

# ***Waste Classification's Contribution to Sustainable Development: A Case Study on Shanghai***

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**Abstract:** This paper explores Shanghai's comprehensive waste classification policy, highlighting its impact on waste reduction, recycling, and the economy. The policy engages citizens in waste sorting at the source and leverages a combination of regulations, incentives, and penalties. This study examines the policy's outcomes, including increased recyclable recovery, reduced hazardous waste, and conversion of waste to valuable resources. Economic benefits such as job creation and a recycling-driven economy are discussed as government investment has boosted the recyclable sector. Growing customer demand under the new policy also creates more jobs. However, challenges such as economic strain and impacts on informal waste collectors should also be acknowledged. Environmental and social concerns, such as plastic bag usage and public dissatisfaction are also addressed. Drawing lessons from waste classification policies in Tokyo and Germany, potential solutions are suggested, including regulatory enhancements, charging mechanisms, stakeholder cooperation, and expanded recycling channels. The abstract underscores the need for continuous evaluation, adaptation, and collaboration to ensure the policy's success in fostering a sustainable urban environment.

**Keywords:** waste classification, waste management, sustainable development, Shanghai

## **1. Introduction**

Shanghai has emerged as a shining example of successful waste management and sustainable development in recent years, through its robust waste classification policy. As one of China's most populous and economically significant cities, the challenges of managing its waste were immense. However, through a series of innovative initiatives and effective policies, Shanghai has tackled this issue head-on, setting a precedent for other urban centres to follow.

Shanghai's waste classification policy was formally introduced in 2019, marking a significant milestone in the city's efforts to combat its mounting waste crisis. The policy requires residents and businesses to sort their waste into four distinct categories: recyclables, hazardous waste, wet waste (household food waste), and dry waste (residual waste). This approach enables more efficient waste disposal and enhances the potential for recycling, reducing the strain on landfills and incineration facilities. Overall, Shanghai's waste classification policy has effectively reduced waste generation and increased recycling, which contributes to environmental protection and further contributes to climate stabilization. On the economic front, resource recovery is also an opportunity – not only has the Waste-to-Energy industry grown, but the materials recovery industry has added jobs with

government assistance. Of course, this policy is not without flaws. With the government’s financial limits, stringent garbage classification is putting a strain on both the public and the government. At the same time, because this policy is not standardized across the country, tourists usually take a long time to grasp and adapt to it, thus causing Shanghai to lose some prospective tourist arrivals.

## 2. Waste Classification

### 2.1. Classification and Dispose Process

The core of the policy is the concept of waste segregation at the source. Residents are provided with separate bins or bags for each waste category and are responsible for sorting their waste as they dispose of it. The Shanghai government has transformed waste separation--a task that previously depended on the morality of its citizens, into a legal obligation that citizens should fulfil, and has set up a rigorous system of regulation, rewards, and penalties. Figure 1 illustrates how the government, communities, residents, and corporations work together to re-establish the waste classification process. When a resident wants to dispose of his or her waste, he or she first needs to divide waste into 4 categories. Community staff at the waste collection point will help and supervise residents to make sure waste will be disposed of in the right rubbish bins. After the waste has been collected, it will be transferred to the waste disposal station, where recyclables will first be separated and sold to the market, so they can be reused or made into other items. The remaining part will be delivered to the waste treatment plant and secondary sorting is carried out to mix dry waste that can be used for combustion to generate electricity with wet waste to be used as fuel. The remaining waste will be sent to a landfill after harmless treatment.

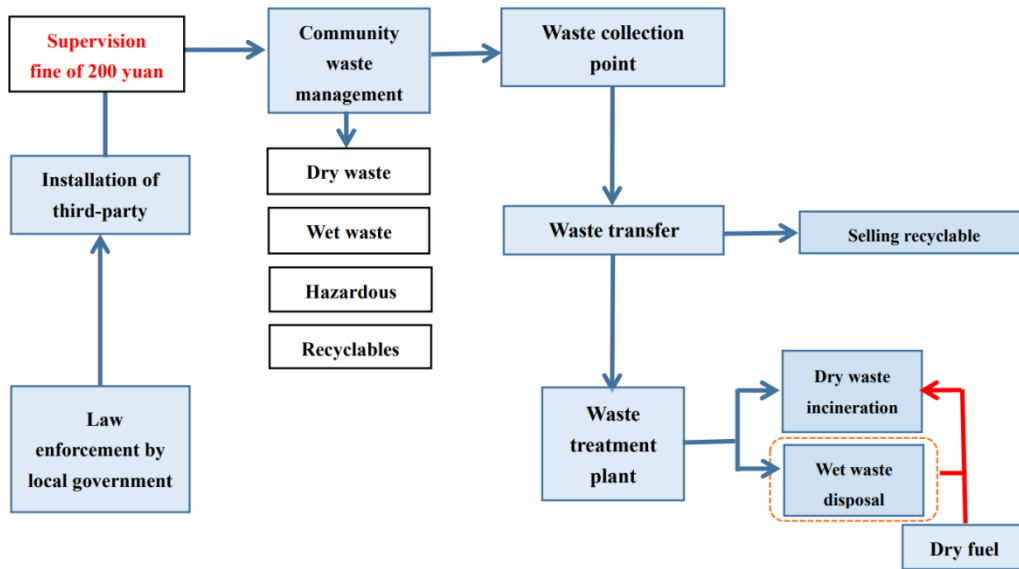


Figure 1: Waste separation and disposal process.

### 2.2. Current Situation

Waste segregation plays an indispensable role in promoting urban sustainable development in Shanghai. By refining the source steps of waste collection and correctly delivering wet waste and recyclable waste that were previously easily misplaced by the public in dry waste, the amount of dry waste going to landfills can be effectively reduced and resource recycling can be increased. At the same time, the correct placement allows more wet waste to be separated and with a lower content of

impurities, which on the one hand increases the amount of wet waste to be recycled for composting and so forth, and on the other hand, due to the reduction of impurities, reduces the carbon dioxide emissions during incineration and provides more energy to be used for power supply.

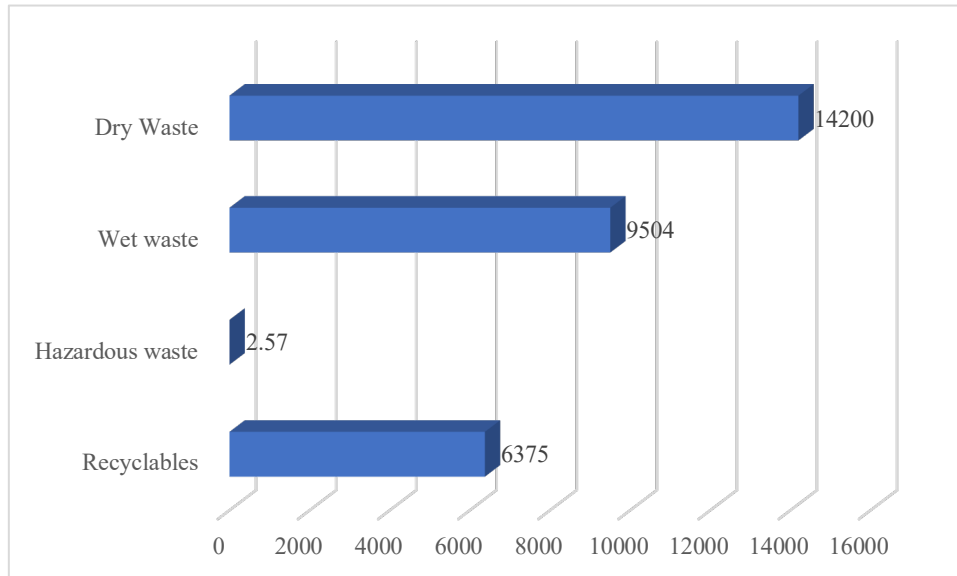


Figure 2: Daily Waste Collected (tons per day).

After the official implementation of the waste classification policy, which is shown in Figure 2, in 2020, the number of recyclables recovered reached 6,375 tons per day, which rose 57.5% compared to the last year. The amount of hazardous waste collected and transported reached 2.57 tons per day, more than triple the amount year-on-year. Furthermore, the amount of wet garbage collected and carried per day was 9,504 tons per day, a 27.5% increase over the previous year, while the amount of dry waste disposed of was around 14,200 tons per day, a 20% decrease year on year [1]. This reduction in dry waste reduces the carbon dioxide produced by incineration, the amount of land needed for landfills, and the pollution that landfills can cause.

Besides dry waste, wet waste also plays an important role in promoting sustainable development. In 2020, the city's recycling of kitchen waste oil and grease amounted to 64,511 tons, of which 38,591 tons were utilized within the city of Shanghai to produce biodiesel, with a total cumulative total of 28,351 tons of biodiesel produced throughout the year and 25,920 tons were utilized outside the city, mainly to produce biodiesel or plasticizers and other chemical products [2]. Biodiesel has more advantages in fuel performance, lubrication performance and renewability compared with ordinary fossil diesel. Waste segregation increases the amount of wet waste recycled on one hand, and the purity of fats and oils on the other hand, which increases the production of biodiesel and allows more traditional energy sources to be replaced by biodiesel. Meanwhile, a report shows if household food waste separation increases by 20%, greenhouse gas emissions can be reduced by 5-7 per cent [3]. This alleviates the energy crisis in Shanghai as a mega-city, and at the same time reduces the amount of carbon dioxide emitted by the inhabitants when producing and using the same amount of energy.

In addition to the necessity of environmental improvement, waste classification is also a major event from the economic point of view to drive the development of the relevant industrial chain and the gradual realisation of a recycling economy. The economic benefits of waste separation can be divided into two aspects: the direct income from the sale of recyclables on the one hand, and the economic effects created by promoting the recycling industry on the other hand. In 2020, the amount of recyclables recovered increased by 57.5%, and for governments and waste treatment plants, as the total amount rises, so does the total profit made from the sale and secondary production of recyclables.

Waste classification also brings a huge amount of job opportunities. As residents consciously begin to separate and collect recyclables, door-to-door recycling companies are welcoming a new group of customers. Before the implementation of waste classification, these recycling companies tended to interface only with large companies, and the recycling content was mostly paper and scrap metal, but now, door-to-door recycling also reaches out to residential areas to collect the recyclable parts of household waste [4]. Waste classification has enabled household items that were once thrown away, such as quilts, to be recycled without contamination, re-cleaned, and put back on the market or processed to make other items, instead of being put into other waste streams and disposed of only by incineration. This not only reduces carbon emissions from incineration, but also improves urban sustainability by utilizing resources more fully, and the re-sale and re-production of goods brings considerable economic value. At the same time, the total amount of door-to-door recycling has increased because of the rise in residents' awareness of recycling items, and the average income of the recycling industry has risen as a result. Meanwhile, many new recycling apps have been invented, such as second-hand goods trading apps, or apps that charge for waste classification and recycling, and more people are participating in the waste recycling industry, which increases economic vitality and promotes the flow of goods. As a result of the increase in demand, the government has invested more money in the waste industry, and the related technology has been further developed, for example, from incineration and landfill treatment to more advanced resource treatment, and some of the secondary manufacturing processes have been further upgraded to achieve higher efficiency. As a result, the cost of waste disposal has been greatly reduced, with the total cost of waste classification and disposal in Shanghai being 985 yuan per ton, much lower than that of Tokyo, also a mega-city, where the cost of the whole process of waste disposal amounted to 3,672 yuan per tons [5].

### **3. Evaluation of the Waste Classification Policies**

Waste classification has achieved success in both environmental protection and economic development. However, the existing waste classification ordinance is not perfect for such a fast-paced and highly trafficked city.

#### **3.1. Economic Concerns**

From an economic point of view, government expenditure is undoubtedly a big problem. Publicity and education, upgrading of physical equipment, and fine-tuning of management all imply rising costs. Shanghai government invest in public awareness campaigns to educate residents about waste classification practices, which may include producing educational materials, organizing workshops, and running advertising campaigns. At the same time, to ensure the effective implementation of waste classification, the Government has invested in the production and standardization of garbage removal trucks to ensure that garbage is not re-mixed in the garbage trucks after it has been categorized for collection. As waste classification requires the cooperation of many parties and the task targets issued by the government require the cooperation of each street to complete, the Shanghai government subsidized a total of 295.78 million yuan to the 16 districts in Shanghai in 2022, which has certainly made the government's budget even tighter in the aftermath of the epidemic [6]. Even though waste classification, recycling and resource treatment can generate additional revenue for the Government, the high expenditure on subsidies is still a great pressure on the Government.

On top of that, while waste classification brings new businesses and jobs, it is a huge challenge for the scavengers at the bottom. Whereas scavengers used to collect recyclable waste such as used plastic bottles from community trash cans, now that recyclable waste is centralized by the government, scavengers can only collect it from street trash cans. Many of these elderly people make their living

as scavengers and have no other means of earning a living, making it impossible for them to change their profession and forcing them to lose their source of income [7].

### 3.2. Environmental Concerns

Waste classification is undoubtedly effective and successful in promoting environmental protection, however, for a mega city, waste classification increases recycling but does not help much to promote residents reducing the amount of waste they produce every day. Although waste classification can slightly reduce part of the output of household waste, for firms at the source, since the implementation of waste classification is not the producers, they still do not notice the problem of excessive packaging and packaging materials that are not environmentally friendly. At the same time, the waste classification itself has increased the use of plastic bags to some extent [7]. Whereas many households originally used one garbage bag and threw away all their garbage in a mixed bag, they now use two or three to store different types of garbage. Due to the incentive mechanism set by the government, whereby communities that rank high in waste classification and community cleanliness receive bonuses, many communities frequently change the bags of garbage cans at their drop-off points to cope with government inspections, even if the garbage cans are not filled to the brim.

### 3.3. Social Concerns and Public Complaints

According to the “Survey Report on the Status of Classification and Reduction of Domestic Waste in Shanghai” recently released by the National Bureau of Statistics Shanghai Survey Team, 98.9% of the citizens expressed their willingness to participate in waste classification [8]. However, even if people are willing to participate in waste classification, there are still many people who do not recognize the requirements and specific measures of the Shanghai government on waste classification or are not satisfied with the specific practices of the community.

According to the survey conducted by the community and the government (shown in Figure 3), 13.6% of the respondents were ‘very satisfied’, 55.7% were ‘more satisfied’, 27% were ‘fair’, 1.8% were ‘dissatisfied’, and 0.1% were ‘very dissatisfied’. ‘Unsatisfied’ accounted for 1.8%, ‘Very Unsatisfied’ accounted for 0.1%, and 1.8% said ‘Don’t Know’ [8]. Those who are dissatisfied with waste classification and unwilling to cooperate are mostly young people. People complained that the government puts the end pressure of waste classification on ordinary people, while some overly rigid rules have created negative feedback. To reduce costs and standardize management, timed and scheduled waste disposal is implemented in many communities, and some communities are only open for two-time slots a day, which is often impossible for people who leave early and return late to discard their waste [7]. In addition to this, tourists often do not adapt to Shanghai’s waste classification policy, resulting in fines or conflicts with administrators due to not knowing how to put out their waste. Due to the reduction in the number of trash cans on the streets, tourists may not know where to look for trash cans, and then feel dissatisfied.

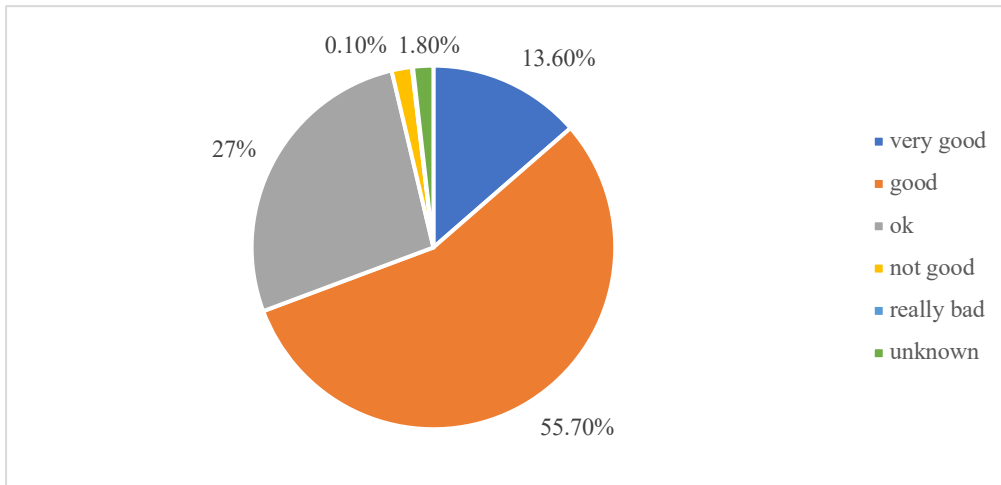


Figure 3: Residents' satisfaction with waste classification policy and management.

## 4. Possible Solutions Learnt from Other Countries

### 4.1. Waste Disposal Policies in Japan

In Japan, waste is divided into four main categories, combustible waste, incombustible waste, recyclables, and large-sized waste based on how it is disposed of. Depending on the type of waste, the Government will collect and transport the waste for disposal regularly. For example, combustible waste will be collected twice a week, while incombustible waste will be collected once a month [9]. For specific types of waste, such as bulky waste and electronics, a recycling fee is often levied.

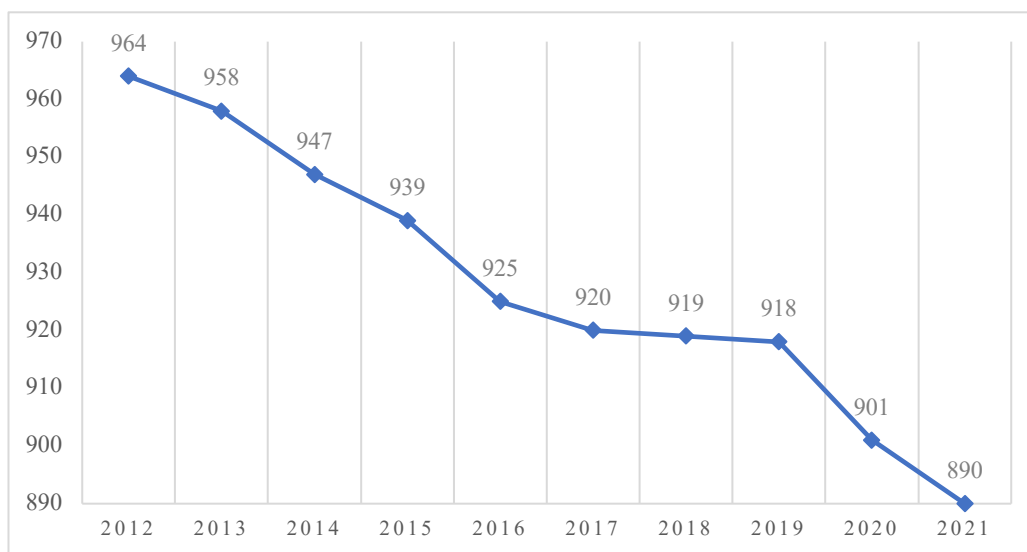


Figure 4: The average daily amount of waste generated per capita in Japan from the fiscal year 2012 to 2021(in grams).

Japan has also established management measures for businesses, such as the use of recyclable materials to reduce resource use. By 2018, 10 categories of industries and 69 items were mandated. Due to high population density, low per capita resources, and low available land resources, Japan became one of the first Asian countries to enforce waste classification, and with the combined efforts of enforcement and education, the recycling rate of domestic waste in Japan has been able to stabilize

at more than 20% after 2007 [10]. With policies encouraging residents to reuse and recycle products at home, the amount of waste produced by each resident in Japan, shown in Figure 4, from 964 grams per day in 2012, experienced a decade-long reduction until it reached its lowest point at 890 grams per day [10].

## 4.2. Recycling in Germany

Germany has the highest recycling rate in the world, with a 67.4% recycling rate in 2020 [11]. On average, each person in Germany produced 194 kg of house trash per year in 2020. Household waste in Germany is divided into four main categories, which are distinguished by different coloured bins, where blue is used for paper products, yellow for plastics and soft metals, green or brown for organics, and grey for residual waste. In addition to this, glass bottles should be separated when sorting. For Germany, successful waste management is not only due to strict governmental control measures but also due to the strong personal awareness of the population. Most Germans participate in waste classification on their initiative and have long been in the habit of doing so. Government-organized recycling donation services have also been effective in increasing the waste recycling rate in Germany. Not only clothes and furniture can be recycled, but also construction raw materials such as paint can be taken back to local hardware stores for recycling. This improves the utilization of resources on the one hand and brings benefits to low-income groups at the same time.

## 4.3. Lessons Learnt for Shanghai

Compared to other countries that are more successful in waste classification, Shanghai still has a lot of space for improvement. First, more than half of Japanese cities try the policy of charging for waste bags, which effectively controls the number of bags used and avoids empty bags and underutilization [12]. In Shanghai, the abusers of plastic bags are property companies and large corporations, and the government can similarly implement a charging policy to regulate large corporations. Secondly, compared with the daily removal in Shanghai, the regular recycling system practised in Japan can also effectively reduce expenditure and alleviate financial pressure. At the same time, charging for the removal of some of the waste supplements government funding on the one hand, and encourages residents to reuse and recycle their waste, reducing the need to replace it with new products, and promoting the reduction of waste produced. Due to Shanghai's large population, there may be a need to remove the dry and wet waste daily, which would otherwise be subject to rotting and odour. However, recyclable, and hazardous wastes are produced in smaller quantities and do not need to be removed immediately, so it is still possible to try to collect them once every two days or more.

Regulation of business is also important. Japan's '3R' policy emphasizes the use of recyclable materials, the use of biodegradable materials, and other measures that not only reduce waste from production but also recycle most of the products after they have been used, which effectively reduces the amount of waste that ends up in landfills and improves the sustainability of cities [9]. When the waste classification policy was introduced, Shanghai mandated the use of biodegradable materials in straws and garbage bags, but the use of recyclable materials is still at the stage of 'recommended' rather than 'mandatory'. Therefore, it is also very important to strengthen the restriction on the raw materials of the products. In addition to this, strengthening cooperation between businesses, communities and governments is one of the breakthrough points. Most of the recycling companies in Shanghai are still small-scale private enterprises with insufficient coverage. At the same time, many items that are recycled by private companies are only dismantled into parts and sold, while the items themselves can still be used, such as TVs. If the government establishes a unified recycling channel like Germany, it will not only ensure that the service is provided to every household but also donate

those items that are still valuable and can be reused by those in need through the community, thus further increasing the utilization of resources.

## 5. Conclusion

Shanghai's waste classification policy has shown remarkable results in reducing waste generation and promoting recycling. This has been achieved by placing the responsibility of waste sorting on citizens, supported by stringent regulations, rewards, and penalties. The policy has led to a substantial increase in the recovery of recyclables, a decrease in hazardous waste, and the efficient conversion of wet waste into valuable resources like biodiesel. Moreover, the policy's economic benefits are evident through the growth of the Waste-to-Energy and materials recovery industries, generating jobs and contributing to a recycling-driven economy.

However, the policy is not without its challenges. Economic concerns arise from the substantial costs associated with public awareness campaigns, infrastructure upgrades, and management adjustments. The strain on government finances, particularly after the pandemic, has raised economic pressures. Additionally, waste classification has impacted the livelihoods of informal waste collectors, potentially leaving some vulnerable populations without income sources. Environmental concerns are also present, as waste classification may not significantly curtail overall waste production, especially in terms of excessive packaging in products. Plastic bag usage has increased due to the need for separate waste containment. Socially, while most of the citizens express willingness to participate, dissatisfaction with the policy's implementation and its impact on daily routines persists, particularly among young people and tourists.

In search of solutions, lessons can be learned from waste classification policies in other countries. Japan's approach includes regular removal of specific waste types and incentivizes responsible behaviour through charges for waste bags. Germany's high recycling rate is attributed to a combination of governmental regulations and a strong culture of personal responsibility. Shanghai can consider implementing these approaches to enhance its waste classification policy. By further regulating businesses, adopting a charging mechanism, strengthening cooperation between stakeholders, and expanding recycling channels, Shanghai can refine its waste management strategies and address economic, environmental, and social concerns.

Shanghai's waste classification policy demonstrates the potential for significant positive change in waste management practices. However, ongoing evaluation, adaptation, and cooperation between government, businesses, and residents are essential to refine the policy's effectiveness and ensure its long-term success in creating a sustainable and cleaner urban environment for Shanghai and beyond.

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