Comparative Study on Garbage Classification Influence Based on Analysis of Yangpu District of Shanghai

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Abstract. As the amount of municipal garbage has grown rapidly, the hidden perils of environment have become increasingly outstanding and needed to be resolved. This paper selects Yangpu District of Shanghai as the research object, and quantify the positive influence of garbage classification and recycling. After the dry and wet garbage classification method in the source classification method is obtained, per ton of garbage can have positive impacts amounts to 256.97 Yuan. Although the concept is new and the prospect is broad, there are still many challenges in the current source classification. Therefore, this paper tries to put forward some suggestions for the garbage recycling and disposal of Shanghai based on the actual situation in China and other countries.

1. Introduction
With the further acceleration of urbanization pace and the rapid development of the express and take-out industry in China, the urban domestic waste is more and more. Whether the disposal of urban domestic waste is appropriate, it is directly related to the life quality of urban residents, therefore, it has attracted much attention.

The current research status is summarized; it is found that the academic circles mainly pay close attention to the charge effect of garbage disposal and the reduction incentive mechanism. In the charge mechanism of garbage disposal, at present, the implementation effect of metering charges is often tested by investigating and surveying the data of a certain region [1,2]. Based on the relationship between classification ways of domestic waste and the behavior and psychology of residents, enterprises and other subjects, Many scholars have improved the charge mechanism of urban domestic waste classification and reduction incentive [3], and put forward policies and suggestions. However, there are still few scholars who study the benefits of classification and disposal methods of domestic waste from the perspective of cost-benefit analysis; this is the research emphasis of this paper.

2. Combine Cost-Benefit Method to Analyze the Mainstream Garbage Classification and Disposal
At present, domestic garbage recycling can be divided into mixed collection and source classification collection. Mixed collection means not classifying garbage before recycling. Source classification collection is widely adopted in developed countries, it means that residents classify garbage according to its nature and composition and put it into corresponding collection containers.
2.1. **Mixed collection.**
The social cost composition of this approach is shown in Figure 1.

![Fig.1 Social cost division of mixed collection method](image)

2.1.1. **Collection cost.** The collection cost of garbage mainly consists of the cost of public garbage can, transportation cost and the cost of closed cleaning station. The cost of public garbage can is calculated by market price. The depreciation cost of vehicles in the transportation cost is calculated by the fixed assets depreciation method, the labor cost is calculated by the market price, the closed cleaning station cost includes land cost and operation and maintenance cost, and the opportunity cost method and the market price method are adopted, respectively.

2.1.2. **Transfer costs.** The costs incurred in the transfer link consist of two categories: fixed cost and variable cost. Fixed costs include fixed costs such as land costs of transfer station and transport vehicles. Variable costs include transportation expense, labor expense, and management expense, etc.

First, the transportation cost is calculated. Taking Yangpu District as an example, A and B are garbage disposal stations, and C and D are garbage collection stations. The garbage of each district is transported to the nearest garbage collection station. The garbage of C and D is transferred to A and B, respectively.

![Fig.2 Distribution condition of garbage stations in Yangpu district](image)

The transport costs of garbage collection to collection stations are as follows:

\[
D_{ToCollectionPlants} = k \times \left( \int_{OESCOarea} D_{OC} \times P_O + \int_{OESD} D_{OD} \times P_O \right)
\]  
(1)
The average transport cost of waste transfer to the disposal station is as follows:

$$D_{\text{ToTreatmentPlants}} = k \times \left( D_{AC} \times \int_{SC} P_{O} + D_{BD} \times \int_{SD} P_{O} \right)$$

(2)

$p_i$ is the population density function of Yangpu district at point $i$, $D_{ij}$ is the distance between point $i$ and point $j$, and $k$ is the ratio between the actual length of transport line and the linear distance, approximation is 1.4.

2.1.3. Safe disposal cost. The safe disposal cost is calculated by taking landfill cost as an example. In addition, we include the cost of environmental protection, in order to prevent landfill from polluting groundwater, the cost of seepage-proofing and other prevention input can use environmental protection prevention cost calculate in advance.

2.2. Source classification collection

Dry and wet garbage classification belongs to source rough classification method, which is simpler and more suitable for China's national conditions. Therefore, the benefit model is established and empirical research is carried out in the following paragraphs.

2.2.1. Establishment of economic model. According to the calculation method proposed by Bernard J Nebel in Environmental Science: The Way the World Works,

$$N_t = P_t - (A_t + B_t)$$

(3)

$N_t$ is the change of consolidated profit and loss in $t$ year of operation of the classified collection system; $P_t$ is the change of the total benefit in $t$ year; $A_t$ is the change in the depreciation expense of the total fixed investment in $t$ year; $B_t$ is the change of the total operating expenses in $t$ year.

According to previous section:

$$P_t = \sum_{m} (P_m X_m) + \Delta P \Delta X + (P_i + P_n) \left( \sum_{i} X_i + X_j \right)$$

(4)

$p_m$ is the selling price of recycling category $m$ garbage, and $X_m$ is the increased amount of category $m$ garbage; $\Delta P$ is the garbage unit price that can generate energy, $\Delta X$ is the increased amount of effective garbage amount; $P_i$ is the unit price of transportation cost in the collection stage, $P_n$ is the unit price of disposal cost in the collection stage, $X_i$ is the reduced disposal amount of category $i$ wet waste, and $X_j$ is the reduced disposal amount of kitchen waste.
2.2.2. Economic benefit evaluation of dry and wet garbage classification

(1) New benefits of recyclable garbage generate

| component  | average price (Yuan /T) | content of each component of waste per unit (%) |
|------------|--------------------------|-----------------------------------------------|
| wastepaper | 2483.33                  | 22.10                                         |
| plastics   | 6900.00                  | 15.40                                         |
| glass      | 250.00                   | 3.20                                          |
| metal      | 15075.00                 | 3.10                                          |

Data source: market research, arrangement of public data

According to table 1, \( \sum P_m X_m = 1667.25 \) Yuan in formula (4).

(2) Recycling benefits of new energy

According to the "Notice on Further Improving the Price Policy on Waste Incineration Power Generation" of National Development and Reform Commission, waste incineration power generation project with domestic waste as raw material, all are converted to on-grid power for settling accounts according to the amount of waste disposal in the factory, tentatively set at 280 kWh/ton, and implement the national unified garbage power generation standard price of 0.65 Yuan per kWh (including tax), the rest of the on-grid electricity quantity implement the on-grid price of local coal-fired generating units. Incineration-type garbage accounts for about 0.562. In summary, in formula (4), \( \Delta P \Delta X = 280 \times 0.65 \times 0.562 = 102.28 \) Yuan/ton

(3) Transportation and disposal costs saved by garbage classification

Wet waste is dehydrated to reduce weight, subsequent transportation and disposal costs are saved. According to Wang Wenjun et al [21], during transportation, transportation and disposal costs \( P_t = 80 \) Yuan/t, garbage disposal station costs \( P_n = 68 \) Yuan / t. At present, the average dehydration rate of wet garbage disposal in the market is 75%, and the proportion of wet garbage is about 0.47. In summary, the garbage collection and disposal cost per unit of wet and kitchen waste due to the reduction of wet waste is 34.78 Yuan.

Since China has not implemented the garbage classification system, it is difficult to know the actual increase percentage of each component per 1t comprehensive household garbage was disposed, so the change rate is conservatively estimated as 5% to calculate the increased total benefits change due to garbage classification.

\[
P_t = \sum P_m X_m + \Delta P \Delta X + (P_i + P_n)(\sum P_m X_m + X_w) = (1667.25+102.28+34.78) \times 0.2 = 360.86
\]

(4) Input costs of increased fixed asset

The investment of fixed assets brought by coarse classification of dry and wet garbage mainly includes the cost of garbage collection container and dewatering facilities of wet garbage. The market price of 50L garbage can is 25 Yuan, and the average service life is 2.5 years. Classification requires 2 garbage cans. According to the results of market research, the treatment of wet garbage should be first broken and then centrifuged. The total amount of crusher and centrifuge needed is 75 thousand Yuan, and its service life is 5 years, on average, 0.5t garbage is processed per hour, if it works for 8h every day, it can handle about 7300t of garbage within the service life, per ton of garbage is about 102.6 Yuan.

Since the dispensing of garbage can depends on the actual situation in different places, the cost shared in the unit garbage is extremely low and difficult to calculate, so ignore it for the time being.

(5) Operating expenses and other expenses
The operating expenses are mainly the increased operation and maintenance costs of the wet garbage disposal system. Since the centrifugal processing equipment can handle 0.5t per hour, the electricity consumption per hour is only 1.3 degrees, and the electricity cost is 0.65 Yuan per degree. It can be known that the electricity cost for wet garbage disposal is \( \frac{7300}{1.3 \times 0.65} = 8639.05 \) Yuan, in addition, the water fee and disinfection fee is about 150 Yuan per year, 750 Yuan for five years, grand total is 9308.05 Yuan, and the average garbage per ton is 1.29 Yuan.

Other expenses mainly include labor costs and publicity expenses, since the two cannot be shared to each unit of garbage and have a large relationship with the area; they will not be calculated temporarily.

In summary, under the situation of conservatively estimating the total revenue change ratio, it is known that after the implementation of garbage classification net income can add 256.97 per t-garbage. Therefore, the garbage classification is conducive to the improvement of economic efficiency.

3. Improvement Measures and Policy Suggestions of Garbage Classification

Although the concept is emerging and has broad prospects, the current source collection still faces many challenges, including the single collection and classification models, backward classification equipment, not strict law and regulation supervision, the balance between government-led and market-led models is also needed to be explored.

In order to achieve management innovation in the classification of domestic waste sources, Shanghai can improve from the following aspects:

1. Start from the source and achieve garbage reduction. For example, restricting excessive packaging, encouraging the sale of unpackaged vegetables, etc., reducing the amount of garbage generated from the source.

2. Improve the legal system and eliminate the "vacuum zone" of the law.

3. According to the characteristics of garbage components in various areas such as business districts, residential areas, and school districts, special collection points should be set up reasonably.

4. Provide more support in the field of technology research and development of garbage recycling industry chain, and support the transformation of technological achievements of enterprises;

5. Social popularization and mobilization of source classification of domestic waste are carried out through various methods, including traditional publicity models such as TV public service advertisements and community bulletin board; new media platform promotion modes such as Weibo and WeChat; the concept of environmental protection is introduced into the school environment education model of classroom education.

References

[1] Michael J. Podolsky and Menahem Spiegel, 1998, “Municipal Waste Disposal: Unit Pricing and Recycling Opportunities”, Public Works Management Policy, Vol. 3.

[2] Seonghoon Hong, 1999, “The Effects of Unit Pricing System upon Household Solid Waste Management: The Korean Experience”, Journal of Environmental Management, Vol.

[3] Thomas S. and Bartelings H., 1999, “Household Waste Management in a Swedish Municipality: Determinants of Waste Disposal, Recycling and Composting”, Environmental and Resource Economics, Vol.

[4] Bernard J Nebel, Environmental Science: The Way the World Works. [M]Prentice Hall 1999.