Research on the Implementation Status and Optimization Path of Classified Management of Rural Domestic Waste in China

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Abstract. The Chinese government attaches great importance to rural revitalization, and doing a good job in the classification and management of rural domestic and foreign waste is the main direction for improving the rural living environment. Combining with the pattern of domestic and foreign rural domestic waste, this paper attempts to explore a public-government-enterprise model, a waste management model for continuous operation. Combining the education of domestic waste classification management with Internet technology and mining waste to make a new profit point, the classification management provide relevant suggestions for the long-term operation of the reproducible, recyclable and sustainable closed-loop platform for the classification management model.

Classification Status and Problems

Classification Status

\textbf{Classification of Rural Domestic Waste in Germany.} In the early 1970s, Germany began to pay attention to waste management, and almost achieved a dynamic balance between the amount of waste generated and the amount of treatment. This achievement was mainly attributed to the classification management of domestic waste. Germany focused on source and established a domestic waste sorting and recycling system. In this system, the waste is divided into four different colors of blue, yellow, gray and green, which correspond to waste paper, waste packaging, organic waste and biological waste. It is beneficial to the recycling of waste.

\textbf{Classification of Rural Domestic Waste in Japan.} Under the guiding principles promulgated by the Central Environmental Committee, Japan took the lead in applying the PPP model to the management of rural domestic waste. The Japanese government will take the lead in formulating a plan for the classification, storage, collection, transshipment and regeneration of domestic waste, and encourage farmers to participate in the double-rule principle, which is to initiate large-scale waste sorting and recycling at the specified time and place; Companies are responsible for recycling “renewable resources” to reduce management and labor costs.

\textbf{Classification of Rural Domestic Waste in China.} Affected by many factors such as people's living habits, economic development level, government-related policies, and natural geographical environment, China's rural areas are limited in their development in dealing with domestic waste. Combined with the analysis of rural data in five provinces (Jiangsu, Sichuan, Shaanxi, Jilin, and Hebei), the proportion of government-managed unified transshipment from high to low is Jiangsu Province (38.6%), Jilin Province (25.4%), Hebei Province (13.1%), Shaanxi Province (11.4%) and Sichuan Province (7.1%). 5 provinces in the province to carry out random disposal of domestic waste.
waste treatment in Hebei Province (64.6%) and Jiangsu Province (30.3%) is the most serious. In China, the rural areas in the western part of China, where the economic strength is slightly weak and the government management is relatively backward, the domestic waste is often not managed by special personnel. The classification management of rural domestic waste is still in the beginning stage, but in the rural areas of more developed provinces such as Jiangsu and Zhejiang, it has already begun. The waste disposal mode of “house classification, village collection, township transshipment, and municipal treatment” has been realized. It can be seen that the regional differences in the classification and management mode of rural domestic waste in China are large and need to be optimized.

Problems in the Source Classification of Rural Domestic Waste

The Participation of the Masses is not High, and the Awareness of the Classification of Sources of Domestic Waste is Weak.[1] Farmers' long-term living habits are difficult to change in the short term. Farmers have no practical understanding of waste sorting, and their awareness of waste sorting, resource utilization, and environmental protection is still relatively shallow.

The Standard System of Waste Classification is Confusing and Impractical. In 2008, the Ministry of Housing and Urban-Rural Development of China proposed the “Classification Mark for Domestic Waste”. However, due to the fact that the system construction is different and the actual situation in different regions is different, some standards are inconsistent, so the practicality is not high. At present, the most widely used method is the “four-point method”, that is, kitchen waste, recyclable waste, other waste, and hazardous waste, but it is difficult for farmers to understand the classification criteria. However, the classification criteria adopted by some regions are not uniform and large-scale promotion of waste classification cannot be achieved.

Lack of Supervision, Management, and Incentive Mechanisms. In the past five years, the government has attached great importance to the problem of domestic waste in rural areas, and has issued a series of related policies such as the “Implementation Plan for Domestic Waste Classification System”, but the legal and regulatory system is still not perfect, lacking mechanisms such as supervision and management, effective incentives, and strict punishment. It is difficult to run long-term on the model of relying on party members and cadres to lead the guidance.

Relevant Governance Reference

China's Eastern Rural Areas for Reference

Classification and Treatment of Rural Domestic Waste in Jinhua City, Zhejiang Province.[2] Approved by the second meeting of the Standing Committee of the 13th People's Congress of Zhejiang Province in March 2018, the “Regulations on the Management of Rural Domestic Wastes in Jinhua City” was implemented on June 5, 2018, and a complete waste classification system was established. We began to strengthen the management of rural domestic waste treatment mode and implement classification. The waste disposal mode of “house classification, village collection, township transshipment, and municipal treatment” was adopted. The specific embodiment is that a large amount of funds have been invested to build a new waste transfer station, and the cleaning staff is arranged to realize that about 90% of the domestic waste is harmless and resource-based.

Classification and Treatment of Rural Domestic Waste in Nanjing. In 2018, Nanjing City promoted the classification of rural domestic waste in an all-round way, and implemented 50% of the administrative villages for waste sorting. It used the two-category collection method of the household source classification + cleaning staff to collect the waste, adopt the household self-treatment, village or street town. Combined with centralized treatment, hazardous waste is stored centrally in the storage and sorting center of each district, and other waste is transported by the sanitation professional units to the waste incineration plant or landfill treatment mode. The step-by-step construction of rural domestic waste separation facilities and facilities is promptly promoted and configuration.[3]
Rural Domestic Waste Classification and Treatment in US

The laws and regulations governing the classification and management of rural domestic waste in the United States are very complete. As early as the 1990s, the states have successively formulated their own waste management laws and regulations. In the United States, where the control of waste sources is highly valued, the rural domestic waste management facilities are also relatively complete. Each household in the rural areas will be equipped with waste bins. Each rural area has special personnel responsible for waste collection and transshipment. In addition, waste collection and sorting in the rural areas of the United States are basically automated, saving labor costs. In the United States, the collection and recycling of rural domestic waste and the disposal of special hazardous waste are being transferred to the private sector, and the government has gradually withdrawn from the disposal of some waste by signing a licensing contract. Through such a waste outsourcing business, the United States not only promotes the concentration of the waste disposal market, but also reduces the cost of waste management.

Ways to Optimize the Classification of Rural Domestic Waste

Combined with domestic and international experience, China should strengthen and improve the relevant laws on rural domestic waste at the present stage, and restrict and standardize through legislation.[4] At the same time, we must vigorously improve the basic construction of rural domestic waste management and strengthen the control of rural domestic waste. In view of the fact that China's current domestic waste management is dominated by the government and the capital investment is relatively simple, the market mechanism can be gradually introduced in the future to guide social funds to invest in rural domestic waste management.

The classification management of rural domestic waste shouldn't be made to maintain traditional ways for hiring work force by the government to keep waste spots clear and sort waste manually one after another. Instead, every villager should develop the awareness of waste classification to reduce the amount of mixed waste at the source. Reducing the high work force and material costs in the process of waste transportation and classification is one of the most effective ways to maximize the recreated value of classified waste. According to the waste sorting facilities implemented in most parts of China, it is proposed to divide domestic waste into four categories, as shown in Table 1 below.

According to the actual situation in rural areas, an optimized three-step path for the classification of domestic waste is proposed: collect by household, transfer by village, and recycle by county government. Each household put classified waste into smart trash can, and the cleaners simply check and inspect each type of waste. The waste trucks load and transfer these waste to collection center; Cleaners will re-distribute the waste to the recycling sites for secondary classification; The kitchen waste would be transported to a specific location for composting; The non-recyclable and toxic waste would be harmless through centralized disposition. The main process of rural domestic waste classification and collection is shown in Figure 1. In this way, deploy the closed-loop model to achieve waste classification management of rural domestic waste.

<table>
<thead>
<tr>
<th>Classification</th>
<th>Details</th>
</tr>
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<tbody>
<tr>
<td>recyclable waste</td>
<td>waste paper, plastic, glass, metal and cloth</td>
</tr>
<tr>
<td>Toxic waste</td>
<td>heavy metals, toxic substances, batteries, fluorescent tubes, light bulbs, mercury thermometers, paint buckets, expired drugs, etc.</td>
</tr>
<tr>
<td>Kitchen waste</td>
<td>Leftovers, bones, vegetable roots, peels, toilet paper, husks, dust, etc.</td>
</tr>
<tr>
<td>Other waste</td>
<td>Brick and tile ceramics, muck, toilet waste paper, porcelain fragments</td>
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</table>
Household Collection Stage

**Design of Smart Trash Can and Online Platform.** According to the actual situation in rural areas, design a semi-intelligent smart waste bin which is suitable for most areas of China. The waste bin identifies waste through deep learning and visual processing technology to achieve assistant classification. Based on the block chain currency technology, a electronic business platform is designed to provide green points for people who has classified waste correctly as feedback. The offline smart trash can has an online platform consisting of a mobile app and a WeChat public account. The villagers can check their own waste records and trace the disposal of each waste. At the same time, the platform will regularly display the knowledge of waste classification and prize competition, so that the villagers can reach the waste classification knowledge from all its aspects and multiple perspectives, and let villagers apply what they have learned to better use the smart waste bin.

**Workflow of Smart Trash Can.** Once the villager is close to the smart waste bin, the infrared sensor will transmit the signal to the CPU, and the waste bin will change from the standby state to the running state. There are two modes of user identification for the trash can, namely IC card recognition and face recognition. When the identity is detected, if the result is that the information of user isn't existed in the database, the screen is automatically directed to the sign up page to create an account; if the result is that there is a existed user information, the screen is directed to the next page which contains five buttons, namely "recyclable waste", "kitchen waste", "toxic waste", "other waste" and "individual waste".

After the user chooses the specific waste type to deliver, the smart trash would open the baffle portal. A waste bag or a single waste falls on the load board by gravity along the guide plate. When the pressure sensor connected to the load plate senses the change in pressure, it automatically starts recording the weight of the waste and transmits it to the CPU. At the same time, changes in pressure would activate the camera mounted on the top of the box to take a top view of the trash bag or individual trash on the load board, and transmit the data to the chip.

The CPU recognizes the transmitted top view data, if it is identified as a waste bag, according to the type of waste selected by the user, the electric push rod is called to push the waste bag to the
specific waste storage; if it is identified as a single waste, the electric push rod is called to push it into the specific waste storage selected by the transmitted top view data of individual waste. At the same time, the speaker tells the type of waste to the user to develop the user's classification awareness. When the pressure value of the sensor is restored, the system determines whether the waste disposal work is completed, and automatically calculates the credit of the waste. At the end of the workflow, the speaker of smart trash bin tells the villagers relevant results, and the screen displays corresponding information.

**Online Platform.** This paper has developed two online platforms for smart waste bins, namely "Love Classification App" and "WeChat public account Life Waste Assistant". The Love Classification App is a software specially designed for users who use smart waste bin. Users can use this software to query the smart waste bins which are close to the user's geographical location check corresponding waste storage conditions of each smart waste bin, so as to avoid that users are unable to put waste into bins due to the situation that the corresponding waste storage is full. So that users can quickly find the right bin for putting waste. App has a built-in historical waste record query function, and can track the recycling and utilization of each waste. The personal center page can help users to view their own "reward" and "punishment records", "contact addresses", "real-name certification", "purchased items", "invite friends", "contact customer service" and other functions.

WeChat has a large installed capacity in China, and its WeChat public account has a secondary development function, which can have some functions of software and use the APIs to interact with users. “Life Waste Assistant” provides some functions of the "Love Classification App" for users who use it for the first time or who haven't the habits to download apps, and regularly pushes the waste classification knowledge and the waste recycling and utilization report of this platform for all users who follow this WeChat public account. Users can also check their green points and use these points to exchange items.

After the villagers correctly put the waste, they will get green points according to the rules set by the platform. The points rules are as follows:

**Village Transfer Stage**

At present, the rural areas have been basically constructed the “village to village” countryside road by the government which providing better conditions for waste transportation. The smart waste bins at each site automatically monitor the amount of space in the four kind waste storage and transmit the information to the data center in real time. The data center store a task list that displays the location of the smart trash can, the amount of storage in the trash, the address of the waste collection center, and the green points rewarded to the people who transfer the waste to the nearest collection center by the way to work.

There are two ways for transferring waste in the village. One is to arrange waste trucks directly for transportation, and the other is to encourage villagers to carry waste in the nearest smart waste bin by using app to collection center on their way to work. The information of the waste bin that meets the conditions will be posted to the love classification app and the small waste assistant. Users who are close to the waste bin or just pass by can receive the task, open the corresponding storage space of the waste bin, transport the waste bag, and get rewards. However, for some smart waste bin spots with a large amount of waste, once the number of garbage specified by the system exceeds the number that the system allow a ordinary user can carry, the task of the smart waste bin will not be displayed to ordinary users, but will be directly released to the waste truck for optimal route arrangement.

**County Recycle Stage**

The county recycle stage includes three aspects: on-site composting of kitchen waste, further recycling of recyclable waste, centralized disposing of toxic and other waste.

**Harmless Composting of Kitchen Waste.** Local villagers are hired as cleaning workers to collect and transfer the kitchen waste collected by the smart waste bins to the nearby composting house for harmless composting processing. The fertilizer produced in the composting house is sold to the local villagers with green points.
Recyclable Waste for Secondary Recycling. Recyclable waste is classified into five categories by cleaning workers, including waste paper, plastic, glass, metal and cloth. Sell these five types of recyclable waste to the waste collector for profit.

Centralized disposing of Toxic and Other Waste. For toxic waste, the harmful substances in the waste are decomposed by special methods. For other waste which is difficult to recycle, in order to reduce the pollution of ground water, surface water, soil and air, the waste is disposal by sanitary landfill.

Construction of Related Security System

Fund Security. The treatment of domestic waste in rural areas, the expenditure on the construction of related facilities, and the salary of cleaning personnel during the operation are mainly supported by the financial allocation of local government departments, while the design, research and, development and promotion expenses of smart waste bins are introduced into social funds through the PPP model. Social enterprises bear the cost of roughly 15-20 million yuan per year. Enterprises can participate in the sharing of profits related to domestic waste recycling, and the government gives certain financial subsidies to relevant enterprises. The villagers do not bear the relevant waste management fees in the early stage of this household waste separation management. However, after the model is mature, they will bear the daily waste management fee of 100-120 yuan per person per year.

System Guarantee. The implementation norms for the classification management of domestic wastes shall be formulated by local governments, and the participation behavior of domestic waste classification management shall be incorporated into the social credit system, and the behavior of social entities shall be restricted by the credit system.

Organizational Structure Guarantee. The implementation of the "College Student Assistance Program” encourages and calls on college students to use the holiday time to do common sense education promotion of household waste classification management in rural areas and guide residents to correctly classify the use of smart waste bins. Implementing the responsibility-to-house management system in the rural areas, and managing the card-integrated users for the waste classification, not only realizes the implementation of the points system but also ensures the feasibility of the source behavior supervision.

Conclusion

In summary, combined with the reference model of rural domestic waste classification management at home and abroad, it is of great practical significance to explore a set of rural domestic waste classification management scheme with Chinese characteristics and wide promotion significance. Combined with cost-benefit analysis, the system construction of rural domestic waste classification management is inseparable from the triple guarantee of capital, system and organizational structure; the innovative waste management model also needs to actively apply science and technology to simplify the classification process; Classified education is inseparable from the guarantee of talent introduction strategy.

References


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