one context or another. It is estimated that the current rate of resource extraction is ten thousand times higher than the rate of natural resource production. In the foreseeable future, this ratio is unlikely to change significantly. In addition, it is not clear whether SWM can help in a meaningful way. Thus, it is better to develop a sustainable SWM instead of a SWM for a sustainable community. The SWM system must be compatible with both the financial capacity of a given community and the capacity to absorb the environment.

The Asian continent is a mix of complex cultures, a combination reflected in solid waste management systems. Countries like Japan show that a sustainable approach is possible through solid waste management. At the same time, countries like China are trying to meet the new demands of aggressive development.

For any nation, solid waste management is a must. At present, the public service system is significant and needs to be delivered to the community to maintain public aesthetics. Urban organizations must plan and implement the system taking into account urban population growth. Today, Asian countries have the potential to provide sustainable SWM systems through an integrated approach. Principled efforts are needed to improve a variety of factors, including policies and legal frameworks, organizational arrangements, financial regulation, technology, operations management, human resource development, and public participation.

Discussion and conclusion

Given the extent of sustainability and its applicability in management issues, researchers have moved towards the use of sustainability. In the discussion of sustainable management of municipal solid waste, research has been done that has often integrated social, economic and environmental dimensions. In some studies, indicators have been used for more accurate evaluation. The present study also examines the sustainability of the solid waste management system in some Asian cities in order to finally find a general perspective for future decisions by comparing developed and developing countries.

In future research, approaches such as life cycle assessment or LCA can be combined with sustainability. It is also possible to make more precise decisions by considering different indicators for their dimensions of stability and weighting and using techniques such as hierarchical analysis or AHP.

Resources

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