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# Sorting out a problem: Co-production as a policy tool for household waste management in Shanghai

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**Abstract:** Rapid urban population growth in China has resulted in significant challenges for Municipal Solid Waste (MSW) management. To combat these challenges, Chinese authorities implemented several new initiatives including a pilot program of MSW sorting. This top-down program was implemented in eight Chinese cities including Shanghai but is yet to reach a widespread success. In contrast, in the two instances, one in an urban and one in a rural areas of Shanghai when the program was complemented with a bottom-up community-based voluntary effort, the results were overwhelmingly positive. This paper explores the potential for a bottom-up co-production model as an alternative to the conventional top-down waste management approach in China. The analysis suggests that co-production could be a potent policy tool, in which community-based volunteers oversee and enforce household waste sorting. The success of a co-production model also depends the presence of strong pushing and pulling forces from a well-designed and well-balanced mix of command and control and market-based mechanisms such as strict volume-based waste disposal fees, an effective and convenient recycling network, and financial incentives. In addition, context-specific conditions must be present including consistence of policy implementation, community involvement, and strong volunteer effort.

**Key Words:** household waste sorting; co-production; policy tool; Shanghai

## Highlights:

- Co-production is a valuable policy mechanism for waste management.
- Co-production of waste management is compatible with centralized governance regimes.
- Contextual elements are critical for the success of waste management policies

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**1. Introduction**

January 1, 2018 marked a drastic waste-management policy change in Shanghai, China. Pursuant to the new policy of Shanghai Administrative Regulation of Construction and Demolition Waste Disposal (Government of Shanghai 2018), the city's construction and demolition (C&D) waste will no longer be allowed to be transported and disposed outside of Shanghai's administrative boundaries. This policy change was triggered by a notorious waste dumping incident.

On July 1, 2016, eight ships carrying 4,000 tons of mixed construction and household waste from Shanghai were stopped in the neighboring city of Suzhou where their crew was about to illegally dump the waste in the Tai Lake National Tourism and Recreation Zone (Liu 2016). In the

course of the ensuing investigation, it was discovered that approximately 23,000 tons of waste had already been illegally dumped there since June 15, 2016. The investigation resulted in extensive public indignation and also caught the attention of the central government in Beijing. One month later, three national agencies, the Supreme Procuratorate, the Ministry of Public Security, and the Environmental Protection Department jointly investigated this matter.

The company ultimately responsible for dumping was at the very end of a subcontracting chain. The Shanghai Administration of Greening and City Appearance (SAGCA) initially contracted out the construction-waste disposal project to a licensed company at the price of 120 yuan (approximately 19 U.S. dollars) per ton. Because of limited disposal capacity, this company subcontracted it to another company at a lower price of 70-80 yuan (approximately 11-12.60 U.S. dollars) per ton. In turn, this company, subcontracted the project to the responsible party, an unlicensed small company for 10 yuan (approximately 1.60 U.S. dollars) per ton (Gu and Meng 2017). Settled with a marginal profit, clandestine dumping outside the city's administrative limits became this company's final choice. At the end of the investigation, four people involved were indicted on charges of environmental pollution and the City of Suzhou was settled with a sizeable cleanup bill.

This incident is one of the several instances of illegal transboundary waste-dumping happening in China (Zheng and Yang 2017). Although the size of and the circumstances under which each incident occurred vary, all the incidents share the same core cause. Chinese municipalities, large cities in particular, have been struggling to manage the increasing waste output with insufficient disposal capacity (Sun 2016).

In recent decades, rapid industrialization and urbanization in China have resulted in large quantity of industrial waste, C&D waste, and household waste (Shekdar 2009; Zhang et al. 2010).

Under Chinese law, the industrial waste should be properly disposed by the businesses themselves. However, the burden of both C&D and household waste disposal lies on municipal authorities, such as the SAGCA. After the 2016 dumping incident, the burden increased as the disposal of C&D waste was no longer allowed outside the Shanghai municipal boundaries and the regulatory change also emphasized the importance of municipal solid waste (MSW) management efficiency and effectiveness. Moreover, the volume of each waste type varies. In Shanghai, for example, C&D waste (not including the debris) accounts for the smallest share of MSW (Shanghai Statistics Bureau, 1978-2017). This elevates the importance of household waste management and places the responsibility to develop effective and efficient solutions to the problem on the SAGCA.

The concept of waste management hierarchy (Figure 1) is widely used to encourage those who generate and manage waste to take actions at the upper tiers of the hierarchy (Directive 1975). Thus, preference is given to prevention of waste production and when it is not feasible, reuse, recycling, and raw material and energy recovery. Best practices of waste management generally entail an integrated strategy to incorporate all the five steps. Waste source-reduction, by means of waste sorting, is a key component of recycling as it alleviates the burden placed on landfills and incineration (recovery) (Hearn and Ballard 2005).

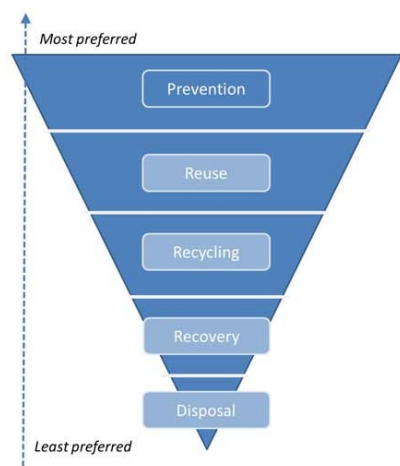


Figure 1. Waste management hierarchy (UNEP 2011).

In 2000, Shanghai as one of the eight pilot cities in China, had already enacted the MSW source-sorting program (Tai et al. 2011). To facilitate implementation, the Ministry of Construction promulgated several regulations. In addition to national-level policies, pilot cities also adopted specific policies to further advance the initiative. Yet, to date, the implementation of the sorting policies has been problematic (Tai et al. 2011). Thus, the overarching objective of this paper is to explore alternatives to the current MSW management approach in China. More specifically, this paper focuses on the household waste source-sorting, exploring the ways in impacts of the roaring urbanization and industrialization on municipal waste management and citizen's recycling behavior. Ultimately, the paper aims to explore the extent and ways in which a co-production model can be used as the foundation of MSW management in China by using Shanghai as a case study.

The paper begins with a review of the conceptual framework of public service co-production, followed by an overview of the waste regulation and waste sorting regimes in Shanghai. Then it continues with two community-based empirical examples with the goal of exploring the bottom-up approaches to waste sorting in China, as well as the analysis of a combined command and control and market approaches aimed at sustaining the social co-production model. The paper concludes, with the discussion of the three barriers to wider implementation of the explored co-production approaches: policy consistency, public engagement, and volunteering.

## **2. Conceptual framework: co-production of public service as a novel public governance approach**

Waste management has long been regarded as a public service that ought to be provided by the government (Ahmed and Ali 2006; Guerrero et al. 2013). In conventional public

administration, public services are provided directly by government agencies. Over the past decades, concerns over economic efficiency and adequacy of government resources resulted in the emergence of market-based approaches to public administration. This led to the changes in public management models that included public services and goods being provided by contracted private entities with lower cost and higher efficiency (Rakić and Rađenović 2011; Rhodes 1996). Later, it was discovered that the production of public services, in contrast to public goods, could be achieved more efficiently when the service recipients actively participated in the process (Pestoff and Brandsen 2010). Accordingly, a new type of approach to public governance was proposed by incorporating the civil society in production of public services (Joshi and Moore 2004; Osborne 2006).

According to Howlett et al. (2017), the concept of co-production lies at the core of this novel approach to public governance. Co-production is narrowly defined as “involvement of citizens, clients, consumers, volunteers and/or community organizations in producing public service” (Alford 1998) and is closely associated with the idea of “self-service” (Mizrahi 2012). First, co-production effectively shifts the role of service recipients, transforming them from consumers and beneficiaries of public services to consumer-producers (Pestoff and Brandsen 2010). Second, co-production emerged and evolved as a notion emphasizing individual citizen’s engagement in service production and delivery. Over the years, it has broadened to include both individuals and non-government organizations. For example, Joshi and Moore (2004) find that in some countries, public services may be delivered via unorthodox organizational arrangements. Third, the co-producing service is not limited within the domain of delivery, but also in design and management of services on the basis of mutual trust and shared responsibility (Pestoff and Brandsen 2010).

Pestoff and Brandsen (2010) identify the following two benefits of co-production involving the third sector: democratization and collective innovation. The former means direct engagement by citizens in public service delivery; the latter comprises innovative collective structure of service provision premised on the diversity of skills, activities, and the paradigm shift. In practice, like new public management, co-production can help deliver a public service at lower costs with improved efficiency by pooling non-governmental resources. This is critical for MSW management, as many local governments have insufficient funding to satisfy the growing demand for solid waste management (Tacoli 2012). However, Pestoff and Brandsen (2010) also warn that involving the civil society does not necessary translate into economic benefits. They view such involvement from a normative perspective, noting that certain conditions must be present in order to result in such benefits.

The co-production concept has been employed to understand public service delivery including education, child care, healthcare, post, and other social services (Alford 2009; Howlett et al. 2017). Although co-production in waste management is yet to receive comparable level of attention in the literature, a few studies provide a solid departure point (Gutberlet 2015). McLaren and Agyeman (2015) find that co-production in waste management in South Korea took the shape of voluntary waste reduction and waste sorting for recycling. The democratic nature of co-production combined with the cultural readiness of Korean citizens positively affected citizen participation. Because citizen participation is essential for the success of co-production, McLaren and Agyeman (2015) conclude that culture plays an important role in waste sorting activities.

### **3. Data and methods**

The qualitative data about MSW in this paper are obtained from the Shanghai Government



Municipal Practical Tasks annual reports for 1986-2017 and from the primary MSW management reports obtained by one of the authors in the course of her work on the Yearbook of Shanghai Greening and City Appearance from 2009 to 2017. The quantitative data of annual MSW output was retrieved from both the Shanghai Statistical Yearbooks for 1978-2016 and from the Yearbook of Shanghai Greening and City Appearance for 2017.

A case study approach was employed to illustrate the emergence of a participatory co-production model of waste management in Shanghai. The two aforementioned empirical examples are premised on two instances when co-production was utilized in the context of waste sorting. These examples have been well recognized by the local government, and have been repeatedly highlighted in the mass media. The data are collected through media coverages and from the government-sponsored magazine, *Shanghai Greening and City Appearance*. Data from various sources were coordinated and verified by Yuhua Wang, the vice director of Shanghai Information Center of Greening and City Appearance. Wang closely cooperated with the two main actors, Xinhua Sheng and Xiaoqin Lu, of the two examples. One of the authors conducted field trips to the Shanghai Laogang landfills in 2012, and the Zhuhai landfills in Guangdong Province and disposal plant in 2016 to observe waste disposal.

## **4. Increasing waste output and staggering waste sorting**

### **4.1. Top-down regulations and staggering household waste sorting**

In China, waste sorting has been regarded as one of the MSW management's main components (Tai et al. 2011). In 2000, the central government selected eight pilot cities, including Shanghai, to explore the MSW sorting mechanisms. In order to facilitate the advancement of waste sorting in these cities, the Ministry of Construction promulgated two guidelines: "Classification

and evaluation standard of municipal solid waste (CJJ/T102-2004)” in 2004 and “The classification signs for municipal solid waste (GB/T19095-2008)” in 2008 (Tai et al. 2011).

At the local level, Shanghai also adopted a series of administrative regulations: “Regulations of the city appearance and environmental sanitation” (2001); “Management of urban household waste collection, transportation and disposal” (2008); “Guidance on the reinforcement of household waste management” (2010); “Guide of Shanghai urban household waste sorting facilities disposition” (2012) (Zhu 2014). All these national and local administrative regulations promote and advocate for waste sorting, yet they do not specify penalties for non-compliance.

Upon being selected as a pilot city, Shanghai municipal government put waste sorting high on its policy agenda. In the following five years (2000-2004), the government listed waste sorting as one of the Municipal Practical Tasks thereby ensuring its priority. The overall “reduction, reuse, and harmless waste disposal” policy goal was also set with the focus on facilities construction including waste compression station. However, no volumetric waste-reduction goals were specified. The priority status was suspended during 2005-2010 and was reinstated in 2011 (Table 1). The reinstatement followed the Expo 2010 Shanghai, during which city officials were persuaded by the success of the Taiwan case of waste sorting (Qi 2017).

Table 1 Policy tools devised to facilitate MSW management

<b>Year</b> <b>Policy tools</b>	<b>Before 2000</b>	<b>2000-2004</b>	<b>2005-2008</b>	<b>2009</b>	<b>2010</b>	<b>2011</b>	<b>2012</b>	<b>2013</b>	<b>2014</b>	<b>2015</b>	<b>2016</b>	<b>2017</b>
<b>Listed as Municipal Practical Task (Policy Target)</b>	No	Yes	No			Yes						
	N/A	Waste disposal: Reduction, Reuse, Harmless	N/A			Millions of families go low carbon; waste sorting goes first.				Waste sorting and reduction		
<b>Annual increase of Green Account</b>				20 K	19 K	Data N/A			400 K	100 M	100 M	200 M

\*Source: Shanghai annual report of Municipal Practical Tasks (1986-2017) (www.shanghai.gov.cn)

In addition to the administrative regulations, an economic incentive policy was also employed. In 2009, the SAGCA, together with the Bank of China, began to introduce the “Green

Account” (Table 1) for households to encourage citizens to sort waste and was formally put into effect in 2013 (Wu et al. 2016). Sorted waste resulted in points in the account, which could be exchanged for daily goods or offset utility fees. To aid these measures, the government launched an information and education campaign using TVs, newspapers, and the internet. In 2013, three institutions, the SAGCA, the Municipal Spiritual Civilization Office, and the Municipal Women's Association jointly launched a voluntary prize-winning waste sorting catchphrase competition and many citizens participated (Hu 2013). Several catchphrases were created, including “Millions of family go low-carbon, waste-sorting goes first” and “Mixing produces wastes, sorting produces resources”.

#### **4.2. Increasing household waste output**

All the waste management policies channeled through the aforementioned administrative regulations required household waste sorting; yet, the pilot cities’ waste output per capita did not decrease. For some pilot cities, Hangzhou, for example, the per capita output increased from 1.4 Kg/day in 2006 to 1.74 Kg/day in 2012 (Du et al. 2014). Such a trend is consistent with the nationwide waste increasing rate, which is 3-10% during 1980-1998 (Wang and Nie 2001). Similar increasing trend is present in Shanghai. As shown in Figure 2, in the past four decades, both the annual and daily household waste outputs increased, except during 2000-2002 following the national pilot city program. As of 2016, the daily household waste in Shanghai reached over 20,000 T/day. Most of the waste are disposed through either landfill or incineration with composting far behind. Although waste sorting has been advocated for over a decade, it is estimated that, as of 2014, only around 20% of population in the city really engaged and continued to sort their household waste (Wang 2014). For a large part of Shanghai residents, habit formation of waste

sorting remains stuck at “the government wants me to sort” and is yet to reach “I want to sort” (Cheng 2014).

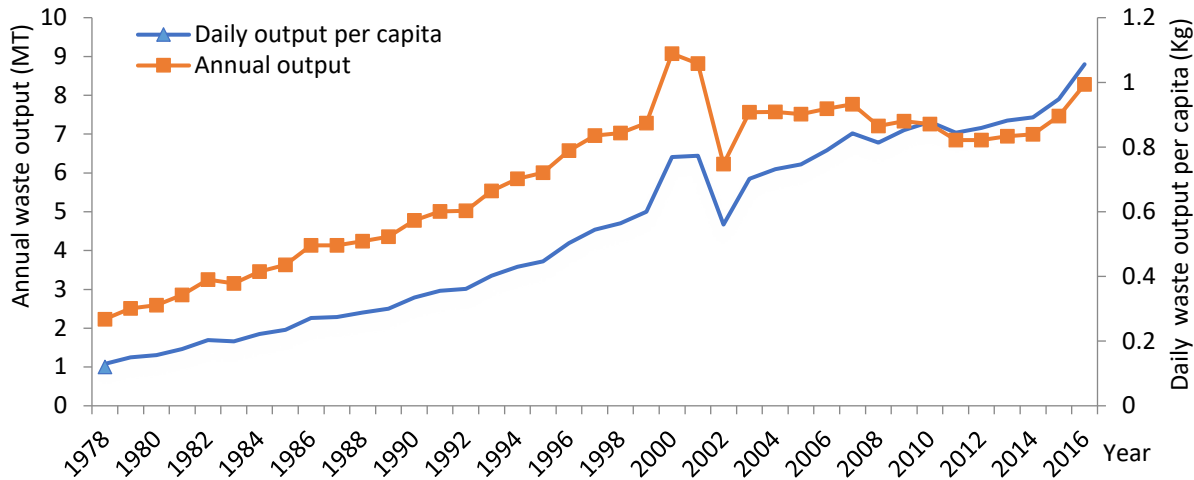


Figure 2 Household waste output in Shanghai (1978-2016) \*

\*Source: the data of annual household output is directly available from Shanghai Statistical Yearbook (Shanghai Statistics Bureau 1978-2017) and the daily output per capita was derived when dividing the annual output by population of the city and the number of days each year.

### 5. Bottom-up voluntary participation in waste sorting

In contrast to the slow progress of waste sorting through top-down regulation, grassroots initiatives have emerged and thrived in several Shanghai communities. These initiatives are characterized by involvement of volunteers and voluntary organizations in awareness-raising, design, implementation, and oversight of waste sorting. The following two examples in Shanghai, one in an urban area and one in a rural area, may serve as evidence of the self-service and self-governance in co-production of waste sorting.

#### Example 1: Participatory urban waste sorting in Jing'an District

The Jing'an district in downtown Shanghai attracted extensive public attention with outstanding performance in waste sorting. This is to a large part attributable to the efforts of Xinhua Sheng, a retired former health industry professional. With Sheng and her voluntary team's continuous efforts from 2014 to 2016, about 97.5% of the households in her neighborhood engaged

in waste sorting, and 95.3% opened a Green Account (Chen and Zuo 2016).

In 2014, the Caojiadu neighborhood of the Jing'an district, where Sheng lives, planned to implement the new municipal policy entitled "Measures to facilitate household waste sorting and reduction in Shanghai" (Chen 2014). Three institutions, the neighborhood committee, the property owners' committee, and the property management company, jointly carried out this program and invited Sheng to act as the resident representative. Deeply impressed by the German waste sorting system when visiting Germany, Sheng was excited to take part in the waste sorting program in her own neighborhood and accepted the invitation (Huang 2015). She realized that her own efforts were insufficient and invited another 11 residents. The volunteer group created a three-month plan and carried it out in August 2014.

The *first month* of the plan focused on informing the residents on waste sorting and opening Green Accounts. Initially, many residents were reluctant to engage, arguing that because they have already paid the property management fee, which includes waste disposal fee, they were not required to do anything else regarding waste disposal. Nevertheless, every morning Sheng stood by the waste station and carefully checked the waste bags and helped to resolve in case of mis-sorting. She praised those who sorted properly and placed the waste bag to the right bin, as well as encouraged the holdovers to join the initiative.

Sheng and her fellow volunteers also helped to facilitate the implementation of the Green Account initiative. Each account has a unique barcode which corresponds with each household's ID. When a household opens an account, it is given a set of stickers containing a unique barcode. The stickers are placed on a waste bag for tracking. During waste collection, each waste bag containing a barcode is scanned and matched with a household. If household members correctly sorted the waste, points are credited to their household account. In the first month, the volunteer

group scanned the barcode for each waste bag. In case when household members did not place the barcode onto their waste bag, volunteers can scan the barcode of the Green Account. However, despite all these efforts, by the end of the first month, only around 20% families in the neighborhood engaged in sorting (Huang 2015).

The *second month* of the plan focused on publicizing each household's waste sorting behavior and Green Account score through a bulletin. Families receive either a red, blue, or green star according to the extent to which they involved in waste sorting and Green Account activities. This proved to be an effective strategy as non-participants felt ashamed for the green star they received and approached Sheng and other volunteers to consult about how to join. Capitalizing on this opportunity, Sheng educated them how to follow waste sorting rules, as well as how to redeem the credits. By the end of the second month, around 70% households engaged in waste sorting (Huang 2015).

During the *third month* the volunteers had to overcome the challenges that resulted in from the waste disposal site schedule changes. Like many sites in the city, the waste disposal site in Sheng's neighborhood was usually accessible 24 hours a day. In the summer, the odor and pollution from the accumulated waste started to bother the residents, especially those living nearby. To mitigate the problem, fixed access hours (6:00-9:00 AM and 6:00-9:00 PM) were introduced to ensure that all the waste collected during the access hours was transported to special facilities straight away. The volunteers monitored the waste disposal site and persuaded residents to discard their waste during the designated hours and not leaving waste bags outside the waste disposal area.

The volunteer team led by Sheng built upon its initial success a few months after the plan was implemented. After the residents became accustomed to waste sorting, from April, 2015, the volunteers transitioned the initiative from the four-category sorting system of dry, wet, harmful,

and recyclable suggested by the government, to an eight-category system adding more categories like kitchen waste, plastic, glasses, papers, clothes, and others (Chen and Zuo 2016).

Besides, tenants and housekeepers proved to pose a particular set of challenges for the success of the waste sorting initiative. Tenants comprise around 20% of residents in this neighborhood while many residents employed hourly housekeepers. Tenants are frequently away during work week or come back late, often after the waste disposal site closed. While the housekeepers, who would generally be responsible for taking waste to the waste disposal site sometimes begin their work after the site morning hours and finish their work before the site evening hours. In addition, they lack the direct incentive created by the Green Account. Sheng and her team visited the tenants door to door at night, gave them the waste bag and taught them how to sort. As to the housekeepers, Sheng contacted the landlords, and asked them to explain to their housekeeper what and how to sort. In addition, Sheng also organized various gatherings to make the neighborhood more cohesive. For example, at Christmas, the housekeepers were invited to the party for their contribution to the initiative, which further enhanced their cooperation (Huang 2015).

## **Example 2: Participatory rural waste sorting in Songjiang District**

In the rural Songjiang District, Xiaoqin Lu, a young professional, committed to waste sorting in village communities after attending a photography exhibit highlighting environmental problems. She was particularly struck by a photograph of a desperate young villager who became ill with cancer due the exposure to waste from a polluting factory near his village in Fujian Province, China (Lin 2015). The Expo 2010 Shanghai was a turning point for her as she was inspired by numerous new concepts for living an environmentally-conscious lifestyle, including waste sorting. In 2012, Lu quit her job in downtown Shanghai, and became a full-time volunteer

of waste sorting (Lin 2015). She spent three months to visit each town in the district and studied rural waste generation and disposal. She contacted the local government of the town of Maogang and proposed a waste sorting initiative. Although it took time and persistence, the town government finally approved and funded a waste sorting pilot program.

Lu decided to focus on the Yaojing village, where the concept of waste sorting was still new to its residents. She moved to the village to provide guidance on the waste sorting program. Rural waste sorting differs much from that of urban area. Villagers are used to a particular lifestyle where littering is not uncommon. Waste sorting proved to be a significant behavior change for them. Yet rural communities feature certain opportunities for waste sorting. For example, there communities are less constrained for space, which creates flexibility in terms of waste collection and disposal sites, as well as opportunities for composting. Lu determined the collection and disposal make waste sorting a deadlock for many cities. Accordingly, she added on-site composting to her toolbox along with the door to door persuasion and education. As a result, kitchen waste turned into compost and was utilized for local agricultural production, emerging as an additional benefit of waste sorting in a rural setting. Later, the town government purchased a compost machine to further support her idea (Wang & Lin, 2014).

The village officials and villagers were deeply touched by Lu's work, causing many to become participants and volunteers. Participation in waste sorting also became a criterion for municipal employee evaluation (Dong 2015). The village officials felt shameful if they got lower credits because of poor performance in waste sorting (Chen and Zuo 2016).

To sum up, both examples of Sheng and Lu serve as an illustration for the bottom-up component of co-production in waste management (Huang 2015; Jin 2015). However, as Peters (2010) and Sørensen (2012) point out, the effectiveness of co-production is also highly dependent



on skillful top-down governance. In the next section, we elaborate on the governmental policy design to ensure the viability and sustainability of the emerging co-production model.

## **6. The synergy of command and control and market-based approaches for co-production of waste sorting**

In the previous two sections, we demonstrate the importance of converging top-down and bottom-up approaches to waste sorting. However, the mere fact of the bi-directional converging efforts does not always result in a positive outcome. The design of the top-down component is particularly important as a combined, command and control and market-based approach has produced some encouraging results (Pestoff and Brandsen 2010). One example is the Taipei City, which in the span of 7 years, successfully reduced its daily waste per capita from 1.34 Kg in 1995 to 0.37Kg in 2012 (Du et al. 2014). Such achievement is attributable to both carrot and stick approaches, including the “To Keep Trash off the Ground” and the “Three-in-one Recycling Plan” initiatives, as well as the mandatory waste sorting policy and the per-bag waste-collection fee charge. The former two are premised on removing all the waste disposal sites in communities and requiring residents to dispose waste bags directly into the garbage trucks and recyclables into the recycling trucks which drive in tandem twice a week at the designated time along the designated route. Mandatory sorting, convenience for recycling, as well as the large number of volunteers were the most critical factors contributing to the success of MSW reduction in Taiwan (Chao 2008).

### **6.1. Redesign the legal and regulatory system to mandate waste sorting**

In the past three years, the Chinese central government increased the stringency of waste management regulations. In many large cities, waste disposal facilities including landfills, incineration plants, and open-air waste piles have caught much public attention over soil

contamination, air pollution, and the increased risk of man-made disasters (Song et al. 2017; Song et al. 2013). For instance, seven months before the 2016 Shanghai dumping incident, the landslide of a 330-foot-high pile-up of industrial waste in the Shenzhen City caused dozens of deaths (Yang et al. 2017). To ease increasing public concerns, in November 2016, the central government released “The 2016 Guidance on Strengthening Incineration Management of Urban Household Waste” pledging to have stricter regulations regarding site selection for incineration facilities. In February 2017, the State Council enacted “The 2017 Implementation Scheme of Household Waste Sorting System” stating that, by 2020, household waste will be managed in the outmost responsible and benign manner in both the four municipalities directly administered by the central government and all provincial capital cities. These cities will be required to strictly enforce waste sorting with the goal of the recycling and reusing rate reaching over 35%.

Accordingly, municipalities were required to set new waste management goals under these central guidelines. For instance, Shanghai imposed the following goals, by 2020 or by the end of the 13<sup>th</sup> Five Year Period: (i) all household waste must be sorted; (ii) every family must have a Green Account; (iii) no household waste can be disposed of through landfills and; (iv) the recycling rate must reach 38% (SAGCA 2016). With these goals set, waste sorting is still not directly mandated by law (SAGCA 2016).

## **6.2. Market-based policy tools to incentive waste sorting**

### **6.2.1. Pay-as-throw (PAT) charging policy**

Although the government actively advocates waste sorting, it is rather hesitant to enforce the volume-based household waste charge policy (Zhang et al. 2010). In 2013, the Shanghai government imposed a volume-based fee for workplace waste disposal (Shanghai Bureau of Commodity Price and SAGCA 2013). In addition, due to the 2016 Shanghai dumping incident, in

2017, the SAGCA adopted the “No Sorting, No Collecting” collection policy for workplace waste.

Yet for residential waste, this policy is yet to be implemented because of the perceivable implementation and oversight cost and difficulties (Qi 2017). Currently, the household waste fee is charged monthly as part of the property management fee and is calculated based on the apartment size. That means the waste charge has nothing to do with the actual waste volume generated by a household. As a result, the citizens are not incentivized to reduce and/or to sort their daily waste; some even do not know how they pay for waste disposal, since it is included in the overall property management fee. The government’s main concern is that some residents may dump their waste illegally to escape charge, resulting in even higher waste management cost (Onishi 2005).

Nevertheless, Bilitewski (2008) finds that there is positive relationship between the financial incentives resulted from pay-as-throw (PAT) schemes and the level of waste recycling. PAT is premised on the widely-accepted polluter-pays principle (Poon et al. 2001) and has been adopted in Japan, the United States, and Taiwan among other countries and regions. However, in order for a PAT-based policy to result in waste reduction, the following two factors must be present. First, such policy must be strictly enforced to prevent counter-productive and illicit behavior such as illegal dumping (Onishi 2005). Although the government should play a leading role in the oversight and enforcement, it can work hand in hand with the community via the process of co-production (We address this in more detail below). Second, a well-functioning recycling system must be put in place to provide an outlet for discarded recyclable items (Dahlén and Lagerkvist 2010).

#### **6.2.2. Rebuilt of the urban waste recycling mechanism**

Generally speaking, many cities in China possess the cultural readiness for waste recycling and reuse programs. The City of Yiwu in Zhejiang province, for example, is renowned for its

resourcefulness captured by a Chinese jingle “Chicken feather in exchange for candy”, (referring to the practice of collecting chicken feathers to make feather brooms) (Guishan 2000). However, rapid economic growth and urbanization contributed to the growth of personal wealth thereby reducing the need for reuse and recycling. At the individual level, it signaled a cultural shift in the perception of such behavior from a virtuous conduct to an association with a low-income socioeconomic group. At the city level, economic structure of Shanghai is shifting from manufacture-based towards service-oriented. As a result, there are fewer facilities that can use recycled materials, and overall lower demand for them.

One sign of declining recycling practices is the rapidly decreasing number of waste recycle stations that used to be scattered in every corner of Shanghai (Zhang 2012). Although the demand for recycled materials is decreasing, the costs of running a recycle station are going up. Small-scale recycle stations are usually operated by rural migrants who often cannot afford the high housing prices and are forced to move to the suburbs. In addition, fewer types of waste are accepted by the few remaining collectors because of a low-profit margin and restrictions imposed on recycling of certain items. The recyclable waste like paper, metal, and plastic is accepted at very low prices, others like old clothes, wooden furniture, and glass items are rejected. Even donation of old clothes to charities is often refused for the risk of “skin or infectious diseases”. These factors make waste recycling in Shanghai rather difficult.

Bernstad (2014) finds the existence of necessary infrastructure and convenience as critical factors for household waste recycling. A network of waste recycle stations in residential neighborhoods can make recycling much easier for their inhabitants. Therefore, the failure of market mechanisms to sustain recycling and the public benefits that it provides make an excellent case for government support of this service (Zhang 2012). The categories of the recyclable stuffs

should also be broadened, to include things like old clothes, used wooden furniture, electronic wastes etc. They may not be profitable, but it is a wiser measure for the government to reasonably subsidy this recycling system, than to let these stuffs go simply into the waste bin and burden the waste disposal industry. For example, Hawley (2009) suggests that textiles are almost 100% recyclable, there is no reason to let them end up in a landfill.

### 6.3. External pushing and pulling forces

The aforementioned regulatory tools, including the PAT scheme and tight government oversight, as well as market mechanisms can serve as pushing and pulling forces to increase waste sorting. As Figure 3 depicts, on the one hand, a volume-based waste disposal fee (PAT) will likely create an incentive to reduce the waste output through avoidance of unnecessary waste, recycling, or reuse. Although government effort is essential for introducing and enforcing PAT schemes, the overall success of the initiative is contingent upon community self-governance and self-oversight. This makes both indispensable pushing forces.

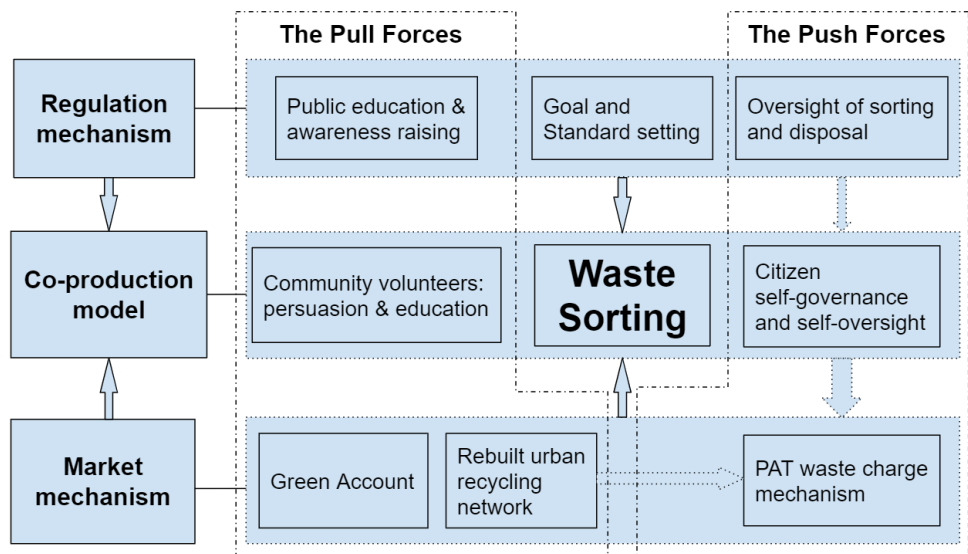


Figure 3. A conceptual framework of waste sorting co-production model in Shanghai

On the other hand, pulling forces can make rules easy or even appealing to follow, which is critical for successful policy enforcement. Thus, a convenient urban recycling network and

Green Account-like initiatives are the most appropriate mechanisms for making waste sorting convenient and otherwise desirable. Convenience is regarded as one of the key elements in both waste sorting and recycling (Chao 2008; Schneider 2008); resident-friendly waste recycle stations will help re-introduce the Chinese tradition of recycling. Initiatives similar to the Green Account can further increase popularity of waste sorting especially among retirees and stay-at-home parents, who have been the main force of recycling house waste (Li 2003). In addition, this behavior change may signal a major cultural shift. Recycling and reuse in times of poverty are often necessary to combat economic hardship; while in times of prosperity and overconsumption, recycling and reuse are seen as attributes of environmental consciousness and social responsibility (Hawley 2009). Although the Chinese government has already launched a series of public awareness programs, a continuous effort is required to achieve the cultural shift. In this sense, as Figure 3 shows, public education and awareness campaigns carried out by both the government and volunteers complement Green Account-type initiatives and the rebuilt urban recycling network as major pulling forces to ensure waste recycling and sorting.

## **7. Towards a successful co-production model for waste sorting**

As we show in the two examples above, a co-production approach to waste management is compatible with the Chinese top-down governance regime. Moreover, if premised on a well-balanced combination of the command and control and market mechanism, a co-production model appears to have provided an effective solution to Shanghai's growing municipal waste problem. Unsurprisingly, there is a concerted effort by the Shanghai government to replicate Sheng and Lu's successes in every neighborhood and village through recognition of volunteers and the districts in which they reside and contribute time. In 2015, Lu was awarded the honor of "Top Ten Volunteers

of Environmental Sanitation” of Shanghai (Lin 2015). In 2016, Sheng was elected as the representative of the People's Congress in Jing'an District (List of the first session of people's congress in Jing'an 2016). Both Jing'an and Songjiang districts were recognized for being among top of the twenty-six national demonstration cities/districts of waste sorting (Huang 2015; Jin 2015). Yet volunteer and best performing district recognition *alone* is unlikely to produce the same level success in over 4,000 urban neighborhood committees and nearly 1,600 villages in Shanghai, let alone at the national and international levels (Xiao et al. 2016). Below, we offer our reflections on potential pathways towards a successful co-production model for waste sorting.

### **7.1 Consistency of policy implementation**

It can take, a new concept, such as waste sorting, as long as 30 years before it could be completely accepted by the public (Schipperijn et al. 2005). Achieving high public acceptance requires long-term persistence and extensive public engagement. In a co-production model, mutual trust between government and citizens is an important precondition. Unfortunately, such trust sometimes may not be present.

The lack of public trust originates from the Shanghai government's inconsistent waste management policies. For instance, waste management was first listed in the Municipal Practical Task program (Table 1) in 2000 to echo the national “pilot city” program. However, in 2005, waste management was removed from this program for six years and did not appear back in the program until 2011. As a result, neighborhood committees were given conflicting directives – sometimes higher authorities demanded strict implementation, and sometimes they left implementation and enforcement to the discretion of neighborhood committees (Wang and Lin 2014). This left both the committees and the residents at a loss. The same is true with the Green Account program. Initially, Bank of China employees told customers that credits in the account could be used to

offset their utility bills. But later, whenever the bank had shortage of dedicated funds, the credits became not deductible or could not be exchanged for daily goods such as oil, rice, shampoo (Wang and Lin 2014). Such inconsistencies caused wide-spread disappointment among the public and the neighborhood committees had to take great efforts to restore residents' commitment to waste sorting. This echoes White et al. (2013) findings in Canada that the drastic cuts in the renewable energy subsidies resulted in significant loss of confidence in the government continuous support of this sector. Because waste sorting requires behavior changes that often take significant time to materialize, the degree, manner, and frequency of policy alterations influence people's trust to the government's commitment to a new policy and, therefore, their commitment to making such changes. Therefore, a co-production model is only effective if it is based on mutual trust, as well as the long-term stability and consistency of the underlying policy.

## **7.2 Culture matters: community as a foundation of self-governance**

Self-governance is a critical element in a waste management co-production model. Inclusive and effective self-governance is key for the overall waste management efficiency, as well as alleviating government resource shortage. When people's behavior is entrenched in years of habit, even a balanced mix of command-and-control and market-based policy mechanisms is not always successful at producing a desired influence on citizens' behavior (Schneider 2008). However, people are more likely to change their behavior if such policies are complemented with timely and extensive government oversight and enforcement. One of the advantages of a co-production model is that the community shares a large part of oversight duty with the government thereby reducing the strain on government resources and improving the efficiency of policy implementation and enforcement.



In tight-knit communities that tend to be rural areas, peer-pressure can become particularly effective, as everyone becomes a potential policy enforcer. In contrast, in urban areas, especially in the rapidly growing ones, communities lack the same level of cohesiveness. As with the Jing'an example, because people often do not know their neighbors, waste sorting stumbles over the "none of my business" attitude. However, through the process of co-producing, waste sorting becomes a shared habit of most if not all residents. Not only a neighborhood becomes much cleaner as a result of waste reduction, the residents become neighbors, and neighbors become acquaintances and friends. In such communities, residents tend to have a strong sense of belonging, which in turn serves as a solid foundation for self-governance and self-oversight (Chen and Zuo 2016; Onishi 2005). For example, Onishi (2005) finds that in Japanese small towns and villages, where everybody knows each other, not sorting one's waste would be unimaginable.

However, the community solutions that are in line with the Chinese culture may not work in other countries. In the Jing'an example, each family's sorting behavior is rated with red, green or blue stars representing good, middle or poor performance. The results are publicized on wall-bulletin board in the neighborhood that everybody can see. Such measures may be viewed as privacy violation in other countries (Personal communication, 2017). In addition, in order to meet, inform, and educate the tenants in person, the voluntary team had to knock on the doors late in the night. This might be regarded as disturbance in other societies. In the same vein, some practices that were effective in other countries could not have been used in China. In Japan, for example, the tenants who failed to comply with the sorting policy could be evicted (Onishi 2005), which is something that could not occur in China. Since co-production depends on voluntary participation, culture-sensitive measures are paramount to facilitate residents' cooperation.

### **7.3 Volunteer engagement**

Besides residents' cooperation, another critical factor of co-production is the close cooperation between the government and the volunteers (Pestoff and Brandsen 2010). In the Jing'an example, the neighborhood committee realized they needed resident representative's support and invited Sheng to help. In the Songjiang example, Lu contacted the town government and acquired official support. As we note throughout this paper, co-production of waste sorting relies heavily on volunteer support for public education and oversight. The former features face-to-face persuasion and demonstration, during which residents are educated on what and how to sort. The latter involves personal presence at a waste station and monitoring for the "wrong" waste. Volunteers not only need to spot the improperly sorted waste, more importantly, they need to persuade and nudge the residents in the right direction. According to the Japanese experience, the so-called "waste guardians", teams of volunteers across the country, play critical roles in persuading citizens to engage in waste sorting (Onish, 2005). These are rather straightforward and effective ways to change the public's consciousness and behavior of waste sorting, from "You want me to sort" to "I want to sort". Volunteers with passion and patience, like Sheng and Lu in the Shanghai case, are particularly effective in accomplishing such tasks.

However, in China, the mechanism of voluntary individual and organizational involvement is still developing (Civicus 2006 ). This can be interpreted that co-production is not the best fit for the Chinese circumstances. According to Hustinx et al. (2010), in regimes with more government involvement in public service delivery, there is less capacity for volunteering. Because China is a socialist country, its citizens are used to the government delivering public services. Therefore, co-production of waste management involves an institutional innovation. In this model, instead of being a direct service-provider, the government needs to take a step back and to act as a facilitator to encourage more co-producers and support them. Adequate financial support from the

government is equally critical. In the Songjiang example, when Lu became a full-time volunteer, she had to depend on her parents for financial support (Dong, 2015) [39]. The same goes for the Green Account program. The Bank of China has supported it as part of its corporate social responsibility (CSR) program. Yet in the case of an economic downturn when CSR initiatives are often downsized and suspended, the government ought to step in to shoulder the responsibility of sustaining waste sorting initiatives. Although in established democratic societies, volunteer engagement of individuals, businesses, and non-governmental organizations in providing public service is less of a concern, the governmental role as an overseer, enforcer, and supporter remains largely the same. Hence, although co-production can deliver the service at lower cost or higher economic efficiency, the government should not take the citizens' and organization's voluntary commitment for granted and view co-production as a cost-free solution.

## **8 Conclusions**

China is currently the largest MSW generator in the world and the total amount of waste keeps on increasing (Chen et al. 2010; Tai et al. 2011). Therefore, sustainable and environmentally-conscious MSW management warrants the utmost attention by the country's leadership. The top-down approach to waste sorting in eight pilot cities, after 17 years' implementation, has proven to be inefficient in reaching the goal of waste reduction. Conversely, the community-based self-governance approach can provide a resourceful solution, as shown in the two examples in Shanghai, with decreased costs and improved efficiency. However, Howlett et al. (2017) argue, co-production's potential could be fully realized only if a strong direct and indirect government support is present. As to waste management, comprehensive, coherent, and cohesive governmental policies, laws, and regulations, including volume-based waste charge, as

well as market mechanisms, including an urban waste recycling network and the Green Account initiative, can become strong pushing and pulling forces facilitating waste sorting in a co-production model. Hence, the synergy of the reciprocal relationship among command and control, market-based incentives, and co-production must be present. This paper suggests that a bottom-up co-production model can thrive in a centralized governance regime akin to that of China. Its application beyond China needs to be further investigated in a particular national context and with the emphasis on consistence of policy implementation, community involvement, and extensive volunteer efforts.

## References

- Ahmed SA, Ali SM (2006) People as partners: Facilitating people's participation in public-private partnerships for solid waste management *Habitat International* 30:781-796
- Alford J (1998) A public management road less travelled: Clients as co-producers of public services *Australian Journal of Public Administration* 57:128-137
- Alford J (2009) Engaging public sector clients: from service-delivery to co-production. Springer,
- Bernstad A (2014) Household food waste separation behavior and the importance of convenience *Waste management* 34:1317-1323
- Bilitewski B (2008) From traditional to modern fee systems *Waste management* 28:2760-2766
- Chao Y-L (2008) Time series analysis of the effects of refuse collection on recycling: Taiwan's "Keep Trash Off the Ground" measure *Waste management* 28:859-869
- Chen S (2014) Shanghai Formulates the policy to facilitate household waste sorting and reduction *Policy Outlook*:55-55
- Chen X, Geng Y, Fujita T (2010) An overview of municipal solid waste management in China *Waste management* 30:716-724
- Chen XH, Zuo Q (2016) The experience of household waste sorting: to make strangers' community acquainted in Guihua Garden of Jing'an District. *Shanghai Observer*, Shanghai
- Cheng J (2014) The "Shanghai Model" of waste sorting. <http://www.cn-hw.net/html/china/201409/46939.html>. Accessed 1 May 2017
- Civicus (2006) A nascent civil society within a transforming environment. CIVICUS Civil Society Index Report China (Mainland) SPPM, Tsinghua: NGO research Center, Tsinghua University
- Dahlén L, Lagerkvist A (2010) Pay as you throw: strengths and weaknesses of weight-based billing in household waste collection systems in Sweden *Waste management* 30:23-31
- Directive C (1975) Council Directive 75/442/EEC of 15 July 1975 on waste *Official Journal L* 194:0039-0041
- Dong L (2015) Waste sorting is her lifetime venture---Story of "environmentalist" Xiaoqin Lu. <http://news.songjiang.gov.cn/detailNews.shtml?id=170407>. Accessed 28 April 2017
- Du Q, Song G, Ma B, Han D (2014) Experience and implications of municipal solid waste management in Taipei city *Environmental Pollution & Control* 36:83-90

624 Government of Shanghai (2018) Shanghai Administrative Regulation of Construction and Demolition  
 625 Waste Disposal. Official Website of Shanghai Government  
 626 Gu M, Meng X (2017) Management and punishment, to stop illegal waste transboundary dumping. Beijing  
 627 Guerrero LA, Maas G, Hogland W (2013) Solid waste management challenges for cities in developing  
 628 countries *Waste management* 33:220-232  
 629 Guishan FJCE (2000) My Involvement in the Opening of the Market 33:39-47  
 630 Gutberlet J (2015) More inclusive and cleaner cities with waste management co-production: Insights from  
 631 participatory epistemologies and methods *Habitat International* 46:234-243  
 632 Hawley J (2009) Understanding and improving textile recycling: a systems perspective. In: *Sustainable*  
 633 *Textiles*. Elsevier, pp 179-199  
 634 Hearn G, Ballard J (2005) The use of electrostatic techniques for the identification and sorting of waste  
 635 packaging materials *Resources, Conservation and Recycling* 44:91-98  
 636 Howlett M, Kekez A, Poocharoen O (2017) Understanding Co-Production as a Policy Tool: Integrating New  
 637 Public Governance and Comparative Policy Theory *Journal of Comparative Policy Analysis:*  
 638 *Research and Practice*:1-15  
 639 Hu Y (2013) Shanghai collecting waste sorting catchphrase with the first prize 5000 Yuan. *Xinmin News,*  
 640 *Shanghai*  
 641 Huang Y (2015) Jiang'an Guihua neighborhood: residents' self-governance to push waste-sorting ahead.  
 642 *Jiefang Daily, Shanghai*  
 643 Hustinx L, Handy F, Cnaan RA, Brudney JL, Pessi AB, Yamauchi N (2010) Social and cultural origins of  
 644 motivations to volunteer: A comparison of university students in six countries *International*  
 645 *Sociology* 25:349-382  
 646 Jin M (2015) Songjiang District explores new measures of rural waste sorting and output reduction.  
 647 *Shanghai*  
 648 Joshi A, Moore M (2004) Institutionalised co-production: unorthodox public service delivery in challenging  
 649 environments *Journal of Development Studies* 40:31-49  
 650 Li S (2003) Recycling Behavior Under China's Social and Economic Transition The Case of Metropolitan  
 651 Wuhan *Environment and Behavior* 35:784-801  
 652 Lin J (2015) Experiences of a waste sorting pioneer in rural area---Xiaoqin Lu, Shanghai's top 10 volunteers  
 653 of environmental sanitation  
 654 List of the first session of people's congress in Jing'an (2016). Website of Jing'an government  
 655 Liu W (2016) Four thousand tons wastes from Shanghai secretly dump in Tai Lake of Suzhou *The Xinhua*  
 656 *News Agency, Beijing*  
 657 McLaren D, Agyeman J (2015) *Sharing cities: a case for truly smart and sustainable cities*. MIT Press,  
 658 Cambridge, USA  
 659 Mizrahi S (2012) Self-Provision of Public Services: Its Evolution and Impact *Public Administration Review*  
 660 72:285-291  
 661 Onishi N (2005) How do the Japanese dump trash? Let us count the myriad ways *The New York Times* 12:2  
 662 *Opinions on Strengthening Incineration Management of Urban Household Waste (2016) Recyclable*  
 663 *Resource and Circular Economy* 9:4-5  
 664 Osborne SP (2006) The New Public Governance? *Public Management Review* 8:377-387  
 665 Pestoff V, Brandsen T (2010) Public governance and the third sector: Opportunities for coproduction and  
 666 innovation *The new public governance*:223-236  
 667 Peters BG (2010) Meta-governance and public management *The new public governance*:36-51  
 668 Poon C, Ann T, Ng L (2001) On-site sorting of construction and demolition waste in Hong Kong *Resources,*  
 669 *conservation and recycling* 32:157-172

670 Qi Y Strong consciousness and guiding ability of community leading teams are key to success of waste  
 671 sorting. In: Chen S (ed) The First Strategic Summit of New Environmental Protection Industry of  
 672 China Environmental Union, Shanghai, 8 December 2017.  
 673 Rakić B, Rađenović T (2011) Public-private partnerships as an instrument of new public management  
 674 FACTA UNIVERSITATIS-Economics and Organization 8:207-220  
 675 Rhodes RAW (1996) The new governance: governing without government Political studies 44:652-667  
 676 SAGCA (2016) All establishments in Shanghai will be mandated to sort the waste by the end of 2017.  
 677 <http://www.shanghai.gov.cn/nw2/nw2314/nw2315/nw4411/u21aw1148629.html>. Accessed 30  
 678 April 2017  
 679 Schipperijn J, Randrup TB, Nilsson K, Konijnendijk CC (2005) Urban forests and trees: a reference book, 1  
 680 edn. Springer-Verlag, Berlin  
 681 Schneider F (2008) Wasting food—An insistent behavior  
 682 Shanghai Bureau of Commodity Price, SAGCA (2013) Notice on the workplace waste disposal charge in  
 683 Shanghai. Shanghai  
 684 Shanghai Statistics Bureau (1978-2017) Shanghai Statistical Yearbook. . China Statistics Press, Beijing  
 685 Shekdar AV (2009) Sustainable solid waste management: an integrated approach for Asian countries  
 686 Waste management 29:1438-1448  
 687 Song G, Sun Y, Zhao C, Liu S, Wang Y, Geng J (2017) Assessment report of social cost of urban household  
 688 waste incineration in Beijing. Renmin University of China, Beijing  
 689 Song J, Song D, Zhang X, Sun Y (2013) Risk identification for PPP waste-to-energy incineration projects in  
 690 China Energy Policy 61:953-962  
 691 Sørensen E (2012) Governance and innovation in the public sector The Oxford Handbook of  
 692 Governance:215-227  
 693 Sun K (2016) The national challenge induced from Shanghai's waste dumping  
 694 <http://dajia.qq.com/original/category/sk20160822.html>. Accessed 28 April 2017  
 695 Tacoli C (2012) Urbanization, gender and urban poverty: paid work and unpaid carework in the city.  
 696 Citeseer, Human Settlements Group, International Institute for Environment and Development  
 697 Tai J, Zhang W, Che Y, Feng D (2011) Municipal solid waste source-separated collection in China: A  
 698 comparative analysis Waste management 31:1673-1682  
 699 UNEP (2011) Towards a Green Economy: Pathways to Sustainable Development and Poverty Eradication.  
 700 United Nations Environment Program  
 701 Wang C (2014) How is your view on "Fine on refusal of waste sorting" Youth Literator 4-4  
 702 Wang H, Nie Y (2001) Municipal solid waste characteristics and management in China Journal of the Air &  
 703 Waste Management Association 51:250-263  
 704 Wang Y, Lin J (2014) Waste sorting, what are the difficulties?-----Report from the pilot communities for  
 705 waste sorting. vol 18. Shanghai Greening and City Appearance, Shanghai  
 706 White W, Lunnan A, Nybakk E, Kulisic B (2013) The role of governments in renewable energy: The  
 707 importance of policy consistency Biomass and bioenergy 57:97-105  
 708 Wu J et al. (2016) Effects and improvement suggestions of green account system for waste classification  
 709 and reduction in Shanghai Journal of Shanghai University (Natural Science) 22:197-202  
 710 Xiao L, Yan J, Chen Q, Xu J, Wu Y, Qian J (2016) 2015-2016 Shanghai Analytical Report of Social Situation  
 711 Scientific Development:32-40  
 712 Yang H, Xia J, Thompson JR, Flower RJWm (2017) Urban construction and demolition waste and landfill  
 713 failure in Shenzhen, China 63:393-396  
 714 Zhang DQ, Tan SK, Gersberg RM (2010) Municipal solid waste management in China: status, problems and  
 715 challenges Journal of environmental management 91:1623-1633  
 716 Zhang S (2012) Research of household waste recycling mechanism in Chinese cities. Jiangxi University of  
 717 Finance&Economics

718 Zheng S, Yang S (2017) Cut off the profit chain of transboundary waste dumping China Comment:78-78  
719 Zhu B (2014) Face off for five times, yet the crux remains——The dilemma of Shanghai waste sorting  
720 Chinese Construction:14-17  
721