Performance Measurement System of Domestic Garbage Sorting in China: An Improved Balanced Scorecard

Zipei Chen¹,* and Jie Ming¹

¹School of Economics and Management, Jiangsu University of Science and Technology, Zhenjiang, Jiangsu 212003, China
*Corresponding author. Email: zipei_chen@outlook.com

ABSTRACT
Domestic garbage sorting has been put on the agenda in China. To promote the implementation of the strategy of garbage sorting and cooperate with its management, it is of certain significance to construct the performance measurement system. According to the characteristics that garbage sorting is composed of multi-stakeholders, this paper improves the Balanced Scorecard and constructs a performance measurement system of domestic garbage sorting in China through investigation method, garbage sorting assessment documents, and analytic hierarchy process (AHP). This system not only highlights the priorities of various stakeholders but also balances the contradictions within each main stakeholder and the relationship between them.

Keywords: Domestic garbage sorting, Balanced Scorecard, stakeholders, AHP

1. INTRODUCTION
Garbage sorting is an important part of China's ecological civilization construction. In 2017, 46 key cities nationwide launched trials on garbage sorting. Starting from 2019, domestic garbage sorting work was comprehensively launched in all cities at and above the prefecture level in China [1]. In July 2019 and May 2020, Shanghai and Beijing [2] respectively implemented their regulations on the management of domestic garbage. Garbage sorting has become a new fashion and a national concern. With the development of garbage sorting, there is a need to evaluate the performance of domestic garbage sorting. At present, the performance evaluation of garbage sorting in China is mostly from the perspective of the government, which is applied to government financial expenditure. Some cities, such as Beijing, Shanghai, Xiamen, have also set up their garbage sorting assessment rules. The above measures are all in the preliminary establishment stage and need to be improved. It should be noted that the garbage sorting in this paper refers specifically to domestic garbage sorting.

2. LITERATURE REVIEW
There are few literature studies on the performance measurement system of garbage sorting in China, showing a fragmented and unsystematic state [3]. China's garbage sorting has just started. Domestic research on garbage sorting is mostly focused on environmental, legal, and computer. The national conditions between foreign countries and China are different. At present, the researches on garbage sorting abroad mainly focus on garbage disposal technology. According to Guerrero [4], developing countries should develop their own models of garbage sorting, considering their own national conditions, technologies, costs, and other factors. Similarly, for the construction of domestic garbage sorting performance measurement system in China, we should also combine China's national conditions to build a system suitable for us. An effective performance measurement system can play a positive role in promoting garbage sorting activities.

3. IMPROVEMENT OF BALANCED SCORECARD

3.1. Balanced Scorecard
Balanced Scorecard is a classic performance measurement system, proposed by Kaplan and Norton [5], which considers the customer as a stakeholder. It refers to the method of performance management based on the strategy of the enterprise or organization, which decomposes the strategic objectives into specific and balanced performance indicators from the four perspectives of finance, customers, internal business process, learning, and growth. Balanced scorecard breaks the performance evaluation mode that only pays attention to financial indicators. It combines financial indicators with non-financial indicators. After years of practical application, it is a set of systematic performance measurement system. As shown in Figure 1.

Figure 1. Balanced Scorecard
3.2. Changing the Customer Perspective to the Stakeholder Perspective to Lead the Other Three Perspectives

China’s domestic garbage sorting management requires the participation of various stakeholders. Freeman [6] defined stakeholders as “any individual or group that can influence or be affected by the realization of organizational goals”. He also proposed that shareholders cannot make decisions alone [7]. All stakeholders have the right to participate in decision-making to achieve organizational goals based on their interests. For garbage sorting, from the perspective of sustainable development, the entire society is its stakeholders. It is not feasible to rely on the power of the government alone to let the society classify garbage more conscientiously. All stakeholders need to participate in governance. Lu et al. [8] even use the method of case analysis to study how to carry out stakeholders’ co-governance of garbage sorting in China. Here, the customer perspective in the Balanced Scorecard is changed to the stakeholder perspective to lead the other three perspectives. As shown in Figure 2.

![Figure 2. Improved Balanced Scorecard](image)

3.3. Identifying Stakeholders

From the perspective of performance evaluation, the “mandatory” and “beneficial” attributes are used to classify the stakeholders of garbage sorting activities. Mandatory means that the subject has some legal restrictions on garbage sorting. Benefit, which means that the subject can get benefits from garbage sorting, which focuses on cash interest, but is not limited to cash interest. Figure 3 shows the main stakeholders of garbage sorting activities.

![Figure 3. Main stakeholders of garbage sorting](image)

3.4. Redefining the Three Balanced Scorecard Perspectives

The garbage sorting performance measurement system can transform the sustainable development strategy of garbage sorting into specific measures, and is also a way to establish an incentive and restraint mechanism, which has a positive effect on guiding the management activities of garbage sorting. The improved Balanced Scorecard includes three perspectives:

1. Financial perspective. It indicates whether the efforts of stakeholders have a positive effect on their own economic returns. It is difficult to realize the garbage sorting of the whole society by self-consciousness alone. Financial incentives include positive and negative incentives.
2. Internal business process perspective. This perspective focuses on the core competitiveness of stakeholders and solves the problem of "what is the advantage". If stakeholders want to play a positive role in garbage sorting, they need to optimize their own internal business processes.
3. Learning and growth perspective. The goal of the learning and growth perspective is to solve the question of whether stakeholders can continue to improve and create value.

In summary, the improved Balanced Scorecard is a performance measurement system based on stakeholder theory, which is composed of three perspectives: finance, internal business process, and learning and growth. It links performance evaluation with the sustainable development strategy of garbage sorting and can be used to express the goals that the garbage sorting activity must reach for strategic development. At the same time, it can transform the task and decision-making of each stakeholder into the concrete targets.

4. CONSTRUCTION OF PERFORMANCE MEASUREMENT SYSTEM OF GARBAGE SORTING IN CHINA

4.1. Evaluation Method

Most of the weights of traditional balanced scorecards come from expert group feedback and scoring, and some defects have a large subjective impact. In order to correct possible defects, this paper uses AHP method [9]-[10] to structure the performance measurement system and provide scientific quantitative decision-making for the determination of indicator weights. It can also be used as a tool for screening and improving three-level indicators.
4.2. Determining the Hierarchical Structure Model of the Performance Measurement System for China's Garbage Sorting

Through the investigation method, and referring to the literature [11]-[16] and existing assessment documents of garbage sorting in China, combined with the opinions of experts and the actual situation of garbage sorting, based on analysis and summary, three-level specific indicators of the garbage sorting performance measurement system are constructed. As the contents overlap with those in Table 3, it will not be expanded here.

Table 1. Hierarchical structure model of performance measurement system for garbage sorting in China

| Stakeholders | Perspectives | Measures          |
|--------------|--------------|-------------------|
| Government   | Financial    | Fund use Compliance |
|              |              | Fund saving rate   |
|              |              | Budget execution rate |
| Enterprise   |              |                  |
| Residents    |              |                  |
| Bank         |              |                  |
| Media        |              |                  |

4.3. Data Collection and Judgment Matrix

The analytic hierarchy process is divided into the target layer, the criterion layer, and the index layer. The target layer is the performance evaluation of Chinese domestic garbage sorting, the criterion layer is the level of stakeholders and the three perspectives of the improved Balanced Scorecard, and the index layer is the specific measures in Table 3. The data came from ten experts in the field of garbage sorting, four from the government, four from universities, and two from enterprises. Based on their rich experience and expertise, we can assume that their opinions can represent the garbage sorting field well. According to the principles and procedures of the analytic hierarchy process, the scale values range from one to nine is introduced. Through the Delphi method, the pairwise importance of each level index of the hierarchical structure model of the performance measurement system of China's domestic garbage sorting is compared, and quantitative judgment matrixes are constructed. As shown in Table 2.

Table 2. Judgment Matrix

| Stakeholders | Government | Enterprise | Residents | Bank | Media |
|--------------|------------|------------|-----------|------|-------|
| Government   | 1          | 1          | 2         | 3    | 4     |
| Enterprise   | 1          | 1          | 2         | 2    | 4     |
| Residents    | 1/2        | 1/2        | 1         | 1    | 3     |
| Bank         | 1/3        | 1/2        | 1         | 1    | 2     |
| Media        | 1/4        | 1/4        | 1/3       | 1/2  | 1     |

4.4. Weight Calculation and Results

According to the judgment matrix scored by experts, Expert Choice software [17] is used to calculate the weight of each perspective. Consider consistency test. If it fails, you need to consult experts to adjust the judgment matrix until it passes the consistency test. As shown in Table 2, $\lambda = 5.0397$, consistency ratio $CR = 0.0089 < 0.1$, passing the test. By combining this weight with the following steps, the performance score of garbage sorting can be calculated, and the importance of each factor in garbage sorting management can also be expressed, it helps to highlight the priorities of the various stakeholders. Table 3 shows the performance measurement system of garbage sorting calculated by weight, which can be used as a reference for the current performance management of garbage sorting in China.

Table 3. Performance measurement system of domestic garbage sorting

| Stakeholders | Perspectives       | Measures                          |
|--------------|--------------------|-----------------------------------|
| Government   | Financial (F) 0.3278| Fund use Compliance 0.2811        |
|              |                    | Budget execution rate 0.2173      |
| Government   | Internal Business Process (IBP) 0.4111| Fund timeliness 0.1989 |
| Learning & Growth (LG) 0.2611| Government bidding compliance 0.2085  |
| Learning & Growth (LG) 0.2611| GS information disclosure 0.1917  |
| Learning & Growth (LG) 0.2611| Release sites layout 0.1886  |
| Learning & Growth (LG) 0.2611| GS education 0.1626  |
| Enterprise   | F 0.5889           | Garbage disposal fee regulation 0.2548 |
| Enterprise   |                    | GS reward and punishment rules 0.2120 |
| Enterprise   |                    | Procurement rules soundness 0.1817 |
| Enterprise   |                    | Personnel training qualified rate 0.1731 |
| Enterprise   |                    | GS supervision 0.1048 |
| Enterprise   |                    | Project period 0.0736 |
| Enterprise   | Government subsidy | Payback period 0.2377 |
| Enterprise   |                    | Return on investment 0.2064  |
| Enterprise   |                    | Cash flow ratio 0.1742 |
| Enterprise   |                    | 0.1056 |
4.5. Standard Setting and Score Calculation

In the process of setting performance evaluation standards, it is necessary to clarify the goals in the process of garbage sorting and convert them into specific quantitative standards as much as possible. Quantitative standards can avoid the subjective factors of qualitative standards and make the evaluation results more convincing. According to the index weight and the score of performance evaluation calculated by the analytic hierarchy process, the bottom index score is calculated combined with the formula (1), and the overall score is introduced in turn in the same way.

\[ B_t = \sum_{r=1}^{n} W_{ij} G_{ij} \]  

(1)

where \( B_t \) is the score of each perspective level, \( W_{ij} \) is the weight of the specific measures layer, and \( G_{ij} \) is the score of the specific measures layer.

### 5. DISCUSSIONS

5.1. Balancing the Internal Contradictions in Each Stakeholder

In the improved balanced scorecard, the performance of each stakeholder consists of three perspectives: finance, process, learning, and growth. There is a causal relationship between the efforts of stakeholders and their prospects, that is, there is a causal relationship between the objectives and performance indicators of each stakeholder in garbage sorting. Its balance includes external and internal balance, such as the balance between the response of other stakeholders to the government's garbage sorting policy and the quality of the government's policy-making team and policy quality; The balance between the achievement measurement and the driving factor measurement, such as the balance between the benefits obtained from the exchange of household garbage sorting points and the participation rate and accuracy rate of household garbage sorting; The balance between financial measurement and non-financial measurement, such as the balance between enterprise profit and enterprise technological innovation capability, staff training; short-term and long-term balance, such as the balance between the profit of bank garbage loans and the level of bank credit.

5.2. Balancing the Game Relationship among Stakeholders

On the one hand, the development, implementation, and effectiveness of garbage sorting will affect the interests of various stakeholders; on the other hand, these stakeholders will also affect the development and implementation of garbage sorting, thus affecting the effectiveness of the entire garbage sorting. Different stakeholders have different interest requirements for garbage sorting. We...
must consider and balance the interest requirements of all stakeholders to achieve an organic combination of fairness, efficiency, and effectiveness. Only when all aspects are coordinated, can the garbage sorting work be carried out orderly, and the enthusiasm of social participation be mobilized, so as to tap a deeper potential and achieve the optimization of garbage sorting. The improved balanced scorecard can not only show the performance indicators of stakeholders but also balance them by implementing performance evaluation, focusing on the contradictions among stakeholders, and formulating corresponding measures.

6. CONCLUSIONS AND LIMITATIONS

The improved Balanced Scorecard, which is constructed from the perspective of stakeholders, provides a new mode of thinking to promote the development of garbage sorting performance evaluation. Cities should attach importance to the application and development of Internet plus, Internet of things, big data, and other technologies in garbage sorting, which can not only promote the development of garbage sorting management but also further assist the efficient implementation of performance evaluation. However, the situation is different in each city. We acknowledge that although this is a promising approach to garbage sorting, it is noteworthy to recognize the limitation in terms of when and where to use it. In the process of implementation, with the specific needs of practice to change the operation, constantly update and improve the performance measurement system, so that it can play a greater role in garbage sorting activities.

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