Municipal Solid Waste Management Practice in China——

A Case Study in Hangzhou

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Abstract. The management of municipal solid waste (MSW) in China is facing urgent problems with rapid industrialization and urbanization. This article focused on the status of Hangzhou, capital city of Zhejiang province, China. The regulations, policies, implementation, barriers and solutions about source separation, separate collection, clean & direct transportation, treatment and disposal were introduced. Source separation, separate collection and clean & direct transportation were seriously carried out from 2010. MSW was classified into four kinds, such as kitchen waste, hazardous waste, recyclable waste and other waste. Four kinds of wastes were collected, transported, treated and disposed, respectively. At the same time, a questionnaire survey was conducted in 2011 on 200 households in Xiasha and Gongshu Districts in Hangzhou. The results indicate that many citizens cannot effectively and correctly separate different kinds of solid wastes. Kitchen waste was directly disposed in landfill, because there is no composting plant in Hangzhou City. The collection of recoverable waste and hazardous waste was not in control of municipal solid waste management (MSWM) system. In order to optimize MSWM system in Hangzhou, the government and the citizen must make efforts in source separation, comprehensive treatment system, effective regulations and policies.

Introduction

With rapid industrialization and urbanization in China, municipal solid waste (MSW) has increased dramatically and its composition has significantly changed, which caused huge pressure on the environment, human health, and MSW management (MSWM) systems [1]. As one of the world’s fastest developing countries with an average annual GDP growth of 8%, resource shortages and municipal solid waste management problems have became a key constraint for China’s sustainable development.

MSWM is an integral part of urban environmental planning. Sustainable MSWM system should be not only environmentally effective and economically affordable but also socially acceptable [2]. There are many overviews that have been written to discuss MSWM, including the status and challenges, in China [1,3-5].

Under the Law of the People’s Republic of China on the Prevention of Environmental Pollution
Caused by Solid Waste amended in 2004, relevant administrative and ministerial regulations were issued by various governmental agencies. For example, the statute of “Management Measures on Urban Waste”, issued in 2007, pinpointed the principles of waste reduction, recycling, and recovery (3R principle) [6-8].

In this paper, the MSWM in China, especially Hangzhou City was introduced. A questionnaire survey was conducted in 2012, in order to collect information about the attitude of the citizens towards MSWM in Hangzhou. Two hundred people in the Xiasha and Gongshu Districts were interviewed, with an effective response rate of 100%. Some suggestions on MSWM in Hangzhou were also given according to the survey results. Through investigating and analyzing the whole MSWM system in Hangzhou, the drawbacks will be put forward, which is helpful to promote MSWM in Hangzhou. At the same time, MSWM in Hangzhou can be used as a reference to other cities in China.

Methodology

The survey was conducted in two aspects. One survey object is the government, the other is the citizen. According to the government, the methods included consulting work reports and literatures, analyzing the results and data from these literatures and reports. Printed questionnaires were distributed to the citizens in investigation area. There were three parts in the questionnaire: (1) general personal information, including age, occupation, education level and income; (2) Awareness on MSWM and practical action in waste classification, such as ‘How does MSW cause harm on the environment?’, ‘What is the MSW separation method in your community?’, ‘Do you separate household waste?’, ‘Do you sell recoverable waste to door-to-door collectors? ’; (3) Evaluation and suggestion on MSWM, such as ‘Do you think that source separation is reasonable?’, ‘Do you think that the propaganda and lectures about source separation is in place?’ , ‘Do you think that the environment and sanitation is improved?’. The Xiasha and Gongshu districts were selected as the questionnaire survey regions considering both of the districts being the earlier stage pilots.

Results and discussion

Municipal solid waste generation and composition. MSW generation in China has increased rapidly in recent years. In 2011, the total MSW generation was approximately 164 million tons, quantity and proportion of harmless treatment was 130 million tons and 79.8%, respectively (Fig. 1).

![Fig. 1 Amount of MSW disposal, quantity and proportion of harmless treatment from 2007 to 2011 in China. Data resource: China Statistics Yearbook on Environment from 2007 to 2011 [9-13]](image-url)
According to Hangzhou Environment Bulletin, the total MSW amount has increased year by year. From 2011 to 2012, the quantity of MSW was increased from 261.06 to 281 (×10⁴ tons) [14, 15]. MSW in Hangzhou is composed by organic garbage, paper, plastic, glass, metal, textile fiber, wood timber and ash, etc, according to the literature (Fig.2). Compared to Singapore and Berlin, the percentage of food garbage in Hangzhou is very high, while the percentage of metal, paper and plastic is very low [16].

![Fig.2 MSW composition in Hangzhou city [17]](image)

**Source separation.** Source separation can reduce the cost of treatment and disposal, increases the quality of produced compost, improves the recyclables ratio and optimizes incineration.

In developed countries, source separation is generally adopted. The collection of recyclables is collected and transported by the communities and the municipal government or recyclables collection companies within the MSWM system [18].

In most regions of China, all kinds of MSW are mixedly dumped. But now, some economically developed cities, such as Beijing, Shanghai, Guangzhou, Hangzhou, have implemented source separation. In Hangzhou, MSW was classified into four kinds, such as kitchen waste, hazardous waste, recyclable waste and other waste. Since waste source separation pilot has been carried out in 2010, more than 800 residence communities promoted source separation of residential garbage in the urban area (except Binjiang District), accounting for 60% of the total living area, covering 407,000 households [19]. The government supplied free kitchen waste bin, other waste bin and kitchen waste bag (throwaway bio-degradable plastic bag) for each household. At the same time, the specific separation methodology was publicized through poster, media, the community and the volunteers. To strengthen source separation, real-name system was carried out in some communities and garbage bag was marked the building number [20].

Our questionnaire in Xiasha and Gongshu Districts showed that only 30% of the respondents really carried out source separation. Based on our observation on garbage bins and citizen’s behavior, many citizens did not put different garbage into corresponding bag and bin. Some citizens even directly dumped kitchen waste (not packed in plastic bag) into garbage bin. Although 92% of the respondents denoted that they are in favour of recycling, they did not truly translate this into action due to the several kinds of reasons. In Chinese city, household work is mainly achieved by the elder who live with their children. These older citizens are mostly from rural area and do not realize the importance of waste separation. They consider that separation is troublesome and time-consuming. Some elder citizens are uncertain of their garbage belonging to which kind waste. Moreover, some citizens are afraid that garbage did not be treated separately after their source
Our questionnaire showed that 8% of the respondents sold waste batteries and mobile phones to door-to-door collectors. 38% of the respondents dumped waste batteries into other waste bin. 98% of the respondents collected and sold recoverable waste to door-to-door collectors.

**Collection and transportation.** The collection and transportation of MSW are very important in the whole MSWM system, because between 75% and 80% of the MSWM budget is spent on collecting and transporting waste [21].

In China, recyclable wastes from daily use are often collected by door-to-door collectors and scavengers patrolling the residential areas from the residents and the garbage bins. Then, these collectors sell the materials to the recyclables distribution centre where the materials are sorted and sold to factories as raw or processed materials [16, 22]. As a result, recyclable waste bins in the residential areas are often empty.

In 2009, the Hangzhou City Government put forward the policy of “clean & direct transportation”, which means that MSW is directly transported to treatment plant rather than transfer station. In the urban area of Hangzhou, all new urban area could not build the garbage transfer station, all the existing transfer station should be transformed before the end of 2011 [23]. In 2010, five transfer stations were reduced, even if the amount of MSW increased by 10.2% in the urban district. To the end of May 2011, the proportion of household waste by clean & direct transportation in the main city has increased to 60.3% [24]. The collection and transportation of MSW in Hangzhou City is shown in Fig. 3.

The questionnaire showed that all of the citizens are in favor of the policy of waste clean & direct transportation. But, some respondents thought that clean & direct transportation generate noise and affect their rest, because transportation began at four o’clock in the morning. The government should design more rational transportation route and time.

**Treatment and disposal.** In some developed countries, such as Singapore and Japan, incineration and recycling were the main methods in MSWM [25]. In the majority of Chinese city, landfill was the uppermost disposal method. Table 1 shows numbers of sanitary landfill, composting and incineration facilities and their treatment quantity in China from 2007 to 2011. In 2011, the ratio of sanitary landfill, incineration and others was 76.88%, 19.86% and 3.26%, respectively [9-13].
<table>
<thead>
<tr>
<th>Year</th>
<th>Numbers of treatment plants</th>
<th>Treatment Quantity (×10^4 tons)</th>
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<tr>
<td></td>
<td>Total</td>
<td>Sanitary landfill</td>
</tr>
<tr>
<td>2007</td>
<td>460</td>
<td>366</td>
</tr>
<tr>
<td>2008</td>
<td>509</td>
<td>407</td>
</tr>
<tr>
<td>2009</td>
<td>567</td>
<td>447</td>
</tr>
<tr>
<td>2010</td>
<td>628</td>
<td>498</td>
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<tr>
<td>2011</td>
<td>677</td>
<td>547</td>
</tr>
</tbody>
</table>

With dramatically increasing MSW quantity, serious scarcity of landfill sites, and enhancement of people’s environmental protection consciousness, the quantity of landfill should be decreased in the whole of China. Incineration has been proven as an attractive method of MSW treatment due to the primary advantages of harmless control, volume reduction (about 90%), mass reduction (about 70%) and energy recovery.

There are two sanitary landfills (Tianziling and Xiaoshan landfill) and four incineration plants (Binjiang Green Energy, Qiaosi Jinjiang, Yuhang Jinjiang and Xiaoshan Jinjiang incineration plant) for kitchen waste and other waste treatment in Hangzhou City. In 2012, the total urban waste treatment quantity was 2.81 million tons, including four incinerators disposal quantity 1.23 million tons, accounting for 49.26% of the total. Recoverable waste was treated and recovered by materials recovery factories. Hazardous waste was disposed by qualified disposal factories, such as Hangzhou Dazhou materials recycling Co., Ltd, Hangzhou DADI Environmental Protection Engineering Co., Ltd.

There is no MSW composting plant in Hangzhou. However, kitchen waste contain high water and chlorine content, which bring about some problems in landfill and incineration, such as added leachate, lower calorific value and more serious flue gas pollution [17]. Kitchen waste composting project should be developed as soon as possible in Hangzhou.

The citizens do not support waste incineration considering flue gas pollution. The waste incineration technology and management should be improved. Some hazardous wastes, such as waste mobile phones, waste batteries, collected by door-to-door collector and disposed by unqualified disposal factories, in which valuable constituent was separated and recovered with simple and environmentally harmful process, other constituent was discarded randomly. This unqualified disposal will cause great harm to environment and health of the workers.

**Conclusion**

In this paper, we presented the results of our survey on MSWM in Hangzhou City. The MSWM practice in Hangzhou could be improved and promoted in other urban. The findings and suggestions were listed below:

1. Source separation has been carried out in the whole city, but the participation of the citizen should be improved. More guidance, propaganda and regulations need to be developed and set up.
2. In order to reduce the side effects of waste transfer, clean & direct transportation was implemented in Hangzhou. Clean & direct transportation improve the city environment greatly.
3. Waste composting project need to be developed as soon as possible. Flue gas pollution from incineration should be strictly controlled.

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Appendix. Abbreviation of governmental agencies

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<tr>
<th>Acronym</th>
<th>Full Name</th>
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<tr>
<td>MOEP</td>
<td>Ministry of Environmental Protection of the People’s Republic of China</td>
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<tr>
<td>NBS</td>
<td>National Bureau of Statistics of China</td>
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</table>

References