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# *Addressing Recycling Inefficiencies in Shanghai Using Circular Economy*

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***Abstract:*** The recycling rate in Shanghai, despite being a role model among China's cities, still has significant room for improvement. If the recycling rate in Shanghai is improved, people's lives will be better. Being aware of it, and since the lack of value recapture in Shanghai is not encouraging, we are interested in offering a possible solution for the current situation. The difficulty for private sectors to enter leads us to the main discussion. By case studying German and other developed countries' incentives toward this issue and researching SRRTA's, Biohm's and other websites' reports, this paper will respond to the challenges demonstrated above by offering a probable solution: By providing governmental help toward the private sectors, the informal sectors' efficiency of recycling can be elevated.

***Keywords:*** Recycling Rate, Circular Economy, Private Sector.

## 1. Introduction

Even though Shanghai has performed well in recycling in recent years compared with other cities in China, there are a few problems that have not been solved.

It is difficult for the private sector to take part in the recycling business. In Shanghai and other cities in China, the government is mostly responsible for the garbage recycling process. The garbage disposal companies in China are not fully developed and it is hard for them to make a profit. As a result, these companies need government subsidies. In Shanghai, there is no such garbage disposal company. The government alone regulates the business with poor private sectors' help, which may result in low efficiency of workers in government-owned businesses and a budget deficit for the government.

Furthermore, the difficulty of contracting the business into the private sector and recognizing potential wastes, along with economics and environmental concerns, such as pollution, are problems that have not yet been solved in Shanghai.

To fix these problems, there are some current solutions. When the Shanghai government cannot deal with waste as efficiently as individual companies, it is wiser for the Shanghai government to subsidize companies that do things similar to recycling waste to develop technology to better utilize these wastes. Shanghai now mainly deals with rubbish by burning them and subsequently using the heat generated to create electricity. Household organic wastes would be deposited to produce fertilizer for gardens. With the help of technology of burning waste in a sealed place, the toxic gas would not

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be spread out and will be dissolved, and thus it is not a concern [1]. However, these ways of reusing waste only solve the problem of the environment, and it is not the best solution since the wastes burned could have been recycled instead of burning them. For example, paper products can be recycled and used as the material of new paper directly, and organic waste (household food waste) could have been used as a material for things like construction materials just like what Biohm in America does. The only problem is the cost of recycling these wastes. Reprocessing these wastes require a huge amount of manpower resource, and the wage paid to employees plus the resources used to design a machine will be higher than the potential profit. Consequently, Shanghai's government's subsidies are quite important to these companies to solve this problem [2].

According to what has introduced above, our group looks forward to figuring out what kind of incentives, including penalties and rewards, can effectively elevate the recycling rate.

## 2. Literature Review

Efficiencies of recycling differ from city to city, and there is no doubt that some of the cities (we are referring to Shanghai in this essay) are good recyclers, while some are not. Now, we should go back for a little bit and see some rudimentary concepts.

### 2.1. Recycling

Recycling has three major rules. Rule 1, bottles, cans, paper, and cardboard are those that must be recycled. Rule 2, we should exclude food and liquid from our recycling. Rule 3 is no loose plastic bags and no bagged recyclables [3].

In general, recycling can be defined as any recovery operation by which waste materials are reprocessed into products, materials, and substances, whether for the original or other purposes [4].

### 2.2. Circular Economy

The circular economy is a production and consumption paradigm that encourages people to share, lease, reuse, repair, refurbish, and recycle existing resources and products for as long as feasible. These encouragements are included in four parts of the circularity:

Value creation, value loss, value extension, and value recapture. In each process, there are certain approaches taken to ensure that the value is circulated properly and meanwhile trying its best to utilize the resource as efficiently as possible.

The circular economy develops a sustainable production and consumption paradigm in which raw materials are retained in production cycles for longer and may be reused several times, resulting in less waste.

The goal of this approach, as its name suggests, is to keep resources in the economy for as long as possible, allowing people to use recyclable materials as raw materials for other sectors.

Reduce, reuse, and recycle are the three Rs of a circular economy [5].

In circularities:

1. The circular concept promotes wealth and employment generation against the backdrop of resource constraints. 2. Circular supply chains are up and running – and they have gone global. 3. Supply chains are the key unit of action, and will jointly drive change. 4. Defining materials formulations is the key to unlocking change. 5. Four materials categories, including 'Golden Oldies' 'High Potentials' 'Rough Diamonds' and 'Future Blockbusters' are prime candidates for demonstrating viability. 6. Catalyzing a series of 'Trigger Projects' is the most effective way to reach tipping points for each category. 7. Tangible outcomes can be achieved in two years through joint action [5].

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## 2.3. Shanghai's Recycling

There are 1.02 kilograms of garbage generated per person every day in Shanghai, a city of 24.89 million people. Shanghai is one of the topmost garbage producers in China due to its astonishing economic development. Statistically, 24.7 thousand tons of waste are generated in Shanghai every day, making Shanghai the secondly-ranked waste producer just after Beijing. Despite this sorry truth, Shanghai is still an astonishing city to deal with this tremendous amount of waste. Like other regions in China, Shanghai copes with the waste mainly relies on burying and burning. Compared with Tokyo and London, the recycling rate is respectively low. Surprisingly, people in Shanghai have never seen a gigantic pill of garbage with flies and mice foraging on it, which means that Shanghai has done a terrific job dealing with a very amount of trash. Recently, Shanghai's trash burning has been more active and more frequent (increased from 1081 thousand tons in 2010 to 3608 thousand tons in 2017). In comparison with burying, which takes up more land area, burning is more economical and more effective. Burning can not only reduce the land used for burying but can also emit a significant deal of power for the surrounding citizens. Thanks to the special mechanisms in the burning cage, the toxic gases will not be released into the external world. Furthermore, by classifying the wastes, the toxins are generated even in a fewer amounts [1].

According to calculations, after the garbage classification, every 1.04 tons of waste can produce power that can support one Shanghai family for one year, which is impressive. Moreover, by taking care of every one ton of organic waste, 0.3 tons of organic fertilizer can be obtained per one ton of original organic trash. As long as the classification is a long-standing process, there is a promising future for Shanghai people [6].

## 2.4. The Three-Sector Theory

The "three-sector" refers to the market, the state, and the community. The resulting institutions - businesses, government, and civic groups (including religious organizations, charities, and interest groups) all owe their existence to the fact that they have a social purpose - they fill a need that benefits some element of society.

In the market sector, transactions between buyers and other suppliers exert competitive pressure to attract and keep customers. The market sector focuses on innovation, and simultaneously it seeks through scale-that is, the opportunity to generate economies by satisfying more needs.

In the state sector, which is comprised of formal organizations at different polity levels, and with different functional realms, social relations are typically organized in hierarchies. So, in general, the purpose of all state institutions is to serve a public need in some way.

In the community sector, the 'organizations' range from volunteer organizations, religious organizations, and even to families. Social relations are often shaped by the identities that initially defined groups and their founding purposes. Interactions are membership and service based [5].

## 2.5. Shanghai's Data

Let us take a closer look at Shanghai. Among cities in China, Shanghai has done an impressive job in recycling. The household garbage utilization rate in Shanghai has reached 37% by the end of 2021. In specific, wet garbage disposal volume is 9,667 tons per day, increased by 77%. Recyclables recycling volume is 6,439 tons per day, increased by 140%. Harmful garbage disposal volume reaches 2 tons per day, increased by 14.6 times. Compared to an average rate of household garbage disposal rate of 17% in China, Shanghai has made an excellent example of garbage disposal and recycling that other cities can use for reference. The government contributes a lot to garbage recycling in Shanghai through legislation and regulation, development of infrastructure, and related services.

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In 2019, the Shanghai government implemented a policy on garbage disposal, Shanghai Household Waste Classification Regime. According to the policy, citizens and businesses that do not make garbage classifications will be charged. The policy also specifies the classification of garbage. Since most citizens had poor awareness of garbage recycling and had no idea of how to classify household waste, the policy helped the citizens to establish awareness. According to the results of the evaluation of the effectiveness of garbage classification in 2020, the rate of up-to-standard garbage classification in Shanghai increased from 15% to over 90% after the implementation of the Shanghai Household Waste Classification Regime. Most citizens have formed the habit of garbage classification.

In the past three years, the Shanghai government has constructed thousands of garbage recycling stations and built a system for garbage recycling. Until now, there are more than 20,000 garbage recycling stations, 170 garbage transfer stations, and 10 garbage gather and distribute centers. Meanwhile, there are more than 1,500 wet garbage trucks, 3,000 dry garbage trucks, 100 hazardous garbage trucks, and 200 recyclables trucks in Shanghai. Citizens take the garbage to the garbage station every day. The garbage trucks travel from station to station and pick up classified garbage. After that, the trucks take the garbage to the garbage disposal center. At the garbage disposal center, the garbage is recycled and made into usable products. A circularity loop is created during the process. In this way, more garbage is recycled and can be used again by people, creating value during the process [7].

The government also offers related services to stimulate people's incentive of garbage recycling. For example, the Shanghai government released a project called Green Fortune in association with the Bank of China. The project encourages citizens to recycle household waste in an incentive-based method. Once a citizen recycles garbage in a garbage station, he will receive credits in his green account. The credits can be used to exchange commodities. One feature of the Green Fortune project is that it is information based. The government creates a platform, including an application and a website, to encourage garbage recycling. Until now, the citizens have already generated more than 0.5 billion credits by garbage recycling. However, there are a few limitations. The project only covers half of Shanghai citizens and active users consists of less than 20% of all users. To cope with the problem of the low utilization rate of the green account, the government should improve the advertisement of the project. Furthermore, the platform that is used by the project can be expanded into a platform that regulates all garbage recycling processes, so that more citizens will start to recognize the project and use the platform [7].

Through imposing regulations and developing infrastructure or related incentive-based services, the Shanghai government managed to improve the garbage recycling rate.

## 3. Research of Incentives to Stimulate Recycling

### 3.1. Shanghai's Current Capacity of Recycling

From the information we have so far gathered, it is worth researching whether current informal private business sectors can efficiently handle the abundant amounts of recyclable wastes, and meanwhile figuring out their capacity.

According to The Collective, most of the materials went to recycling plants with surprising efficiency. Within one day or two of disposal, all aluminum cans, plastic bottles, metal, wood, and cardboard packaging went from waste bin to manufacturers. While following the materials into a recycler, or to a manufacturer who can reprocess the waste, we were encouraged to find that some materials were able to go from the waste bin into inventory in a week. Paper and cardboard often take less time, while metal could take measurably longer [4].

Of the materials we tracked, few, only including some plastic bottles went to incinerators. They were sold to small compressors by private collectors and were crushed and flattened. The material is

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then burned in incinerators with its ashes disposed in government landfills. Shanghai currently owns five incinerators but is determined to build more over the next few years. As they shift away from landfills, Shanghai will expand facilities by a significant margin – building eight new incinerators by 2020 [4].

It was only the carpet that went directly to the landfill. Government and private collectors would pick them up and ship them to sorting sites, which would eventually settle for landfill treatment. Some of the landfills were government-controlled, but others were either private or unregistered, resembling roadside dumping sites. Shanghai's government currently operates five landfills but will close two by the end of 2017 [4].

Under such circumstances, we can conclude that China's private collectors are highly efficient when recycling – sending tons of household waste back to manufacturers.

Driven by the economic value of materials instead city-subsidized, recycling in China is somehow market directed. If material waste has value, it will find its way to a manufacturer [8].

A steady flow of material needs to be delivered daily to an entire ecosystem of companies. Those materials are in part largely sourced from the household and commercial wastes of the city and are being diverted from landfill [9].

So as long as the high demand for raw materials remains unchanged, private collectors will search street corners, construction sites, and waste bins to find anything they can sell. In this case, businesses with recycling plants and expertise will continue to be valuable [10].

While searching for private sectors' capacities, one organization, which is one of the participants in Shanghai's recycling, has attracted my attention: SHANGHAI RESOURCE RECYCLING TRADE ASSOCIATION [11]. Composed of different social enterprises that spontaneously wanted to make Shanghai a better place, this is an environmental-friendly non-profit social group. Under the guidance of Deng Xiaoping's 'Scientific outlook of development theory, this organizing formed a specialized group of professionals to deal with recycling. Recently, the organizations have come up with a policy called 'Multi-license to One-license' policy to make recycling more convenient than ever by cutting off unnecessary pointless licenses. Making the company free to supervise and help with recycling everywhere in the city, the capacity of Shanghai's recycling increased greatly. By carefully taking care of glasses and plastics, Shanghai has found its way out of dealing with waste that are not easy to deal with. From my perspective, however, despite SRRTA's efforts, Shanghai's recycling still has a gigantic room for improvement. We need more people on this journey whose power can pile up and lead us to the ultimate victory of recycling. Whether or not more people are willing to take part in this great event is the key to our problem [11].

A huge problem, which is meanwhile a direct consequence of the low participation rate, in garbage classification in Shanghai, is that the garbage recovery rate is low. The garbage collection rate is obtained by dividing the total amount of material recycled by the total amount of waste processed plus the amount of collection by the community [12]. Shanghai has a large flow of people and generates a huge amount of garbage every year. However, the amount of garbage recycled is extremely small compared to waste generated, resulting in a low level of garbage recycling rate [13].

### 3.2. Foreign Countries' Incentives to Address Issue

In the field of waste recovery, Japan is a model country. A series of laws promulgated by the Japanese government in recent years have greatly improved the overall garbage recycling rate of the country.

One of the laws is Japan's household appliance recycling law, which came into effect in April 2001. The law establishes a comprehensive recycling system for waste electrical appliances. It covers four categories of commonly used household appliances: television, refrigerator, washing machine, and air conditioner [14]. The whole process is divided into three steps:

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1. Consumers pay a transport and recycling fee when disposing of home appliances.
2. Retailer takes back the waste appliances and delivers them to the manufacturer.
3. Manufacturers recycle discarded appliances thus retrieved [15].

Consumers need to pay an additional recycling fee when buying new appliances, which causes the demand curve of the electronic appliance market to shift to the left. The number of new electrical appliances sold will be reduced, and the number of wasted electrical appliances left in landfill will also be reduced. At the same time, electrical appliance manufacturers are also required to pay the recovery fee. To reduce recycling costs, manufacturers will create products that are easier to recycle [15]. The results of the household appliance recycling law have greatly improved the garbage recovery rate in Japan. The Home Appliance Recycling Law requires the recycling of at least 55% of televisions. Sony has consistently achieved this requirement since fiscal 2001. In the fiscal year 2004, the recovery rate of Sony-made TVs was 86%, and about 570000 Sony-made TVs were recycled [16].

It is also well acknowledged that Germany has a successful waste management program in the world. As early as 2015, the domestic garbage recovery rate in Germany reached 66.1%. However, the domestic garbage recovery rate in Shanghai is only 37%. The success of waste management in Germany is attributed to two things: strong government policies and citizens' acceptance of recycling [17].

Germany's Waste Management Act (KrWG) entered into force on 1 June 2012. The waste management act gives a clear definition of waste, a substance no longer qualifies as waste insofar as the following criteria are met:

1. The substance is used for a specific purpose
2. There is demand or a market for the substance
3. Use of the substance engenders no harm (Umwelt Bundesant Waste regulation)

The improvement of waste requirements reduces the waste generated in citizens' lives and releases the pressure on waste disposal sites. There are six different color dustbins: general waste is black, paper is blue, plastic is yellow, transparent glass is white, colored glass is green and compost is brown. Once the residents are found dumping garbage incorrectly, they will be warned by the management personnel. If they do not correct in time, they will be issued a ticket. After they drop garbage into the wrong trash can again, the garbage collection fee will be elevated, thus increasing the garbage treatment fee of the residents in the whole community. Under the strict policy management of the government, German citizens have gradually developed a good awareness of garbage classification [18].

Solutions to garbage recycling in both Japan and German are worth learning about. The Shanghai government should enact some punishment policy for collecting waste garbage which helps the circular economy chain of consumer - EOL - recycling to be more efficient. Reducing the excessive use of goods, increasing the recycling efficiency of waste products, and enhancing the citizens' awareness of waste classification can ultimately improve the current situation of garbage recycling in Shanghai.

Global waste was predicted to grow by 70% as soon as 2050, and as a result, Shanghai's capacity for waste will hardly be enough in the future. Therefore, Shanghai needs to take some actions to increase its capacity such as imitating the system of sorting & recycling waste from some countries which have a high recycling rate. According to Minimizing Waste: Which Countries Are Winning, Japan did the best in the past five years in sorting and recycling waste. The reason why it could achieve this is that its strict law on this problem have contributed significantly and people are taught to develop the awareness of rubbish sorting ever since they are children. In Japan, people will get a penalty if they discard big pieces of rubbish more than 4 times. Besides that, the classification of rubbish is quite detailed in Japan. If people have some mistake in sorting, they will get a penalty as well, and it would cost a lot if a person does not follow the law of sorting. As a result, Japan almost

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achieves 100 percent of the recycling of waste. In Shanghai, it is hard to make people get used to the strict classification of sorting in a short time, but it is helpful for Shanghai to develop people's awareness and start resorting to less strict classifications.

In most States in America, Littering is banned lawfully and is listed as a third-degree misdemeanor, and the punishment can range from a fine of $300 to $1,000, jail time or community service (up to a year), or both or all the above. Rubbish dealing is industrialized in America by a company called Waste Management. Since it is a profitable company, it would increase its efficiency of rubbish dealing and recycling the valuable part of waste to maximize its profit. In Shanghai, it would also be realistic for government to subsidize some companies to take the job of rubbish dealing and recycling to increase efficiency instead of dealing with all rubbish dealing itself.

In Germany, the system of recycling is connected to purchasing. Besides the strict classification of rubbish, Germans have to pay a cash pledge when they buy goods in bottles. For example, when they recycle a bottle with a square logo with a can and bottle twisted together by an arrow, which means it is an Einwegflasche (a bottle can be recycled for once), they could get 25 cents back as the cash pledge of the bottle. This policy gives people an incentive to recycle on their initiative, which is more effective for Shanghai in the short run compared to developing awareness of sorting and recycling waste.

### 3.3. Things We Can Learn from the Incentives

In Japan, retailers take back the waste appliances and deliver them to manufacturers, and then let the supply chain reprocess them to ingredients and produce new products. In the circular economy, this behavior is known as "recycling". This way helps increase the recycling rate of discarded appliances. Combining it with the policy mentioned before that people will get penalties if they throw out a big piece of rubbish, such as discarded appliances that require the Japanese to use one appliance for longer, Japan reduces the cost of production by using circularity loops of the inner circle and circling longer, which means it increases the life span of appliances and reuses the limited resources [19].

In Germany, people who give back bottles with a special sign on them could get back the number of cash pledges back. This action combines recycling with people's daily consumption to increase the degree of participation of all people in Germany in recycling. After bottles are collected, the recycling company would come and take them to manufacturers, and they will reprocess them again to make new bottles. This action increases the refurbishing rate of bottles to cause less value loss. Germany uses a circularity loop of circling longer to reduce the waste of bottles.

The key to strengthening the value recapture process is to elevate the level of reuse, refurbishment, and recycling. It seems that Japan and Germany's approaches have led our path.

### 3.4. One Possible Solution

It is not a bad option for Shanghai to imitate Japan and Germany's approaches based on the city's status.

First, the government could offer to fund to companies that are responsible for dealing with waste. By simultaneously helping with garbage collection and transfer, the government and private sectors can corporately sort out recyclable pieces. The definition of 'recyclable' can be the same as Germany's: one with a special purpose, one has demand and supply and market, and one has no external harm. The benefit of the private sector's entry into this case is that companies can bring positive competition, innovation in the industry, and efficiency among firms.

Second, by packing these selected materials and delivering them to companies who need them, value is in this way recaptured. Companies can use these recyclable wastes as raw materials to save

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the costs of production since directly purchasing raw materials is more expensive than accepting recycled ones.

Third, to make recycling more efficient and to make citizens more engaged in the process, companies can print conspicuous signs on the packages that indicate the recyclability of the product. In this case, it would be easier for the citizens to recognize the recyclable wastes. By giving back these packages, the citizens can get cash rewards.

In this case, the value recapture process would be more efficient.

## 4. Conclusion

All in all, Shanghai's garbage collection system has the capacity to handle a large amount of waste and convert waste into energy. The overall garbage recycling capacity meets the daily life requirement of Shanghai citizens. However, Shanghai's low recycling rate remains a serious problem. Compared with Japan, Germany, and other pioneers in garbage recycling, Shanghai still has a lot of room for improvement. Financial support from the government to enhance the contribution of the private sector in the field of waste collection and publishing effective incentives and punishments are both efforts that the Shanghai government can make. As citizens living in Shanghai, an international city, we have high expectations for the future of garbage sorting and recycling in Shanghai. Reformation and innovation, learning from the advanced fields of other countries have always been the label of Shanghai.

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