Charging Station Demand Assessment Method based on Regional Development Difference Information

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Abstract: Whereas the degree of development in the region is consistent with the trend in demand for charging stations, this paper proposes a grey relational assessment model based on regional development difference information to assess the requirements of charging stations, and derives the proportion of rural suburbs in the suburban rural areas that can be referenced by the decision makers of the charging station network. Due to the different dimensions of the data used in the indicators, we selected various indicators in the less-developed regions as reference values to standardize the index values to incorporate the indicators into a comprehensive evaluation system. The urban suburbs of the United States are selected as an example to optimize the network layout of the charging stations, which has guiding significance for the distribution of the number of charging stations in rural areas in rural China.

Keywords: Distribution of charging stations; Grey Relational Analysis; Numerical standardization

1. Introduction

In order to effectively measure the demand of charging stations, we use the method of grey correlation analysis to quantify the demand for charging stations in the region. At present, there are still insufficient selected evaluation indicators, some indicators may have mutual influence and can only give a general allocation ratio. Taking the regional development differences as the entry point, we selected the relevant indicators for regional development and incorporated them into the grey correlation assessment model to calculate the demand for charging stations. Literature [1]

2. The Model

2.1. Charging station allocation model

2.1.1. Parameter matrix

represents the region's information sequence, i represents the region, $x_i'(1), x_i'(2), x_i'(3), \cdots, x_i'(5)$ represents the population density of the i region (100 million / million square kilometers), the total number of electric vehicles (100 million vehicles), regional quarterly GDP (trillion US dollars), the number of high-tech industries (million), quarterly travel mileage (hundred kilometers).

$$X_i' = \left(x_i'(1), x_i'(2), x_i'(3), \cdots, x_i'(5)\right)^T$$

Represents urban, suburban and rural information sequences , Select the relevant data for the United States in 2017 to form the matrix below. [2]

$$X_1', X_2', X_3' = \begin{bmatrix} 2.5 & 1.4 & 0.7 \\ 1.6 & 1.0 & 0.4 \\ 1.8 & 1.6 & 1 \\ 5 & 2.5 & 1 \\ 45.35 & 60 & 30 \end{bmatrix}$$

2.1.2. Standardized values

Since the collected data is not a standard form, the adoption of five positive indexes for the collection of data in rural areas where the parameters are all low is standardized. $X_i(j)$ represents the value of the j index after normalization in the i area.

Forward standard: :

$$X_i(j) = \left[\frac{x_i'(j) - X'(j)_{min}}{X'(j)_{max} - X'(j)_{min}}\right] * 100\%$$

The standardized values we have obtained are shown in Table 1

Table 1. Standardized Values

	urban	suburban	rural areas
Population density	1	0.3889	0
The total number of electric vehicles	1	0.5000	0

Regional quarterly GDP	1	0.7500	0
The number of high-tech industries	1	0.3750	0
Quarterly travel mileage	0.5117	1	0

2.2. Gray correlation assessment model

Gray relational assessment models are often used to assess the impact of multiple factors on things. literature [3] Selecting rural values as the worst reference sequence: $X_0 = (0, 0, \cdots, 0)$.

Calculate the absolute difference between the j-index and the reference value in the i-region. $\Delta_i(j) = |x_0(j) - x_i(j)|$

Calculate the correlation coefficient $y_i(j)$ for each reference sequence.

$$a = \min_{1<<i<<3} \min_{1<<j<<5} \{V_i(j)\},$$

$$b = \min_{1<<i<<3} \min_{1<<j<<5} \{V_i(j)\},$$

$$y_i(j) = \frac{(a + b\rho)}{(\Delta_i(j) + b\rho)} \quad j = 1, 2, \cdots, 5$$

Calculate the correlation degree to reflect the relationship between each evaluation object and the reference sequence. [4]Mark as:

$$r_j = \frac{1}{n}\sum_{i=1}^{n} y_i(j)$$

The weight of each metric: $r_j^{'} = \frac{r_j}{r_1 + r_2 + ? + r_5} \quad j = 1, 2, \cdots, 5$

Demand score: $Z_i = r_1^{'} x_i(1) + r_2^{'} x_i(2) + \cdots + r_5^{'} x_i(5) \quad i = 1, 2, 3$

3. Design of temperature field measurement scheme

Calculated by MATLAB, we obtained the demand score for the number of charging stations in rural suburbs of the city. As shown in Table 3-1, the decision-makers who assist the charging station distribution have to allocate the charging stations rationally.

Table 2. Regional Evaluation Score (Gray Correlation Assessment Model)

Region	**urban**	**suburban**	**rural areas**
Grade	1.5683	1.2896	0

For problem D of question 1, how to allocate charging stations in rural suburban areas. We have shown that the ratio of the number of charging stations in rural suburbs is shown in Figure 1

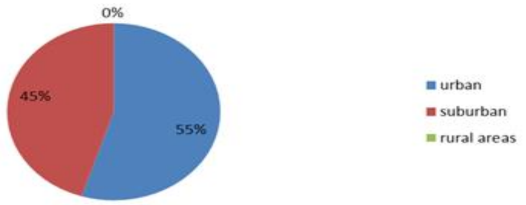

Figure1. The Distribution of the Number of Charging Stations

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