A Comparative Study of Household Solid Waste Regulations in Shanghai, Beijing, and Guangzhou

Qiran Zhou *

School of Social Ecology, University of California – Irvine, Irvine, California, United States

* Corresponding Author Email: Qiranz@uci.edu

Abstract. Since the "Reform and Opening-up" policy in 1978, China has experienced continued urbanization and population growth, contributing to a rapid increase in household solid waste (HSW) in many cities. China launched national HSW sorting regulations in 2017 and designated 46 pilot cities to explore replicable HSW sorting models to resolve this issue. This study compares local HSW sorting regulations in Shanghai, Beijing, and Guangzhou from several dimensions to explore local interpretations of the national HSW sorting regulations and the implications for other cities in China. First, the study provides a brief historical background of HSW sorting regulations in China. Afterward, three HSW sorting models of Shanghai, Beijing, and Guangzhou are investigated from eight dimensions: local legislations, local HSW classification standards, steps for implementation, penalty and rewards requirements, the use of social credit system, HSW sorting evaluation systems, responsibilities of local government to improve waste disposal facility, and civic engagement. Then, a comparison of the three models is conducted. The current study finds that although a top-down approach is dominant in the law-making process, the regulations and waste classification standards are different among the three cities. When implementing the regulations, the local governments vary in preparation, supervision, and sanitary measures according to local HSW sorting conditions. While penalty provisions are found in all three cities, reward stipulations are not. Civic engagement generally forms mutual supervision, obeying the regulations, and reporting violations. However, Guangzhou illustrates the possibility of participatory governance regarding civic engagement in HSW sorting regulations. A potential problem for the three models is the high administration cost. Therefore, alternatives should be explored to make it sustainable and economically efficient.

Keywords: Household solid waste regulations; China; Shanghai model, Beijing model; Guangzhou model.

1. Introduction

China has experienced tremendous economic growth and rapid urbanization over the past few decades. After implementing the "Reform and Opening-up" policy in 1978, China's urban population increased from 18% to 57.35% in 2016. A study suggested that 65% of the total population, approximately one billion, will live in urban areas by 2030 in China [1]. Urbanization brings economic growth and convenience to people. Still, it leads to an unparallel increase in municipal solid waste (MSW) without antecedents to the significant and rapid rise in MSW like in contemporary China [2]. As a significant part of MSW, household solid waste (HSW) is an unavoidable section of everyday activities [3]. Due to the rapid increase in HSW, productive management of HSW is necessary to resolve the issues caused by large HSW generation and complicated HSW stream [4]. In fact, China realized the need for HSW sorting policy as early as the early 2000s by launching an experimental HSW sorting policy in eight selected cities. Only Beijing and Shanghai showed relative effectiveness, whereas the other six cities performed poorly, failing to achieve the desired outcome. Therefore, a more comprehensive MSW system is urgently necessary for a much wider range of cities [5].

In March 2017, China issued the notice of Implementation Plan of Household Waste Sorting System, a national plan that designated 46 cities as pilot cities to pass local regulations or local rules to legislate mandatory waste classification policy by the end of 2020. The plan requires that the pilot cities will form a complete waste sorting legislation and a standardized system that can be replicated and promulgated across the nation. Unlike the previous attempts, the 2017 plan has a compulsory

nature and measurable targets, which marks the new era of HWS in China. In December 2019, Signs for Classification of Municipal Solid Waste (GB/T 19095-2019) was enacted to regulate waste sorting standards nationally. In September 2020, the Law of the People's Republic of China on Prevention and Control of Environmental Pollution by Solid Waste was officially carried out as the legal framework of the waste sorting policy. In November 2020, the central government issued an opinion on further strengthening the Administration over HSW sorting, claiming that it improved centrally state-controlled waste classification policy and preliminarily established an HSW legal framework with Chinese characteristics.

This study aims to investigate the local implementation of the national HSW regulations by conducting comparing current local HSW sorting legislations in Shanghai, Beijing, and Guangzhou. The current study evaluates the impact of current legislations, legal instruments used by the local government, and the local government's legal duties to improve disposal infrastructures were examined, as these are essential indicators to measure the impact of policy. In addition, public participation in the regulations is explored since the public is an essential actor in the HSW sorting regulations. The current study was divided into three parts to illustrate the models operated by the three cities, followed by a point-to-point comparison of all dimensions.

Method of literature review is applied in this paper to explore the differences of the local interpretations of the national HSW sorting regulations in Shanghai, Beijing, and Guangzhou. Source of materials include academic journals, news, and government official documents.

2. Literature Review

Recently, some case studies investigated different HSW sorting models employed by various cities in terms of the effectiveness of local regulations or policies. Zhang and Liu provided an overview of the HSW sorting models of Chengdu by demonstrating the waste classification standards, supervision, and the public's opinions on waste sorting [6]. Li and Wang investigated the impact of HSW sorting policies' transactional context on residents' willingness to sort waste in Shanghai [7]. Chen illustrated current HSW sorting problems in Guangzhou and suggested how to resolve the issue shortly [8]. Finally, Shen and Jiang discussed authoritarian environmentalism in China and the central government's attempt to close the implementation gap of environmental policies [9].

This study analyzes the local interpretation of the HSW sorting policy in Shanghai, Beijing, and Guangzhou, as each city has dynamic HSW sorting policies. All three have more mature HSW legislations and may provide insight to other cities. While previous studies have explored local legislation and its impact, they have limitations. First, although the literature has examined HSW sorting policy in different cities, they have concentrated on local data. As more and more different cities have started to implement local HSW sorting policies, a comparative study would be helpful. Second, while various legal instruments to enforce local HSW sorting policy were discussed, more investigation on different cities would be valuable. Third, very few studies have focused on social actors' roles, for example, civic engagement and third-party enterprises, in terms of their potential impact on implementing the HSW sorting regulations.

3. Analysis of Shanghai model, Beijing model, and Guangzhou model

In this part, each of Shanghai model, Beijing model, and Guangzhou model is explored. The current study selects these three cities because (1) they are designated as pilot cities in the national HSW sorting regulations; (2) they are three major cities that have more mature and more comprehensive mandatory HSW sorting regulations in China; (3) each city represents unique characteristics in the law-making approach and each step that constitutes the models. Investigating these three models draws practical implications for other cities in HSW sorting regulations.

3.1 Shanghai Model

Following the national initiative, Shanghai launched the local regulations initiated by Shanghai Municipal People's Congress on July 1, 2019 [10]. According to the regulations, all HSW must be sorted into four color-coded garbage bins: dry, wet, recyclable, and hazardous. According to a study by Li and Wang, Shanghai model is composed of three steps [7]. The initial step began in January 2019. To prepare for the enactment, Shanghai placed hundreds of instructors in various locations holding waste sorting training sessions for the public. In addition, posters appeared in residential dwellings, public transportation, and so on across the city to inform the public about what goes where. A city official app was also launched to facilitate the process of familiarizing waste sorting. This HSW sorting campaign aimed to educate people and improve their knowledge and attitude toward HSW sorting. The second step, essential to the Shanghai Model, is the supervision mechanism. By relocating waste dropping points, positioning instructors, and creating a timetable, the Shanghai government reduces labor and effectively supervises and corrects residents' waste sorting behavior. The third step is sanitary measures, which includes bag breaking device, hand washing device, and deodorization device. Since the enactment of the regulations, more than 30,000 volunteers have supervised the process.

Accompanied with the local HSW sorting regulations are two penalty provisions. According to a news report, waste sorting mainly relied on coercion [11]. Since penalty provisions were carried out, Shanghai has used penalties as a primary measure to ensure residents' obedience to the regulations. Although reward stipulation has not been established at the beginning of the implementation, it was reported that residents could earn points in the "Green Account" by correctly sorting waste [12]. In addition, the current study finds that Shanghai has established a policy to deduct residents' social credit points as a deterrence mechanism for violation of the HSW sorting policy. Such deduction may negatively affect the individual's capability or capacity to apply for loans, register for a new company, and even take a train or airplane [13].

Furthermore, the local government randomly conducts a waste sorting performance evaluation based on district and street levels. The notice provides criteria for evaluation; however, the document does not state the penalty for a district or street that fails to pass [14]. For legal duties to improve the disposal infrastructure, although the local government addressed the importance of building more waste disposal infrastructures with advanced technology, it does not impose concrete responsibilities and the time limitation to do so. The regulations stipulate that the leadership of residential areas should cooperate with neighborhood committees to carry out the HSW sorting regulations [15]. On the other hand, the study finds that the regulations require civic engagement mainly through obeying, mutual supervision, and reporting violations.

3.2 Beijing Model

Beijing government implemented the local regulations: Beijing Municipal Regulations on the Management of Municipal Solid Waste in May 2020, which is considered the beginning of Beijing's mandatory HSW sorting era [16]. According to the regulations, residents must sort their domestic waste into four color-coded bins: kitchen, recyclable, hazardous, and other waste. In addition, Beijing implements the national HSW sorting standard, which is easier for residents to follow [17]. Beijing's model comprises three main stages: preparation, supervision mechanism, and sanitary measures. Two months before the regulations were carried out, the local government started to educate the public about the regulations. Besides, Beijing pinpointed the importance of governmental institutions' role in taking the lead in waste sorting. In addition, Beijing educates different age groups with materials customized to those groups. Although the supervision mechanism is equally significant to Beijing's HSW regulations, it is more flexible and lenient toward individuals and stricter toward governmental institutions than Shanghai's. Notably, the category of "other waste" allows residents to drop waste that is not clearly defined as the other three categories. Furthermore, Beijing promotes a combination of fixed waste dropping points and flexible waste dropping points for residents' convenience and adjustment to the new rule, aiming at exploring alternatives to lowering the social cost of

implementation [18]. Because Beijing collects HSW differently based on two types of residential areas, and the local government does not require bag breaking, sanitary measures vary in different locations throughout the city [19].

The primary penalty provision in Beijing HSW sorting policy for individuals is fines, but only individuals with repeated violations are likely to be fined. The local government attempts to incorporate education with the penalty for violators [20]. On the contrary, this study finds no specific reward stipulations in Beijing. While the regulations encourage a rewards mechanism for HSW sorting behavior, no laws or regulations illustrate how and when to trigger the rewards mechanism. On the other hand, Beijing has not incorporated social credit system in the HSW sorting policy. Therefore, residents' waste sorting behavior does not affect their social credit points.

For evaluation and assessment of the impact of the policy, although the regulations demonstrate the necessity to create an evaluation and supervision system, the local government has not released rules or regulations regarding the issue. However, the current study discovers that some lower-level governments, such as the Fengtai district government, entrust a third party to conduct an evaluation with specific criteria for executing the HSW sorting policy [21]. Regarding legal duties on improving the disposal infrastructure, the local government exhibits strong determination and achievement in building more waste disposal infrastructures with advanced technology.

Civic engagement of the HSW sorting regulations is spotted in the law-making and implementation process in Beijing. During the legislation process, Beijing established the mechanism "ten thousand representatives go to the grassroots level," during which ten thousand representatives participated and provided suggestions on the HSW sorting regulations process [22]. However, this study finds no details regarding how and where the suggestions from representatives were utilized in the final product. Therefore, there is not enough evidence to measure the impact of citizens' engagement on the legislation process. In addition, residents engage in the implementation process through mutual supervision, educating the neighborhood, and volunteering as "barrel guards" [23].

3.3 Guangzhou Model

Being one of the most developed cities in the Pearl River Delta, Guangzhou has a rich history of HSW management and legislation. The current study discovers that one characteristic distinguishing Guangzhou from any other models in China is a high level of civic engagement in the legislation process.

In 2011, Guangzhou became the first city in the nation to issue government regulations for HSW sorting [8]. It is also the national leader in specific HSW sorting legislations, whole-process management, exploration of waste sorting modes, third-party enterprise service, and "two networks integration." The city has preliminarily formed waste sorting methods with Guangzhou's characteristics through innovation. The city's determination to build a legal foundation for HSW sorting attracted national and international attention, which led to a national-wide movement for HSW sorting. After the initial legislation, Guangzhou launched several improved regulations in the following years to address the issues of recyclable waste and designated government institutions and duties for supervision and implementation. In 2018, the local government issued the Guangzhou Municipal Waste Classification Management Regulations, which started the enforcement of mandatory HSW sorting. Based on the current regulations, residents must sort their domestic waste into four color-coded bins marked as recyclable, kitchen, hazardous, and other waste.

Guangzhou's HSW sorting regulations can be divided into three steps. According to Zhanjiang Li, director of Guangzhou Urban Management Technology Research Center, the first stage is prior to 2010, which creates room for the city to prepare and experiment with various. In this stage, the grassroot movement and protests against the government's decision to build a waste incineration plant without consulting the public's opinion attracted massive media attention nationally and internationally, which was rarely seen in China. Eventually, the Guangzhou government had to suspend the construction and communicate with the public more democratically. Afterward, the local government recognized the necessity of policy transparency and the urgency to resolve government-

public conflict from waste incineration. From 2010 to 2019, the government decided to restart HSW sorting regulations and designated many pilot districts within the city. After repeated experimental policies, the public has built a basic understanding of the need for HSW sorting. Therefore, when the third stage of the mandatory HSW sorting regulations was issued in 2018, the public was mentally prepared, and the infrastructures were abundant to accommodate HSW sorting [24].

Guangzhou's supervision mechanism comprises relocating waste dropping points, positioning instructors, and creating a timetable for each waste category. Chapter Six, Art. 56 to Art. 62 of the regulations specify subjects of liabilities, violation behaviors, punishment provisions, enforcement institutions, and liabilities. In addition, the local government has introduced third-party supervision of residential compounds, organ units, public facilities, and commercial areas with detailed criteria and assessment objectives. Sanitary measures include bag-breaking, hand washing, and infrastructure cleaning devices [25].

Punishment previsions for violating the regulations are stipulated in Chapter Six, Art. 56 to Art. 62 for individuals, food waste production business, waste transportation and process industries, etcetera. In addition, "Interim Measures for Source Reduction and Classification of Domestic Waste in Guangzhou" illustrates rewards stipulations to individuals, business enterprises, and government institutions with good HSW sorting standards [26]. Guangzhou's current HSW sorting regulations do not incorporate the use of social credit system.

The local government expresses a resolution to improve waste disposal infrastructures in the regulations. The latest Guangzhou's "14th Five-Year Plan" for Urban Infrastructure Development proposes to increase domestic waste incineration and the kitchen biochemical treatment capacity and achieve zero landfill of primary domestic waste by 2025 [27].

Civic engagement has been an essential element from the beginning of the legislation process. After the victory of the aforementioned massive NIMBY movements, some protesters established environmental NGOs to promote cutting from the source, domestic waste sorting, and supervision of waste incineration plants. They are considered a robust non-governmental force in HSW sorting, influencing the policy-making process [28]. In addition, Guangzhou has a tradition of promoting volunteering in city management. In 2012, 563 thousand volunteers registered to be volunteers. Furthermore, Management Volunteer Association was established in 2017 to provide a professional organization and management platform to mobilize different sectors of society to participate in urban environmental governance [29].

4. Discussion

Shanghai, Beijing, and Guangzhou are among the 46 pilot cities required to implement HSW sorting regulations. Since the national HSW sorting regulations intend to provide a fundamental guideline for local-level law-making, the local governments are encouraged to exploit regulations that suit the local HSW sorting needs. All three cities investigated in this study have followed the national HSW sorting regulations to establish a basic system of local domestic waste sorting laws, regulations, and standards [30]. In addition, all three cities passed the HSW sorting laws by the local people's congress, creating a legal foundation for enforcing the regulations.

For waste sorting standards, Shanghai has a sorting standard different from Beijing and Guangzhou. All three cities have categories named recyclable and hazardous waste. Shanghai classifies the other two into wet and dry, while Beijing and Guangzhou classify the rest into kitchen waste and other waste. The standards of Beijing and Guangzhou comply with the national HSW sorting standards, which provide practical and reproducible experiences to other cities.

The current study finds that Shanghai, Beijing, and Guangzhou each implement a different model. Shanghai model has a short preparation period before the laws are implemented. As one of the first cities with mandatory HSW sorting regulations, Shanghai only allowed five months for people to familiarize themselves and be ready to comply from the time the laws passed to the time of implementation. Although local government propaganda and massive media exposure are evident,

people still find classification standards challenging to follow [11]. Beijing has a similar preparation period as Shanghai for people to learn about the local HSW sorting policy. However, HSW waste sorting has become one of the most prevalent keywords in the nation since the beginning of Shanghai's policies, so people in Beijing had mentally prepared for the regulations' coming [31]. Guangzhou has more experience with HSW sorting regulations and a much more extended preparation period; therefore, it has a mass foundation for promoting the latest HSW sorting regulations. Both Shanghai and Guangzhou exercise relocating waste dropping points, positioning instructors, and creating a timetable for supervision mechanisms.

On the contrary, Beijing implements various supervision mechanisms adapted to different residential areas based on residents' waste sorting needs. Shanghai and Guangzhou exhibit similar sanitary measures. While sanitary measures of Shanghai and Beijing were developed in practice, Guangzhou has specific sanitary criteria for waste disposal infrastructures to follow.

Penalty provisions are presented in all three cities against violations of HSW sorting regulations. Shanghai and Guangzhou are stricter toward individuals who violate the laws, whereas Beijing is more lenient toward violators, especially first-time violators. Compared to Shanghai and Guangzhou, Beijing illustrates more flexible supervision mechanisms. The rewards mechanism is mentioned in the HSW sorting regulations of all three cities; however, none of the regulations discussed in detail regarding how and when to reward people for obeying the laws. For rewards mechanisms, Shanghai and Guangzhou set detailed reward strategies. Shanghai's "green account" primarily rewards individuals, and Guangzhou's interim measures extend the scope to include individuals, government institutions, business enterprises, etcetera. For Beijing, abstract phrases identical to the national HSW sorting regulations are found, but no enforceable plans have been found for neither individuals nor other entities.

Among the three cities, Shanghai is the only city that currently incorporates the use of the social credit system. However, because China's social credit system incorporates extensive data collection and the use of artificial intelligence to rate individuals' behavior for state control, it has long been a controversial topic [32]. Therefore, whether the local government should be given the authority to supervise people's HSW sorting behaviors using the social credit system is a topic worth exploring.

Both Shanghai and Guangzhou have issued criteria for evaluation of enforcement. Although Beijing does not have standard evaluation criteria, the local government declared that HSW sorting would be included in comprehensive municipal evaluation [33]. The study discovers that both third-party evaluation and government-led evaluation are practiced in the three cities. Third-party evaluation includes entrusting evaluation companies and resident volunteering. Data to assess the effectiveness of these types of evaluation to increase HSW sorting is not available for any of the cities. While government transparency is a problem in HSW sorting evaluation, the social cost of imposing it cannot be ignored. All three local governments exhibit a determination to improve waste disposal infrastructures, but only Guangzhou has imposed a time limit on achieving the upgrade.

There are various forms of civic engagement in HSW sorting regulations in the three cities. The public is an essential actor in HSW sorting because the goal of HSW sorting cannot be achieved without their participation. In Shanghai, Beijing, and Guangzhou, civic engagement is manifested in forms including mutual supervision, obeying, educating the neighborhood, volunteering as "barrel guards," and reporting violations. Public participation has only been observed in the legislation process in Beijing and Guangzhou. Beijing conveys a tendency to increase public participation, but such participation is unilateral and lacks interaction. Even though the top-down model is dominant in all three cities' legislation processes, Guangzhou model reveals a high level of public participation. Among the three models, Guangzhou model is the only one in the public form of a grassroots movement to promote HSW sorting behavior. According to Zhang, communication between the public and the government facilitates participatory governance and a better relationship between the government and the public [34].

5. Conclusion

This study compares HSW sorting regulations in Shanghai, Beijing, and Guangzhou. Based on the finding, all three cities exhibit a high level of engagement in enforcing mandatory HSW sorting regulations, with each interpretation suited to local implementation. Each city experienced three stages differently during the process of implementation. First, the Legal instrument that all local governments use to enforce the regulations is punishment provisions. All three local governments consider their legal duties to improve waste disposal infrastructures. Besides legal instruments, the current study discovers that third-party participation mainly facilitates implementation through assessment and evaluation. Civic engagement primarily involves mutual supervision, obeying, and reporting violations. Finally, Guangzhou reveals a more democratic legislative process. Although the top-down approach presides in all three cities, participatory governance is not excluded from law-making or implementation.

All three HSW sorting models are government-led, with high governmental administration costs. Even though the three cities have outstanding achievements in a short time in HSW sorting management, it will place too heavy a financial burden on the local government to sustain such enforcement models. Alternatives should be explored to form a more economically viable and efficient model. On the other hand, the method of civic engagement remains monolithic in both Shanghai and Beijing. Only Guangzhou presents various and reciprocated channels of civic engagement in law-making and the formation of the Guangzhou model. Since the public is one of the significant components of a well-function HSW sorting management system, dynamic civic engagements should be explored and encouraged, for example, volunteering and NGO. Also, the local governments should educate the public regarding HSW sorting regulations more on "why" instead of focusing only on "how," which can signal to the public the value of obeying the HSW sorting regulations. To better prepare the public for the HSW sorting regulations, the local governments should allow more time for the public to familiarize waste sorting standards, waste disposal locations, and timetables. According to the study above, Guangzhou has a longer preparation time for the mandatory HSW sorting regulations, and the public feels better prepared for the implementation. Besides, specific duties for each government department are usually not readily accessible to the public. Therefore, they need to be clarified and transparent for the public for more efficient implementation. Moreover, by clarifying the different duties of government departments, a solid legal foundation for enforcement can be built to support the local HSW sorting regulations.

Currently, all three models focus on sorting waste; however, cutting from the source and subsequent waste treatment received less attention in practice. Since the other two parts are equally essential to achieve sustainability, more regulations regarding these two should be made to ensure the public's effort is not wasted.

There is still a long way to achieve long-term HSW sorting success in China; however, Shanghai model, Beijing model, and Guangzhou model present the local governments' attempts at achieving the national goal. These models also serve as examples for other cities on what to learn and avoid when making their local HSW sorting regulations.

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