Study on classification of municipal solid waste based on entropy weight method and evaluation model

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Abstract. The impact of domestic waste separation in each province needs to be arranged taking into account the actual situation of carbon emission control, so that the situation of carbon emission control of domestic waste separation is more reasonable. This paper establishes an entropy weighting model to analyze all the factors influencing the development of carbon emission control of domestic waste separation, so that we can get the weights of carbon emission control caused by the carbon emission control index of domestic waste separation. A comprehensive evaluation model is established to score the relevant indicators using the previous weights, so as to be able to derive the amount of influence and compare the influence caused by carbon emission control, so as to complete the classification and get the correlation between municipal domestic waste classification and carbon peak carbon neutrality. For its future development path to be analyzed, suggestions are given and the study is completed.

Keywords: Entropy method; correlation coefficient; prediction.

1. Introduction

Through the development of carbon emission control of household waste sorting, we can get the carbon emission control data of different regions, in fact, in many regions of China, there is a certain imbalance in the problem, and it is necessary to establish a model to effectively analyze it, so that its future configuration can be more reasonable, so that it can make urban household waste get effective treatment.

In this paper, we analyze all the factors influencing the development of carbon emission control of domestic waste classification, so that we can get the weight of carbon emission control caused by the carbon emission control index of domestic waste classification, and then get its influence, and determine its evaluation scheme according to the influence, so that we can get the development of domestic waste classification according to the relevant data. A comprehensive evaluation model is established, and the relevant indicators are scored using the previous weights, so that the amount of impact can be derived and the impact caused by carbon emission control can be compared, so that the classification can be completed and the correlation between MSW sorting and carbon neutral carbon can be obtained. For its future development path to be analyzed, suggestions are given and the study is completed.

2. Model assumptions and notation

2.1. Assumptions

(1) The scope of carbon emission control is determined.
(2) The impact of carbon emission control of domestic waste classification is fixed.
(3) All data are true.

2.2. Notations

Important notations used in this paper are listed in Table 1.

Table 1. Notations

Symbols	Explanation
Z^+	Positive prediction solution
Z^-	Negative prediction solution
m	Target number
n	Feasible solutions
s	Distance

3. Model construction and solving

3.1. Analysis of factors influencing the development of carbon emission control of domestic waste separation

In this paper, the entropy weight method model is established for the analysis of all the factors influencing the development of carbon emission control of domestic waste sorting, so as to be able to obtain the weight of carbon emission control caused by the carbon emission control index of domestic waste sorting, and then obtain its influence, and determine its evaluation scheme according to the influence, so as to be able to derive the development of domestic waste sorting according to the relevant data.

Firstly, the relevant data of each province in China are chosen, and due to the limitation of space, the data of the growth rate of carbon emission control of domestic waste classification in different provinces are given, and only some of them are given here [1-4], and the standardized operation is performed as shown in Table 2.

Table 2. Carbon emission control growth rate data

Province	Carbon emissions growth
Beijing	83.3
Tianjin	82.4
Hebei Province	639.4
Shanxi Province	1474.5
Inner Mongolia Autonomous Region	858.8
Liaoning Province	502.4
Jilin Province	218.7
Heilongjiang Province	347.7
Shanghai	161.8
Jiangsu Province	634.2
Zhejiang Province	381.6
Anhui Province	392.8
Fujian Province	234.4
Jiangxi Province	170.4

Shandong Province	1052.2
Henan Province	537.2
Hubei Province	252.7
Hunan Province	250.5
Guangdong Province	506.7
Guangxi Zhuang Autonomous Region	173.2

The main significance of the coefficient that can be derived from the impact of domestic waste sorting by consulting the data is that by calculating the carbon emission control coefficient, it is possible to estimate the specific carbon emission control by the amount of development of the relevant domestic waste sorting carbon emission control, which can be compared to be able to prove the correctness of the method we have calculated to give the relevant coefficient.

The coefficients are used to calculate the carbon emission control, and the reasonableness of the coefficients can be seen in the small error, which proves the correctness of the data found.

The entropy weighting method is used to evaluate the factors affecting the control of carbon emissions from domestic waste separation and obtain their weights, so that the impact can be quantified.

The system state probability is $p_i, i=1,2,\cdots,m$, then the entropy of the system [5-7] is defined as: $e=-\frac{1}{\ln m}\sum_{i=1}^{m} p_i \ln p_i$.

When $p_i=\frac{1}{m}, i=1,2,\cdots,m$

With m objects to be evaluated, n evaluation indicators, and a normalized data matrix of $R=(r_{ij})_{m\times n}$, define the Jth information entropy of the first indicator as

$$e_j=-\frac{1}{\ln m}\sum_{i=1}^{m} p_{ij}\ln p_{ij} \tag{1}$$

$$p_{ij}=\frac{r_{ij}}{\sum_{i=1}^{m} r_{ij}},\ j=1,2,\cdots,n \tag{2}$$

$$\begin{pmatrix} r_{11} & r_{12} & \cdots & r_{1n} \\ r_{21} & r_{22} & \cdots & r_{2n} \\ \vdots & \vdots & \vdots & \vdots \\ r_{m1} & r_{m2} & \cdots & r_{mn} \end{pmatrix} \Rightarrow \begin{pmatrix} p_{11} & p_{12} & \cdots & p_{1n} \\ p_{21} & p_{22} & \cdots & p_{2n} \\ \vdots & \vdots & \vdots & \vdots \\ p_{m1} & p_{m2} & \cdots & r_{mn} \end{pmatrix} \Rightarrow \begin{pmatrix} e_1 & e_2 & \cdots & e_n \end{pmatrix} \tag{3}$$

$$w_j=\frac{1-e_j}{\sum_{j=1}^{n}(1-e_j)},\ j=1,2,\cdots,n \tag{4}$$

Assign weights to the indicators as $u_j, j=1,2,\cdots,n$

$$v_j=\frac{u_j w_j}{\sum_{j=1}^{n} u_j w_j},\ j=1,2,\cdots,n \tag{5}$$

For the analysis of the original data of carbon emission control of domestic waste separation, we can get four main factors that affect the total amount of domestic waste, total population, domestic waste coverage area, and domestic waste treatment cost [4-7]. In order to obtain the specific influence values, the weights of different factors were calculated as shown in Table 3.

Table 3. Indicator weights

Indicators	Weights
Total amount of domestic waste	0.2679
Total population	0.1057
Area covered by domestic waste	0.2015
Cost of domestic waste disposal	0.4249

Through the entropy weighting method for the original data, we can get the weights of total domestic waste, total population, domestic waste coverage area, and domestic waste disposal cost as 0.2679, 0.1057, 0.2015, and 0.4249 respectively, so the domestic waste disposal cost is the most important factor affecting the impact of domestic waste classification, and we need to use this weight for domestic waste disposal Costs are analyzed.

For the analysis of carbon emission control in all provinces, it can also be obtained that it is mainly concentrated in normal distribution.

The distribution is detected by using the normplot command, and it is found that it is basically evenly distributed on both sides of the line, so it basically satisfies the normal distribution without much deviation.

Through quantitative analysis, it can be calculated that it satisfies the normal distribution with the mean value of 0.0914 and the variance of 0.0309, which proves that the established model is valid and basically matches the actual situation, as shown in Figure 1.

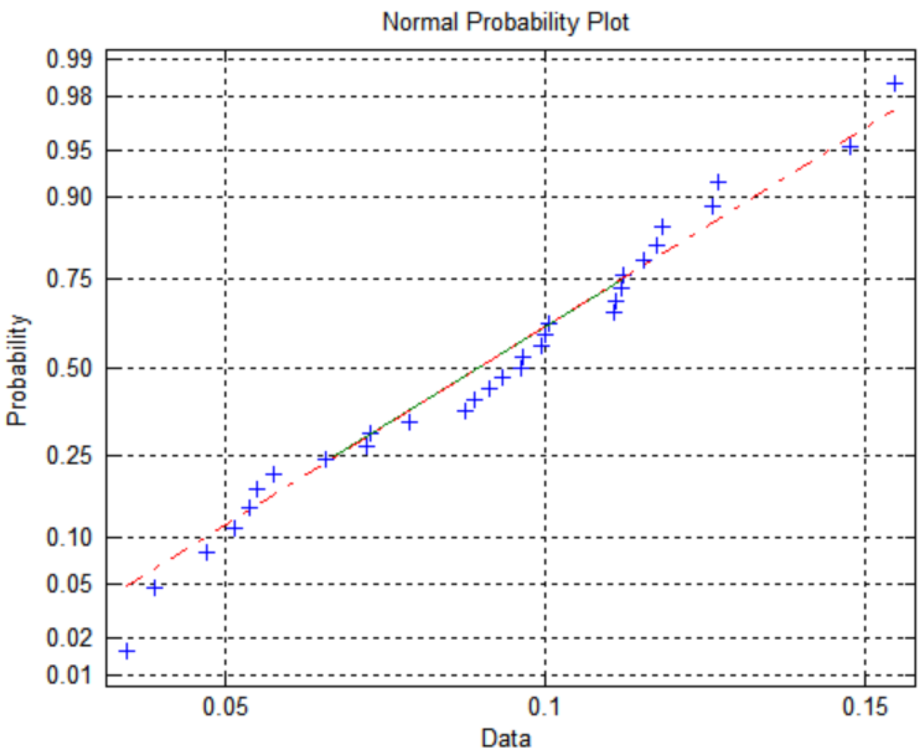

Figure 1. Normal distribution test

3.2. Amount of impact and comparison of the impact caused by carbon emission control

A comprehensive evaluation model is established in this paper, and the relevant indexes are scored using the previous weights, so that the impact amount can be derived and the impact caused by carbon emission control can be compared to complete the classification and get the correlation between MSW classification and carbon peak carbon neutrality.

In order to analyze the carbon emission control, a comprehensive evaluation model is used to complete the calculation of the carbon emission control.

Let Bayesian prediction have m objectives f_j ($j=1,2,\cdots,m$), n feasible solutions $Z_i = (Z_{i1}, Z_{i2}, \cdots, Z_{im})$ ($i=1,2,\cdots,n$), and let the ideal solution be Z^+ ,Among them [8-10] $Z^+ = (Z_1^+, Z_2^+, \cdots, Z_m^+)$.

$$S_i^+ = \sqrt{\sum_{j=1}^{m}(Z_{ij} - Z^+{}_j)^2} \quad i=1,\ldots,n \tag{6}$$

$$S_i^- = \sqrt{\sum_{j=1}^{m}(Z_{ij} - Z_j^-)^2} \quad i=1,\ldots,n \tag{7}$$

$$C_i = \frac{S_i^-}{S_i^- + S_i^+} \quad 0 \le C_i \le 1, i=1,\ldots,n \tag{8}$$

Standardized Decision Matrix

$$Z'_{ij} = \frac{f_{ij}}{\sqrt{\sum_{i=1}^{n} f_{ij}^2}} \quad i=1,2,\cdots,n; j=1,2,\cdots,m \tag{9}$$

Constructing a weighted decision matrix *Z*, Its elements

$$Z^+ = (Z_1^+, Z_2^+, \cdots, Z_m^+) = \{ \max_i Z_{ij} \mid j=1,2,\cdots,m \} \tag{10}$$

$$Z^- = (Z_1^-, Z_2^-, \cdots, Z_m^-) = \{ \min_i Z_{ij} \mid j=1,2,\cdots,m \} \tag{11}$$

The use of weighted decision matrix to complete the complement of carbon emissions control, through the pre-calculation can be concluded that the actual carbon emissions control in China is 381.6000, the predicted carbon emissions control is 380.8368, the impact factors of carbon emissions control is already calculated, focus on the data substitution calculation of its reasonableness as shown in Table 4.

Table 4. Indicator weights

Indicators	Eastern Region Weights	Western Region Weighting	Central Region Weights
Total amount of domestic waste	0.2679	0.2947	0.2891
Total population	0.1057	0.1163	0.1093
Area covered by domestic waste	0.2015	0.2216	0.2109
Cost of domestic waste disposal	0.4249	0.3673	0.3907

It can be seen that there are slight differences across the country, in that the weight of the cost of domestic waste disposal is still the largest, but there are differences in the weight of the east, middle and west regions. The above indicators are used to score and classify several provinces as shown in Table 5.

Table 5. Scoring Results

Province	Domestic waste situation and carbon emissions The correlation between
Shanxi Province	76.1004
Guangxi Zhuang Autonomous Region	48.5488
Inner Mongolia Autonomous Region	50.4739
Hebei Province	54.0679
Jiangsu Province	54.1832
Henan Province	56.7442
Guangdong Province	57.7521
Liaoning Province	57.9041
Anhui Province	62.8997
Zhejiang Province	63.5718
Heilongjiang Province	65.87
Hubei Province	75.5956
Hunan Province	75.9082
Fujian Province	78.3746
Jilin Province	81.1294
Shandong Province	91.9342
Jiangxi Province	92.7876
Shanghai	95.5933
Beijing	97.9832
Tianjin	99.1626

It can classify the areas with more than 70 points as areas with strong correlation between domestic waste and carbon emission, 50 to 70 points as areas with medium correlation between domestic waste and carbon emission, and below 50 points as areas with weak correlation between domestic waste and carbon emission, which are considered to be more consistent with the actual situation according to the classification results.

3.3. Model Evaluation

The model is able to optimize the classification of different types of waste and give more reasonable influencing factors, which can help us to judge the effectiveness of waste classification and get the impact on the environment, etc. The calculation is more accurate and reasonable.

The disadvantage of the model is that the amount of data is not enough, so more data is needed to make the calculation results meet the needs of different cities and different types of areas.

The model can be used in other similar problems by modifying the relevant weights to complete the impact evaluation, giving the impact of different indicators, and the calculation speed is faster.

4. Conclusion

This paper analyzes all the factors influencing the development of carbon emission control of domestic waste separation, so as to be able to obtain the weights of carbon emission control caused by the indicators of carbon emission control of domestic waste separation, and then obtain its impact, and determine its evaluation scheme according to the impact, so as to be able to obtain the development of domestic waste separation according to the relevant data. A comprehensive evaluation model is established, and the relevant indicators are scored using the previous weights, so that the amount of impact can be derived and the impact caused by carbon emission control can be compared, so that the classification can be completed and the correlation between MSW sorting and carbon neutral carbon can be obtained. For its future development path to be analyzed, suggestions are given and the study is completed.

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