

Municipal Solid Waste Management in Cambodia

Subjects: **Environmental Sciences**

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Municipal solid waste (MSW) management is one of the utmost challenges for Cambodia's city and district centers. The unsound management of MSW has detrimentally affected the environment and human health.

composting

incineration

landfill

municipal solid waste

recycling

1. Introduction

Solid waste management is an emerging concern for countries around the world, particularly developing nations with limited financial resources, lack of technologies, and an absence of policy framework [1][2][3][4]. In 2016, global waste generation was estimated at 2.01 billion tons with per capita generation at 0.74 kg/day, and the East Asia and Pacific countries shared the highest proportion (23%), followed by Europe and Central Asia (20%) and South Asia (17%) [5]. Developed countries seem to have a higher annual growth rate at 3.2–4.5%, while the yearly growth rate in the developing world is 2–3% [6]. An increase in waste generation is generally associated with population growth, rapid urbanization, and national GNP [1].

Rapid economic growth in recent years has spurred Cambodia to devote effort to waste management challenges [7]. Solid waste in Cambodia is classified into three categories: household waste, commercial waste, and industrial and hazardous wastes (including medical waste) [8][9]. However, there is no consensus on this classification, and the up-to-date data are relatively limited [10]. Municipal solid waste (MSW) combines wastes from households and commercials [11], generated from households, markets, restaurants, shops, hotels, offices, street sweepings, and miscellaneous [12][13]. Rapid urbanization and industrialization have led people to migrate to cities to obtain better jobs, a higher education, and access to health care services, making waste generation unpredictable. The data on MSW generation are mainly estimated based on population and constant generation rate in the entire country, and the reliable data of MSW generation are hard to come by.

MSW composition is primarily food and organic waste (52–63%) [12][13], usually disposed of by mixing with plastic, glass, textile, paper, and other fractions without separation at the sources. An increase in population, rapid urbanization, economic growth, and improved living standards are the main factors affecting MSW generation, in terms of both quantity and quality [14]. The change of lifestyle and consumption patterns is also a driving force behind a rapid increase in MSW in the country [15]. For example, the use of plastic cups, plastic straws, and plastic bags for takeaway coffee is becoming more popular in Cambodian society. Another example is using plastic bags and Styrofoam containers for packaging food instead of reusable containers. These practices may not only pollute the environment but also negatively affect human health. Jadhav et al. illustrated that using plastic materials for packaging food and beverages releases microplastics and toxic substances, which may be harmful to consumer health [16].

A rapid increase in MSW in urban areas has put pressure on the collection and management system. The collection service is mostly prioritized in populated areas with good infrastructure and high commercial activities due to lack of transportation and low revenue collection [13][17]. In 2021, approximately 2.10 million tons of MSW were collected from 204 city and district centers [12] with an average rate of 72% [18]. The collection rate varies by city and district. Phnom Penh, the municipality of Cambodia, has the highest collection rate at 91–92% [5][19]. The limitation of public awareness and participation also poses a challenge for the environmentally sound management of MSW. Cambodia has no large-scale waste treatment and recycling

facilities. The lack of waste treatment technologies and infrastructures has shortened the lifespan of landfills since most MSW collections are directly sent to landfills without intermediate treatment [17]. The effort to reduce and reuse refuse materials is still weak, and the management of landfills is poor. In recent years, the government has made many efforts to enhance MSW management by developing new regulations, policies, strategies, and guidelines. However, the question is how such instruments can be effectively implemented towards the sustainable management of MSW by taking account of environmental, economic, and social aspects.

2. MSW Generation, Characteristics and Composition

2.1. MSW Generation

MSW has been observed to increase substantially in the past decades and vary from place to place. The generation of MSW is generally associated with population growth, economic conditions, standard of living, and urbanization [13][20][21][22][23]. However, the robustness of national data in Cambodia is hard to obtain and inconsistent among the sources, except for Phnom Penh Municipality (PPM), where the data are more available and reliable after installing the weighting bridge at the landfill site [13].

The aggregate data of MSW throughout the country revealed a linear increase trend from 2.50 million tons in 1990 to 4.24 million tons in 2016 [24]. Akenji et al. reported 4.09 million tons of MSW generation with a generation rate of 0.73 kg/capita/day in 2015 [9]. The MoE estimated that approximately 4.78 million tons of MSW were generated in 2020 with per capita generation at 0.78 kg/day, while the global average per capita was 0.74 kg/day [5]. An increase in MSW in the cities and districts of Cambodia is significantly influenced by population growth and the movement of people from rural to urban areas [10]. In addition, the World Bank reported that a rapid increase in MSW in Cambodia was caused by an improvement of living standards and an increase in economic activities from the tourism, construction, and industrial sectors [25].

Urbanization has positively influenced MSW generation in developing countries where the gap in economic activities and living standards between rural and urban areas is significant, and MSW per capita in the urban environment has shown to be higher than that in rural areas [26]. Furthermore, the difference is also observed among cities; high-income cities are more likely to generate more MSW per capita than those with lower incomes [1]. For example, a recent rapid development, per capita MSW generation in PPM was 1.32 kg/day in 2016 [27], almost double the country's average value [9][28].

The global MSW generation is expected to increase from 2.01 billion tons in 2016 to 3.40 billion tons by 2050, and the low- and middle-income countries are projected to have the highest increase rate, by at least 40% [5]. In Cambodia, MSW generation is expected to increase by 36% by 2050 with per capita generation from 1.16 kg/day in 2030 to 2.13 kg/day in 2050 [24]. This drastically increasing trend may cause landfills, particularly in large cities such as Phnom Penh, Sihanouk Ville, Siem Reap, and Battambang, to rapidly reach their capacity limit.

2.2. MSW Characteristics and Composition

Waste characteristics greatly depend on socio-economic conditions [29]. Other factors such as food habits, cultural traditions, climate, and socio-economic factors of households, including average family size, house size, employment status, and income, significantly influence waste characteristics and composition [11][30]. MSW typically includes food waste (kitchen waste, food waste, vegetables, snacks, etc.); paper (office paper, newspaper, booklets, cardboard, etc.); plastic (plastic bottles, PET bottles, plastic bags, foam plastic, etc.); metals (ferrous can, ferrous scrap, aluminum scrap, copper, etc.); textile (cloth, fabric, cotton, etc.); glass (glass bottles, broken mirrors, etc.); wood and dry matter (branches, grass, trim, etc.); and others (ceramic, brick, inert materials, stone, etc.). Bulky wastes such as furniture and packaging materials are broken up into

pieces before disposal. Food waste is the most dominant garbage in all locations, in which Kampong Chhnang has the highest proportion, while the lowest is Phnom Penh. Plastic waste was the second top, followed by paper.

In PPM, the composition of MSW has changed over the years. Food waste drastically declined from 87% in 1999 to less than 50% in 2015, while plastic waste showed an increasing rate from 6% to 21% in the respective years (Figure 1). Changes in waste composition are mainly due to the economic boom and changes in living standards and consumption behaviors [15]. The information on waste composition is significant for selecting and developing appropriate handling methods and treatment technologies based on each type of waste [31].

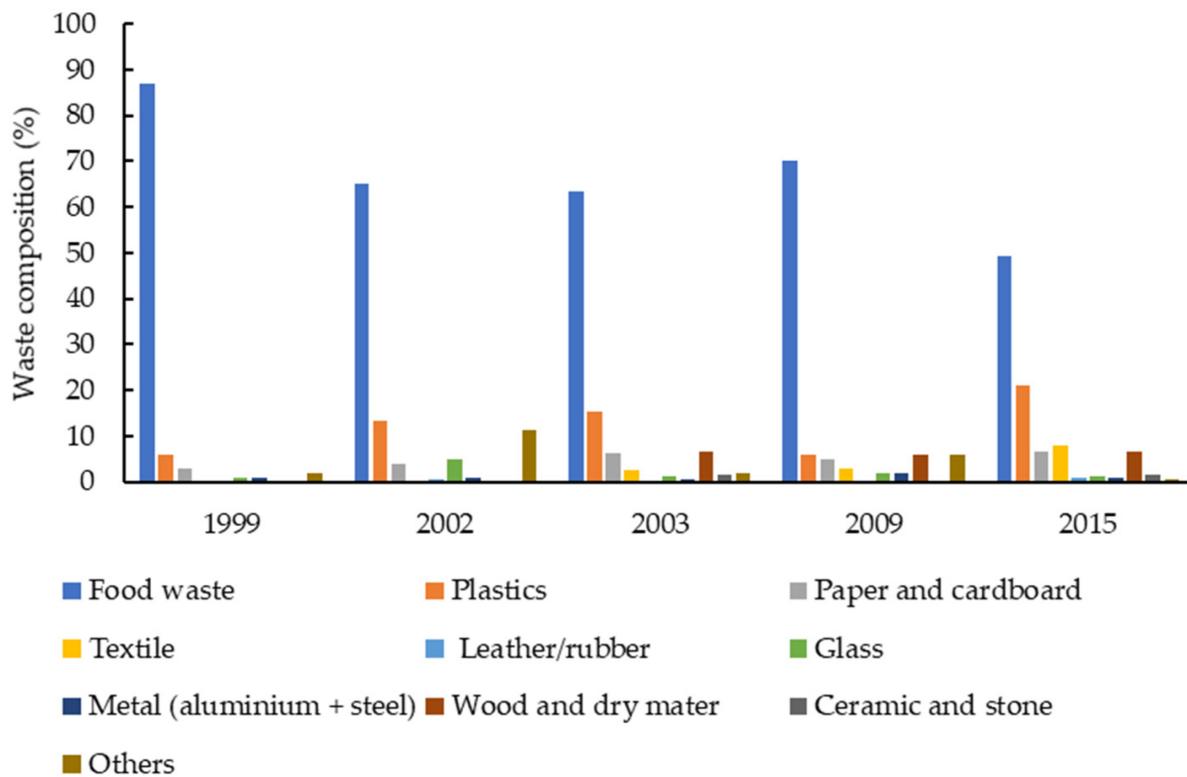


Figure 1. Waste composition in Phnom Penh municipality. Adapted from [12][32][33][34].

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