# Research on Customer Evaluation and Its Impact on Illegal Wildlife Trade Based on Entropy Weight Method and TOPSIS

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**Abstract.** Wildlife protection is a critical issue in today's world, yet determining the most effective human interventions remains challenging. To enhance wildlife conservation planning, this paper establishes a mathematical model based on the TOPSIS method with an entropy weight approach. By analyzing data from 15 organizations, we found that WWF achieved a standardized score of 0.3741, indicating the most significant contribution to wildlife protection. Additionally, the Spearman correlation coefficient was used to assess the interactions among various factors and conduct a correlation analysis of different indicators. Finally, the correlation coefficient between protected areas and protected species was compared with WWF's findings. It was observed that some discrepancies existed between the conclusions derived from the Spearman correlation analysis and actual outcomes. This analysis highlights the complexities of wildlife protection and the importance of precise data-driven approaches.

**Keywords:** TOPSIS, Entropy Weight Method, Spearman Correlation Coefficient.

## 1. Introduction

With the continuous impact of human activities on the natural environment, the survival of many wildlife species is facing serious challenges. All things have their harmony to live and their nourishment to become [1]. To protect these rare species and curb the occurrence of bad behavior, countries signed the CITES Convention in Washington in 1973, and conservation organizations and government agencies around the world have invested a lot of resources and carried out many conservation projects. However, the effectiveness of different projects varies significantly. How to scientifically select and evaluate project customers to ensure the optimal allocation of resources has become an urgent problem to be solved.

For this study, to scientifically select and evaluate project customers, this paper proposed a TOPSIS evaluation method based on the entropy weight method (EWM) based on the structural design of filling mining hydraulic support [2] and refer to DEA-EWM-TOPSIS algorithm [3] to carry out grade evaluation of 7 indicators. The TOPSIS evaluation method founded on the entropy weight method (EWM) has been extensively employed to address the inherent uncertainty and fuzziness of dam risk indicators [4]as well as for the selection evaluation of anti-roll fins for polar cruise ships [5]. The correlation coefficient is a measure of the correlation between two groups of data [6]. Referring to the application of the Spearman correlation coefficient method in water quality analysis of the mainstream of the Yangtze River [7], we also adopted the Spearman correlation coefficient to characterize the degree of linear correlation between indicators and wild animal species. This method has also been applied to many fields such as unit neural networks [8].

Specifically, this paper collected the data of 15 companies and analyzed them to rank the contribution degree of each company. Spearman correlation analysis was conducted meticulously. The results demonstrated that there is a distinct linear correlation between the carefully selected indicators and the total number of wild animals. This linear correlation implies that as the selected indicator varies, the wildlife population changes predictably accordingly.

## 2. The TOPSIS approach based on the entropy weight method (EWM) and Spearman correlation coefficient

### 2.1. The TOPSIS based on the entropy weight method (EWM)

The TOPSIS approach is a multi-attribute decision-making technique, TOPSIS is a method to sort a limited number of evaluation objects according to their proximity to an idealized target and to evaluate the relative advantages and disadvantages of existing objects. The entropy weight method is a common objective weighting method, the Entropy is a measure of system uncertainty. It can be used to determine the entropy by measuring and assessing the amount of information included in the data of an index system. The importance of the index can be better reflected by the entropy weight method. It is widely used to evaluate alternatives and find an ideal solution. The specific calculation steps are as follows:

$$P_{ij} = \frac{X_{ij}}{\sum_{j=1}^{m} X_{ij}} \tag{1}$$

For index i, calculate the probability $P_{ij}$ for each sample j, where $X_{ij}$ represents the value of sample j for index i.

the entropy value $E_j$ for each index i is calculated by:

$$E_j = \frac{\sum_{j=1}^{m} P_{ij} \times \ln P_{ij}}{m} \tag{2}$$

Weight w of i-th indicators is:

$$w_i = \frac{1 - E_i}{\sum_{i=1}^{n} 1 - E_i} \tag{3}$$

Finally, the value of each indicator is multiplied by its weight to obtain the value corresponding to each sample:

$$X_i = \sum_{i=1}^{n} w_i \times X_{ij} \tag{4}$$

### 2.2. Spearman correlation analysis

Spearman correlation analysis uses monotone equations to evaluate the correlation between two statistical variables, and ultimately the Spearman correlation coefficient is used as a reference for the correlation between variables. Spearman correlation coefficient [9]. The Spearman analysis is as follows:

$$\mathrm{r} = \frac{\sum_{i=1}^{n} \left(X_i - \overline{X}\right)\left(Y_i - \overline{Y}\right)}{\sqrt{\sum_{i=1}^{n} \left(X_i - \overline{X}\right)^2 \sum_{i=1}^{n} \left(Y_i - \overline{Y}\right)^2}} \tag{5}$$

In this formula, $r$ represents the Spearman correlation coefficient, $X_i$ and $Y_i$ represent the i value of the two variables, and `X, $\overline{\ }$Y represents the mean of the two variables.

It is known that the correlation coefficient ranges in [-1,1], and it has the following relationship:

$$\begin{cases} 0 \le |r| < 0.3 & \text{(no linear correlation)} \\ 0.3 \le |r| < 0.5 & \text{(low linear correlation)} \\ 0.5 \le |r| < 0.8 & \text{(significant linear correlation)} \\ 0.8 \le |r| \le 1 & \text{(high linear correlation)} \end{cases} \quad (6)$$

Where correlation is negative when r<0 and positive when r>0.

# 3. Results

## 3.1. The establishment of the simulation model

The evaluation class model for the Humane Society's contribution ranking and the correlation coefficient of each factor are implemented in Matlab.

## 3.2. Analysis of experimental results

Fifteen animal protection organizations have been carefully selected for this study. In order to conduct a comprehensive analysis, we have queried their official websites to obtain the corresponding seven animal protection index data. These indices serve as crucial metrics for evaluating the performance and impact of the organizations. By meticulously examining and comparing these data points, we have ranked the contributing enterprises associated with each organization. This ranking system provides a clear and objective assessment of each enterprise's contribution to animal protection efforts, as detailed in Table 1.

**Table 1.** Ranking of impact of animal protection organizations

| Sample | Final score | Ranking |
|---|---|---|
| WWF | 0.3741 | 1 |
| WCS | 0.3628 | 2 |
| WPA | 0.2274 | 3 |
| Global Anti-Poaching Organization | 0.2039 | 4 |
| GEPO | 0.1977 | 5 |
| SAVE | 0.1879 | 6 |
| Wildlife Foundation | 0.1808 | 7 |
| WCPC | 0.1774 | 8 |
| GWF | 0.1732 | 9 |
| WPC | 0.1720 | 10 |
| EPCA | 0.1651 | 11 |
| Reduce Demand | 0.1589 | 12 |
| WildAid | 0.1540 | 13 |
| Global Anti-Poaching Alliance | 0.1436 | 14 |
| FCF | 0.1212 | 15 |

As can be seen from above Table 1, WWF has the greatest influence in the field of wildlife conservation. In addition, the following figure shows the Spearman correlation coefficients of 7 indicators. WWF has been at the forefront of numerous initiatives and campaigns dedicated to protecting endangered species, preserving habitats, and promoting sustainable practices. Through its extensive research, conservation projects, and educational programs, WWF has made significant contributions to the preservation of the world's wildlife and has inspired countless individuals and organizations to take action in support of wildlife conservation.

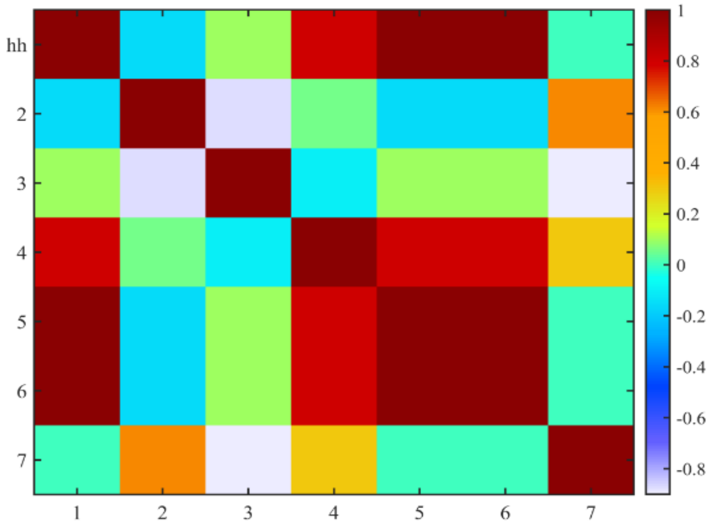


**Figure 1.** Thermal map of the Spearman correlation coefficient

Through the calculation of the Spearman correlation coefficient, we found that the project's financial expenditure and the proportion of attention to illegal wildlife trade had the highest correlation degree for these two variables. In addition, Figure 1 shows that there is no correlation between the area of protected areas and this protected species, however, by comparing the drivers of the spatial distribution of nature reserves in China that we referenced [10] and searching the official WWF website, Figure 2 shows the relationship between habitat and species diversity.

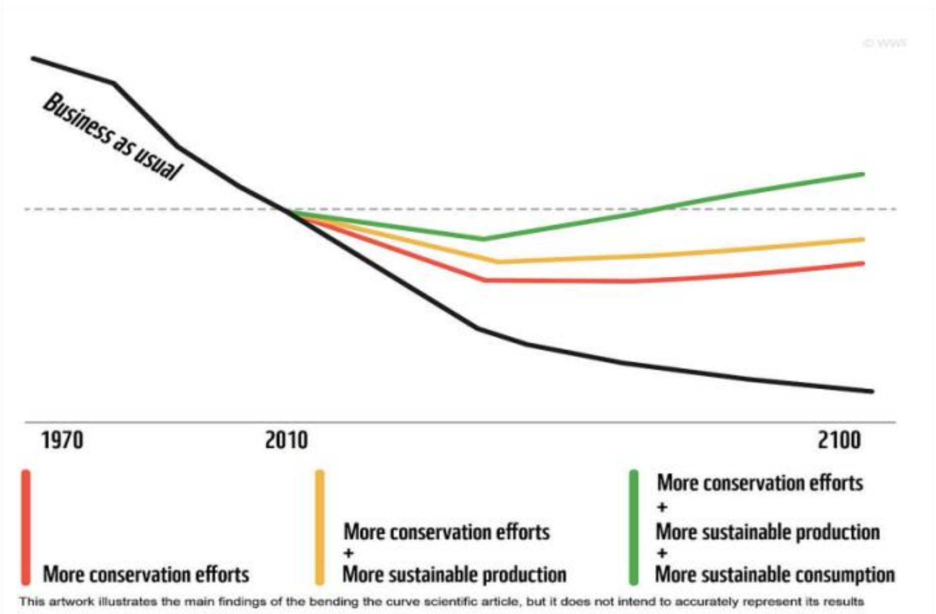


**Figure 2.** Habitat tip model (from WWF)

By carefully comparing Figure 1 and Figure 2, it can be observed that there is a significant difference in conclusion. This difference is primarily attributed to the relatively small variation in the habitat area data collected in Figure 1. The limited range and small fluctuations of this data result in a situation where the reliability and representativeness of the data may be somewhat compromised. Consequently, this leads to the low reference value of the Spearman correlation coefficient obtained. When analyzing the data in Figure 1, it becomes evident that even minor changes in the habitat area can have a substantial impact on the overall results. This highlights the sensitivity of the analysis to the accuracy and precision of the data collected. Moreover, the small variation in the habitat area data may also indicate limitations in the sampling method or the scope of the study. In contrast, Figure 2 may have benefited from a more diverse set of data or a different approach to data collection, which has resulted in a more conclusive and reliable analysis.

## 4. Conclusions

In this paper, the TOPSIS method based on the Entropy Weight Method (EWM) was used to rank the contributions of various wildlife conservation organizations. Additionally, the influence of different indicators on wildlife conservation outcomes was examined using Spearman correlation analysis. The results reveal that, among 15 major wildlife conservation organizations worldwide, WWF makes the most significant contribution, underscoring its critical role in global wildlife conservation. Spearman correlation analysis further indicates that funding is the most crucial factor in wildlife conservation, as adequate financial resources are essential for implementing effective conservation initiatives. Conversely, the analysis shows that habitat area has the least impact on wildlife population sizes, challenging conventional beliefs regarding the importance of habitat area in conservation efforts. This discrepancy suggests that Spearman's correlation coefficient may not fully capture the influence of certain indicators on wildlife populations, particularly when compared to WWF’s findings on the relationship between habitat area and wildlife population dynamics.

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