# Economic Benefit Analysis of Garbage Classification in China and Suggestions for Improvement of Garbage Classification System

**Jingyan Xiong**

Soochow University, Suzhou, China

**Keywords:** “Garbage Siege”, Economic Benefits, Timed Disposal, Improvement of Garbage Classification System

**Abstract:** Vigorously Promoting Garbage Classification is a Long-Term Solution to Solve the “Garbage Siege” Dilemma, and in the Implementation of Garbage Classification Pilot Implementation in Shanghai, There Still Exist Many Factors That May Lead to Inefficient Classification. through Field Investigation, This Paper Sets Up Three Different Situations, Calculates the Economic Benefits of Garbage Classification, Analyzes the Existing Problems in the Current Garbage Classification System and Puts Forward Suggestions for Improvement.

## 1. Introduction

The importance of a country's land resources is self-evident, but China's per capita land, especially per capita arable land area is very weak, so turning valuable land into a dumping ground is a chronic suicide. Throughout the world, developed countries have basically established garbage classification systems suitable for their national conditions. When a country and society develop to a certain level of prosperity, the requirements for environmental health and civilization development will inevitably rise to a new stage. With the basic fact that China has become the world's second largest economy, garbage classification, as a specific field of environmental health, has become a historic choice in China's development process, and sooner or later it will take this step. It is against this background that the pilot implementation of garbage classification was officially implemented in Shanghai on July 1, 2019.

## 2. Problems

Behind the implementation of the pilot waste classification is the fact that the siege of waste hinders development, and the fact that the mixed waste treatment brings serious consequences such as land use and pollution. As early as 2000, the first batch of 8 pilot cities started the attempt of household garbage classification. Over the past 18 years, many urban areas have started household garbage classification. However, because of the disconnection between the collection, transportation and disposal of household garbage classification, the low enthusiasm of residents, it was difficult to form the scale effect. After partial understanding of the implementation situation of this year's pilot program in Shanghai, we find that the reasons for the unsatisfactory implementation of garbage classification over the past 18 years still exist. For example, in some residential areas in Shanghai, the transportation workers mix the separated garbage together and adopt the “one package” method, which cause the separation of garbage collection and transportation. In addition, due to the publicity and education on how to classify the garbage are not in place, many people do not know what is dry garbage, what is wet garbage, which will cause garbage misplacement, and in the process of garbage classification, if there is one person in 100 people didn't follow the rules to classify the garbage correctly, then the efforts of the remaining 99 people are invalid. Moreover, at present, there are few qualified enterprises in China to undertake garbage collection, transportation and treatment. Therefore, it is difficult to form an industrial chain for garbage classification and treatment, so it is hard to have economic benefits. If these problems persist on a large scale, the trial will be like the failed attempts of the past 18 years. When garbage sorting is implemented in cities which are less developed than Shanghai in the future, such situation will be more common than in

  DOI: 10.25236/iwass.2019.142

Shanghai.

Through reading a large number of documentation on garbage classification policies in developed countries, it is not difficult to find that the foundation and conditions for successful implementation in many developed countries do not exist in China. For example, the Japanese people's education and publicity on garbage classification, the public's high recognition of garbage classification and recycling, and the detailed description of the classification and release steps on product packaging. In this regard, many scholars have also raised their concerns. For example, Li Dongmei (2016) analyzed the inefficiency of garbage classification in China from the perspectives of the vulnerability of voluntary cooperation of urban residents. Chen Shaojun (2015) analyzed the deviation of willingness and behavior from the perspective of individual internal factors and external situational factors. Yang Fang (2012) conducted field observation and in-depth interview on the situation of garbage classification in Nanjing, and believed that the main reasons for the low efficiency of garbage classification were unreasonable equipment, disconnection between garbage classification and collection, transportation and treatment, lagging laws and regulations, the absence of constraints, and the lack of overall social atmosphere.

It is undeniable that garbage classification is of great benefit to the environment and economy in the long run, but in view of various objective problems existing in Chinese society today, the economic benefits of garbage classification are not satisfactory in the short run. In this regard, this paper tries to analyze the gap between the economic benefits of garbage classification in regions with strong implementation and those with weak implementation, and points out how to make up these gaps and how to develop the potential of reducing the cost of garbage classification in some regions, that is, to take some measures to bring back garbage sorting really onto the right track.

## 3. Establishment of Economic Benefit Model of Garbage Classification and Case Analysis

In order to compare the economic benefits before and after the implementation of garbage classification and under different implementation intensity in a month, we set up three scenarios here. They are: 1) streets before the implementation of garbage classification 2) streets of relatively weak implementation (after the implementation of garbage classification) 3) streets of relatively strong implementation of street communities (after the implementation of garbage classification).

In order to increase the reliability and representativeness of the results, we tend to choose the streets that are far away from each other for comparison, so we choose Shanghai Street HS and Street LQ. According to the research, among them, the implementation of HS Street is relatively weak, while that of Street LQ is relatively strong. According to Shanghai statistical yearbook 2016 and 2017, the freight charge for each ton of garbage is the same in each district in Shanghai, Street HS and Street LQ in population and garbage output are similar, so we make the following assumptions: 1) The average daily garbage production of Street HS and Street LQ is the same 2) The recycling price of similar recyclable garbage in each district in Shanghai is the same, and there is no fluctuation in one month.

The cost analysis before classification mainly includes maintenance cost (B), personnel cost (M), cleaning and transportation cost (P) and incineration and disposal cost (F). Preliminary analysis shows that the total cost (W) can be expressed as W = B+M+P+F. After classification, the previous cost factor is basically retained, the wet waste treatment cost (G) is increased, and there exists benefit gain (R) resulting from classification. At this time, the total cost can be generally expressed as W=B+M+P+F+G-R. In order to conduct comparison, I collected a large number of data on waste production, transportation cost, processing cost, management cost and so on in Shanghai. After adjusting the assumptions of the model, I substituted the data into the formula for comparison and analysis. Combined with hypothesis and survey data, in July 2019, Street HS and Street LQ each produced 48.4 tons of wet waste, 112.9 tons of dry waste, 8.1 tons of hazardous waste, and 5.2 tons of recyclable waste (hazardous waste was not included in the calculation).

(1)In the first case, before the implementation of garbage classification, the total cost is W=B+M+P+F.

1) B0 is the maintenance cost of garbage station before garbage classification. Considering that

this model compares economic benefits within a month, the maintenance cost is regarded as 0

2) M0 refers to the cost of management personnel in garbage stations in streets before garbage classification, and most of the cost is the wage cost of sanitation workers

3) P0 is the transportation cost of garbage before garbage classification

4) F0 is the cost of incinerating garbage before garbage classification

In order to control variables, we use the data in July 2019 (when garbage classification was actually implemented) to calculate the net cost before garbage classification. Before garbage classification, the cost of garbage transportation is 234 yuan/ton, the cost of incineration is 250 yuan/ton, the maintenance cost of garbage station is 0, and the management personnel of garbage station is 3000 yuan/person, a total of one person. W0= 38961 + 3000 + 41625 = 83589

(2) In the second case, W=B+M+P+F+G-R is the net cost of the garbage sorting in streets where the implementation of garbage classification is relatively weak.

According to the field survey, Street HS is taken as an example. Street HS is relatively weak in implementation.

1) B1 is the cost of building and maintaining garbage stations after garbage classification. Considering that Shanghai garbage classification has been implemented for less than half a year, there is no need to calculate the operating cost and depreciation cost of the system. According to the field investigation, in the new classification and collection system, the investment is 1 million yuan for a recycling station site, 30,000 yuan for an automatic garbage classification and collection machine, and 20,000 yuan for a manual collection site

2) M1 refers to the cost of providing management personnel after garbage classification and the wage cost of sorting workers, which includes the cost of secondary classification

3) P1 is the transportation cost of garbage after garbage classification

4) F1 refers to the cost of garbage incineration after garbage classification

5) G1 represents the cost of biological treatment of wet waste after garbage classification

6) R is the proceeds from the sale of recycled waste in streets with relatively weak implementation

Street HS has a garbage collection site (a total investment of 1 million yuan), 8 automatic garbage sorting and collection machines (each investment of 30,000 yuan), and 3 manual collection places (each investment of 20,000 yuan). The garbage collection site is expected to be used for 30 years, and the machine is expected to be used for 3 years. After amortization, the total investment of HS street garbage classification and collection system in July is 11110 yuan. Before and after the garbage classification, the transportation cost remains unchanged at 234 yuan/ton. After garbage classification, the cost of management personnel increases to 3500 yuan/person. According to the survey, due to the general awareness of garbage classification among residents, the probability of secondary classification is 30%. Meanwhile, the cost of secondary classification for sanitation workers is increased. The qualified rate for recycling is 75% (for example, if milk bottles are left in recyclable waste without being washed, then the milk bottles should be judged as unqualified and cannot be counted as recyclable waste). After garbage classification, wet waste will be treated by biological means at a cost of 200 yuan/ton, while dry waste will be incinerated at a cost of 250 yuan/ton. In this case, we should also calculate the income from sorting out recyclable waste. In Shanghai HS street, the daily average price is 1.0 yuan/kg for paper, plastic and metal, and 300 yuan/air conditioner and 50 yuan/TV for household appliances. According to the survey, the average daily weight of HS street recyclable garbage is 196.7kg, which is 5901kg in a month, including 2801.51kg of paper, 2466.4kg of plastic and 401.62kg of metal. The result is calculated (as above).

W1 = 11110 + 3500 + 2000 = 88188.2 + 37744.2 + 28225 + 9860-4251

According to the analysis and calculation results, the cost in the second case is even slightly higher than that in the first case, and the short-term economic benefits are not ideal.

(3) In the third case, W=B+M+P+F+G-R in the community with relatively strong implementation intensity after the implementation of garbage classification.

Now, Street LQ is taken as an example. Street LQ has more mature implementation of garbage classification than street HS. The set of variables in the third case is similar to those in the second

case.

The investment cost of the garbage station is the same as in the second case, which is 11110 yuan per month. Incineration of dry waste and biological treatment of wet waste are the same as the second case. Unlike Street HS (i.e., the second case), Street LQ takes the approach of red and black boards to motivate residents to do garbage sorting, and the personnel recruit volunteers within the community in order to solve the problem of the elderly disabled who cannot classify garbage by themselves and cannot send the garbage to the designated location problem, thus, LQ garbage classification accuracy can reach almost 100% of the street. What's more, Street LQ adopts the point system in terms of the recyclable waste, such as 20 points for old clothes /kg, 5 points for waste glass /kg, and 1 point for waste batteries. Residents can use points to exchange for daily necessities. As a result, the qualified recycling rate of Street LQ also reaches more than 95%, close to 100%. Since residents in Street LQ do well in sorting, there is not much cost in management, which directly saves the cost of secondary classification of sanitation workers. The management cost recorded here is 3000 yuan/person, a total of one person. Finally, the community management personnel of Street LQ points out that part of the garbage in LQ street can be processed in a reduction-type manner or by compression package, thus reducing the process freight, so the freight is reduced from 234 yuan/ton to 200 yuan/ton. The result of this calculation (from the above formula) is that W1 = 11110+3000+32260+28225+9860-5668=78787

According to the analysis and calculation results, the net cost of streets with strong implementation is less than that of streets with weak implementation, and less than the net income before garbage classification.

In general, the work of garbage classification has just started. Shanghai and even the whole China are all learners and explorers in the field of garbage classification. According to our field investigation and calculation, the total cost of garbage treatment after classification has been reduced compared with that before classification in streets with relatively strong implementation of garbage classification. Although the cost of streets with relatively weak implementation has increased compared with that before the implementation of garbage classification, it still has the potential to reduce the cost of garbage disposal. In the long-term view, considering the garbage classification of poison gas emissions reduction and environmental improvement, the reduction of the water content of garbage leading to the increase of the power generation per unit of garbage incineration and so on, we have every reason to believe that, if garbage classification is properly implemented, we will obtain enormous economic benefits in the future. However, if we do not take measures to remove obstacles in all links of classification, then in the long run, the environment and health field will face various hidden dangers in the future, and the implementation of garbage classification policy will face failure, just as the pilot projects of the past ten years.

## 4. Suggestions for Improvement of Existing Problems in the Current Garbage Classification System

### 4.1 Improve the Pertinence of Publicity and Education

In today's Chinese society, especially in Shanghai, there are many floating population. They are an important factor of social development, but also a difficulty in the implementation of garbage classification. As the floating population comes from all over the country, their cognition of garbage classification is also very different, so it will become the difficulty of garbage classification implementation to a large extent. In the past, most publicity and education of garbage classification have ignored pertinence and the fact that different groups have different degrees of recognition for garbage classification. If we can properly strengthen the education of the floating population and the people who lack the awareness of garbage classification, the accuracy rate of the overall residents will increase to some extent. It is worth mentioning that Street LQ in the past three years has laid the foundation of garbage classification, each month the management personnel would take the door-to-door garbage classification relevant publicity and education, and for the residents of low consciousness towards classification they took the key way of focusing on them, as a result, the

accuracy of garbage classification in Street LQ is close to 100%.

### 4.2 Use the Method of Timed Disposal

The construction of garbage stations and the maintenance of garbage cans is of a very high cost. If this cost is reduced, the economic benefits of garbage classification can also be improved. We can try to learn Japanese way of operation: divide a temporary stacking area in the public area that does not affect the traffic, and set a unified time for the vehicle to be transported after the completion of the disposal. After this, temporary stacking area can be restored to the original public area, which can improve the overall environment of the community, greatly reduce the construction and maintenance cost of garbage station, and reduce the human management cost to a certain extent.

### 4.3 Combination of Rewards and Punishments, Incentive and Restraint

From the example of Street LQ, the adoption of black and red boards and recycle credits for daily necessities greatly improves the participation of residents, who willingly and spontaneously participate in garbage classification. On the contrary, the single punishment mechanism adopted by some community streets improves the accuracy of garbage classification to some extent, but the lack of reward mechanism also makes many residents complain. Such passive participation greatly reduces the enthusiasm of residents, which is not conducive to the implementation of policies in the long run.

### 4.4 Improve the Legal System with Clear Responsibilities and Strictly Enforce Laws.

The implementation of garbage classification has just started, and the social foundation is weak. It is urgent to solve the obstacles of individuals and society in garbage classification, and the most rapid and efficient way to achieve this effect is mandatory system design. For example, Shanghai recently introduced a fine of 200 yuan per time for the wrong garbage, which is a relatively common compulsory means, but also needs to be supplemented by strict law enforcement, in order to ensure the effective operation of the system. The current situation is that the relevant laws and regulations are not sound, and the level of government management efficiency is low. If garbage sorting is to be on the right track, the government must give full play to its leading role, improve relevant laws and regulations, and increase financial input and law enforcement.

## References

[1] Chen M, Mo X , Parnell D, et al. Impact of Image Noise on Gamma Index Calculation[J]. Journal of Physics Conference Series, 2014, 489(1):395-406.

[2] Zhen W, Ha Z, Zhiying L, et al. Demonstration study on garbage source classification measuring system in communities[J]. Recyclable Resources and Circular Economy, 2014.

[3] Ozkaya U, Seyfi L. Fine-Tuning Models Comparisons on Garbage Classification for Recyclability [J]. 2019.

[4] Fukuyama K . Effectiveness of social systems sustained by residents' participation: a collection system of classified garbage and rubbish[C]// IEEE International Conference on Systems. IEEE, 2000.

[5] Xu S , Li G , Ou H , et al. Research and Demonstration of Dynamic Intelligent Logistics System of the Collection and Transportation Process of Giant Municipal Garbage[J]. Lecture Notes in Electrical Engineering, 2015, 286:39-50.