

# Strategic Evaluation and Selection of Partners in Combating Illegal Wildlife Trade Initiative: An AHP-TOPSIS Approach

Yuting Liu<sup>\*</sup>, Yuxuan Jiang

College of Textile and Clothing Engineering of Soochow University, Suzhou, China, 215006

<sup>\*</sup> Corresponding Author Email: rainresettt@163.com

**Abstract.** This paper propose a Wild for life project, looking for the client with the same goal to achieve zero wildlife crime. First, this paper collects a large amount of data related to the illegal wildlife trade, and the situation of relevant international organizations, and preprocesses these data. Then selected potential clients through power, resources, and interest required for the project. This paper used the “Global Influence Index of International Organizations” to assign different weights, and used the AHP-TOPSIS model to determine our client ICCWC, and pointed out the help that customers can provide us in legal, economic, and technical aspects. Then came a visualization of the current state of the illegal wildlife trade, and finally developed a data-driven five-year plan to implement the fight against the illegal wildlife trade. Through the research of this paper, it is expected to provide some reference for the field of combating illegal wildlife crime.

**Keywords:** Illegal wildlife trade, AHP-TOPSIS, Biodiversity Protection.

## 1. Introduction

With the acceleration of globalization, the illegal wildlife trade has become a serious international problem, causing great damage to biodiversity and ecosystems[1]. Moreover, this trade not only threatens the survival of wildlife, but also affects social, economic and political stability[2]. In order to effectively respond to this challenge, this study proposes a combination of the hierarchical analysis process (AHP) and the ideal solution sorting method (TOPSIS), aiming to evaluate and select the most suitable international organizations to jointly combat the illegal wildlife trade. Through an in-depth analysis of relevant data and the global influence of the organization, this paper provides scientific decision support for the development of a comprehensive strategy, hoping to effectively reduce the illegal wildlife trade and protect the global biodiversity through cross-border cooperation.

This paper addresses the following issues:

- (1) Develop a data-driven 5-year project designed to make a notable reduction in illegal wildlife trade.
- (2) Select the appropriate criteria, build a target customer evaluation model based on AHP-TOPSIS (Analytic Hierarchy Process-Technique for Order Preference by Similarity to Ideal Solution), and identify the customers who can complete the project.
- (3) Introduce the suitability of the project for the client, and persuade the customers to undertake the project.
- (4) According to the conditions required for the project implementation, combined with the client’s capabilities, propose the additional power and resources needed.

## 2. Materials and Research Methods

### 2.1. Data acquisition and preprocessing

In order to select the appropriate customers to execute our plan, we screened the target customer groups based on the following principles:

- **Customer nature:** Non-profit international conservation organizations that are committed to protecting wildlife and combating illegal wildlife trade, and have relevant experience.
- **Influence:** Have a certain influence in policy making, implementation and community participation, and be able to appeal to as many people as possible to join the ranks of animal protection.

- **Execution:** Have the relevant rights and abilities to protect wildlife and stop illegal transactions.
- **Financial resources:** Have sufficient financial support, which may come from donations, grants, governments, etc.
- **Cooperation agencies:** Give priority to organizations that have relevant cooperation agencies and have a strong cross-sectoral cooperation network.
- **Interest and commitment:** Have a clear commitment to wildlife protection and ensure long-term investment in the project.
- **Innovation ability:** Give priority to organizations that may be open to adopting innovative algorithms, technologies and solutions.

Finally, we selected the following organizations, as shown in Table 1:

**Table. 1** Potential client groups

UNEP	WWF	IFAW	ICPO	UNODC	OECD	WCS	ICWC	TRAFFIC
IUCN	BirdLife	CI	FFI	TNC	Panthera	STE	World Wildlife Fund	

The data studied in this paper involve the annual budget investment of international organizations (for wildlife protection), the scope involved, the number of wildlife successfully rescued, the trading volume of illegal wildlife trade, and the species and number of endangered wildlife. The sources are shown in Table 2.

**Table.2.** Source of the study data presented in this paper.

Type	Source
On the situation of international organizations	<a href="https://www.unep.org/">https://www.unep.org/</a> <a href="https://www.worldwildlife.org/">https://www.worldwildlife.org/</a> <a href="https://www.ifaw.org/">https://www.ifaw.org/</a> <a href="https://www.interpol.int/">https://www.interpol.int/</a> <a href="https://www.unodc.org/">https://www.unodc.org/</a> <a href="https://www.oecd.org/">https://www.oecd.org/</a> <a href="https://www.wcs.org/">https://www.wcs.org/</a> <a href="https://icwc-wildlifecrime.org/">https://icwc-wildlifecrime.org/</a> <a href="https://www.traffic.org/">https://www.traffic.org/</a> <a href="https://www.iucn.org/">https://www.iucn.org/</a> <a href="https://www.birdlife.org/">https://www.birdlife.org/</a> <a href="https://www.conservation.org/">https://www.conservation.org/</a> <a href="https://www.fauna-flora.org/">https://www.fauna-flora.org/</a> <a href="https://www.nature.org/en-us/">https://www.nature.org/en-us/</a> <a href="https://panthera.org/">https://panthera.org/</a> <a href="https://www.savetheelephants.org/">https://www.savetheelephants.org/</a>
The trading volume of the illegal wildlife trade	<a href="https://ourworldindata.org/grapher/wildlife-exports">https://ourworldindata.org/grapher/wildlife-exports</a> <a href="https://tradeview.cites.org/">https://tradeview.cites.org/</a> <a href="https://www.wildlifetradeportal.org/">https://www.wildlifetradeportal.org/</a>
Species and numbers of endangered wild animals	<a href="https://www.iucnredlist.org/en">https://www.iucnredlist.org/en</a>

Upon analysis, it was discovered that the dataset contained some missing and outlier values, necessitating certain preprocessing and cleansing procedures. The data, after undergoing these treatments, is presented in Table 3.

**Table.3.** Specific data of these clients in 2020

Client	Investment	Successful case		Species involved	Distribution range (number)
		single	Organ (t)		
UNEP	500	0*	0*	5800	190
WWF	12000	1000	0	1000	100
IFAW	18000	2000	0	500	40
ICPO	300	0*	100	300	194
UNODC	15000	0*	0*	7000	21
OECD	500	0*	0*	10000	37
WCS	21000	3000	0	600	60
ICCWC	1000	4360	1.3	5800	194
TRAFFIC	200	0*	0*	10000	30
IUCN	400	0*	0*	12000	86
BirdLife International	300	1000	0	10000	120
CI	15000	500	0	1000	29
FFI	16000	1000	0	500	40
TNC	25000	0*	0*	2000	72
Panthera	3000	200	0	100	50
STE	1000	100	10	200	19
World Wildlife Fund	500	300	0	10	30

In these cases, some organizations supported the governments, non-governmental organizations and international institutions of various countries and regions to jointly formulate and implement policies and plans to protect wild animals instead of having specific plans or measures to directly protect animals, we hope that the target customer group can directly participate and act, so this part of the organization is marked as 0\*.

In addition to direct animal rescue, it also involves cases such as ivory smuggling, and we quantified this part of the data (based on the average weight of each ivory tooth).

$$Animal_{save} = Animal_{amount} + 10Animal_{organ} \tag{1}$$

In addition to the above indicators, we also need to evaluate the rights, data, interests and global influence of these organizations. We referred to some experts' opinions and learned about their functions and executive rights, cooperation agencies, and global influence (coverage) from their official websites, and scored them according to the degree of alignment (interest) with our project, with a score range of 1-10. The scoring of "Global influence" refers to the "Global International Organization Influence Index"[3], which employs big data research methodologies. The final scoring results are shown in Table 4.

**Table.4.** The scores of clients

Client	Power	Asset	Interest	Global influence
UNEP	10	9	6	9
WWF	8	8	6	8
IFAW	7	6	6	8
ICPO	9	9	7	9
UNODC	10	8	7	6
OECD	7	7	5	6
WCS	8	7	8	7
ICWC	10	9	10	9
TRAFFIC	6	6	7	4
IUCN	5	6	7	5
BirdLife International	5	6	5	5
Conservation International	6	7	7	6
FFI	6	7	8	6
TNC	7	7	8	5
Panthera	5	6	5	4
Save the Elephants	5	6	5	4
World Wildlife Fund	6	7	10	6

**2.2. Method introduction**

According to INTERPOL [4], the illegal trade of wildlife products on the black market reaches a staggering value of \$20 billion annually. Without intervention, this figure is likely to continue rising in the future. To combat illegal wildlife trade and protect biodiversity, this paper proposes the development of a comprehensive plan and the selection of suitable international organizations capable of executing the plan.

Firstly, through extensive research on relevant data and assessments of the influence of international organizations, an analysis of the current situation will be conducted to achieve preliminary objectives. Subsequently, based on identified potential target clients, the AHP-TOPSIS (Analytic Hierarchy Process-Technique for Order Preference by Similarity to Ideal Solution) evaluation model will be employed to determine our target clients. This will facilitate the identification of the most suitable clients and prepare for the formulation of more suitable plans.

The TOPSIS method (Technique for Order Preference by Similarity to Ideal Solution) represents a multi-criteria decision analysis approach grounded on the concept of distance from an ideal solution [5]. It evaluates the relative merits of various alternatives by calculating their distances to both the ideal (optimal) solution and the negative-ideal (least desirable) solution, thereby facilitating the selection of the best alternative. Conversely, the AHP method (Analytic Hierarchy Process) establishes a hierarchical model of the problem at hand, leveraging pairwise comparisons to ascertain the relative importance of each element, culminating in a decision basis through consistency checks and weight computation [6].

Given the varying correlations among indicators, the AHP method is initially employed to assign weights to evaluation indicators, followed by the application of the TOPSIS method for normalization of the indicator values, subsequently ranking the outcomes. The integration and refinement of both AHP and TOPSIS methods enable effective complementarity, incorporating objective expert assessments and extensive relevant data, thus meeting the data volume and coverage breadth required for the sample study. This culminates in the development of an improved AHP-TOPSIS composite evaluation method.

Upon selecting the customer base, distill mutual objectives with the clients. Visualize the current state of illegal trade, and finally, develop a data-driven, detailed five-year plan to combat illegal wildlife trade.

### 3. Choose Client Based On the AHP-TOPSIS Evaluation Model

#### 3.1. The Establishment of Model

The AHP-TOPSIS model is selected to determine the customers, and the establishment process of this model is shown in Figure 1.

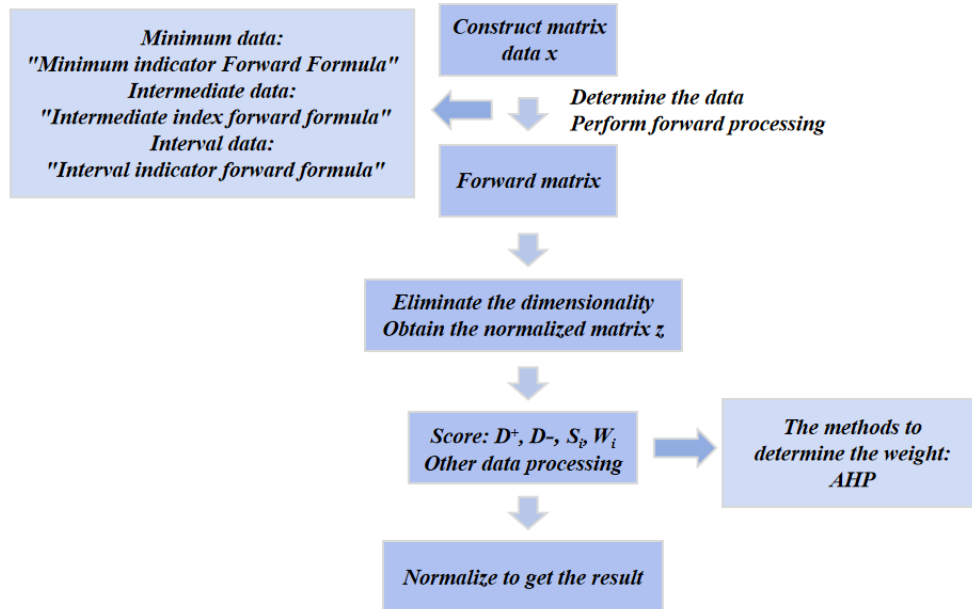


Figure 1. AHP-TOPSIS Model flow chart

#### 3.1.1 Use AHP to determine the indicator weights.

(1) The Delphi method and the 1-9 scale method[6] are used to construct the pairwise judgment matrices between the factors of each layer. The specific matrix A is as follows:

$$A = \begin{bmatrix} a_{11} & a_{12} & \cdots & a_{1n} \\ a_{21} & a_{22} & \cdots & a_{2n} \\ \vdots & \vdots & \vdots & \vdots \\ a_{n1} & a_{n2} & \cdots & a_{nn} \end{bmatrix} \quad (2)$$

The weight vector is denoted as  $W = [W_1, W_2, \dots, W_i, \dots, W_n]$ , where the weight vector  $w_i$  is generally calculated by the square root method, that is

$$W_i = \frac{\sqrt[n]{\prod_{j=1}^n a_{ij}}}{\sum_{i=1}^n \sqrt[n]{\prod_{j=1}^n a_{ij}}} \quad (3)$$

From the above formula, the weight set of each indicator in the evaluation system can be obtained as follows:

$$W_i = [w_1, w_2, \dots, w_3, \dots, w_n]^T \quad j = 1, 2, \dots, n, \sum_{i=1}^n w_i = m \quad (4)$$

(2)Consistency test

$$CR = \frac{CI}{RI} = \frac{\lambda_{max} - n}{(n - 1)RI} \quad (5)$$

Notes: n is the order of the pairwise comparison factors

After calculation, the consistency indicator (CI) is 0.0106, the consistency ratio (CR) is 0.0075,  $CR < 0.1$ , indicating that the judgment matrix has a good consistency level, so the evaluation result is reliable.

From this, the comprehensive weight can be obtained:  $W = (0.070, 0.054, 0.043, 0.091, 0.261, 0.204, 0.157, 0.120)T$ , which is used as the weight coefficient of the TOPSIS evaluation.

### 3.1.2 Use TOPSIS to evaluate and select the best option.

Normalize the judgment matrix  $X = (x_{ij})_{p \times m}$  determined by the  $m$  evaluation indicators of the  $p$  international organizations to obtain the normalized judgment matrix  $Y = (y_{ij})_{p \times m}$ ;

Construct the weighted normalized decision matrix  $Z = (z_{ij})_{p \times m}$ , where:  $z_{ij} = W_j \cdot y_{ij}$  ( $j = 1, 2, \dots, m$ ), where  $W_j$  is determined by the comprehensive weight coefficient obtained by AHP;

Determine the positive ideal solution  $S^+$  and the negative ideal solution  $S^-$  of the evaluation object, where:

$$S^+ = \left\{ \left( (max_{z_{ij} | j \in J_1}), (min_{z_{ij} | j \in J_2}) \right) \right\} \quad (6)$$

$$S^- = \left\{ \left( (min_{z_{ij} | j \in J_1}), (max_{z_{ij} | j \in J_2}) \right) \right\} \quad (7)$$

( $i = 1, 2, \dots, p$   $j = 1, 2, \dots, m$ )

$J_1, J_2$  are both benefit-type indicators.

The distances of the evaluation objects to the positive and negative ideal solutions are respectively:

$$D_i^+ = \sqrt{\sum_{j=1}^m (z_{ij} - s^+)^2} \quad (i = 1, 2, \dots, p) \quad (8)$$

$$D_i^- = \sqrt{\sum_{j=1}^m (z_{ij} - s^-)^2} \quad (i = 1, 2, \dots, p) \quad (9)$$

The calculation of relative closeness and the selection of international organizations. The relative closeness of each scheme to the positive and negative ideal solutions is:

$$\eta_i = D_i^+ / (D_i^+ + D_i^-) \quad (10)$$

According to the size of the value of  $\eta_i$ , the  $\eta_i$  closer to 1, the better the scheme, and the more suitable the corresponding supplier (where  $0 \leq \eta_i \leq 1$ ).

### 3.1.3 AHP-TOPSIS evaluation model

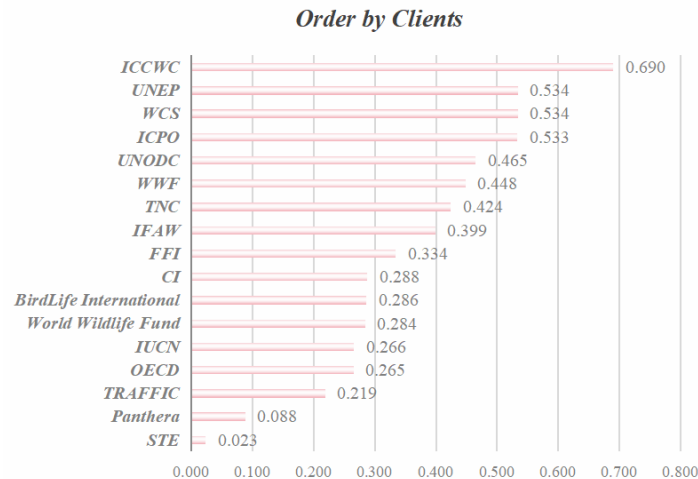
The evaluation matrix is constructed by the closeness analysis of the TOPSIS method, combined with the weight calculated by the AHP method, and the comprehensive evaluation result vector  $Q$  of the evaluation object is

$$Q = W \times C \quad (11)$$

$C$  is the evaluation matrix formed by the closeness of each evaluation object to the positive ideal solution,  $W$  is the criterion layer weight obtained by the AHP method.

## 3.2. The Result of Model

Through model building and calculation, the final results are shown in Figure 2.



**Figure 2.** Comprehensive evaluation result

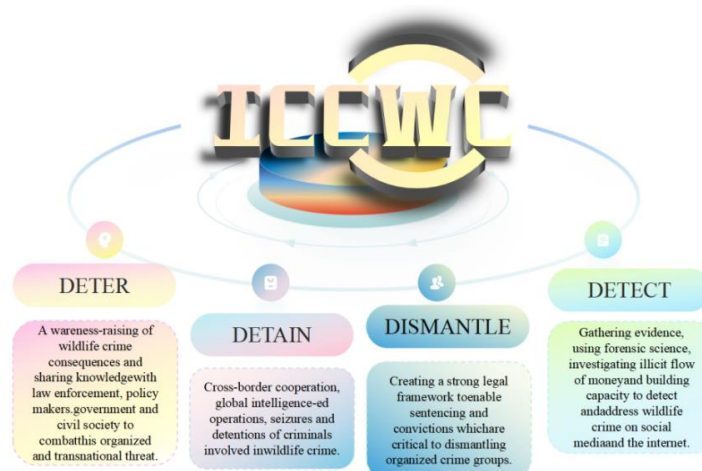
From the ranking results, ICCWC is the best target customer, followed by UNEP, WCS, ICPO, and other international organizations can be excluded from consideration.

### 3.2.1 Client’s profile

From the content of the official website, the study summarized the introduction of ICCWC as follows:

- Taking countermeasures against wildlife crime: publishing the results of the World Wildlife Crime Report, providing information and support for decision-making and law enforcement.
- Combating illegal wildlife trade: supporting and strengthening the global capacity to respond to wildlife crime through strategic plans.
- Focusing on sustainable economic development: linking wildlife and plant crime with environmental and socio-economic goals.
- Committing to strengthening coordinated law enforcement actions: ICCWC is a partnership of five intergovernmental organizations, strengthening the criminal justice system, and providing coordinated and consistent support to combat wildlife and forest crime.
- Promoting natural resource management and development: the organization points out that the criminals involved in illegal trafficking hinder the protection of wildlife and plants, the maintenance of ecosystems, the reduction of poverty, and the response to climate change.
- Expanding the use of knowledge, innovative technology: using more innovative tools and technologies to deepen the understanding of illegal trafficking of wildlife.

The specific strategic plan for the ICCWC is shown in Figure 3.

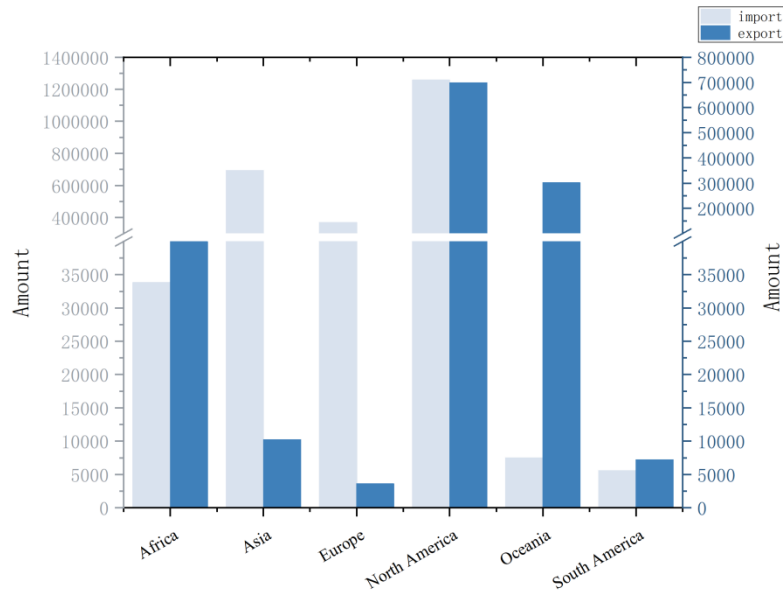


**Figure 3.** Introduction of ICCWC

## 4. Wild for Life Project

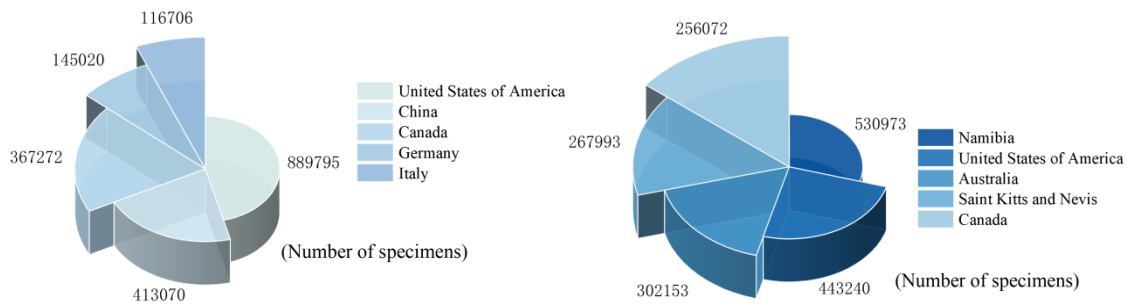
### 4.1. Status of the illegal wildlife trade

According to the relevant data obtained from the statistical website, the import and export of wildlife trade in six continents (except Antarctica) are compared, and the results are shown in Figure 4.



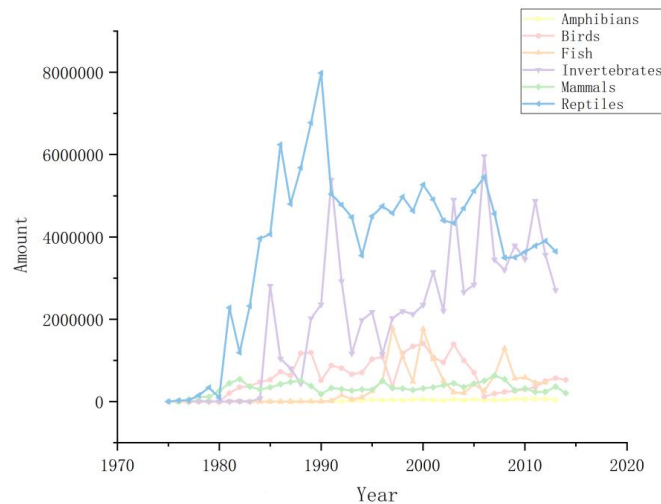
**Figure 4.** The number of wildlife imported and exported from each continent.

As can be seen from the Figure 4, North America is the region with the most imports and exports, while South America is the opposite. The top five countries for the import and export quantity of wildlife are shown in Figure 5.



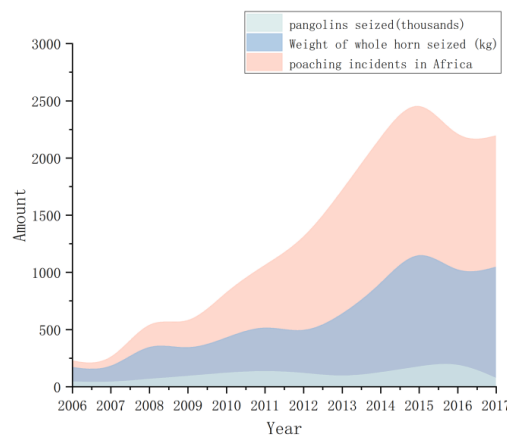
**Figure 5.** Top five countries in wildlife import / export (imports on left, exports on right)

The global illegal wildlife trade reaches 100 billion a year, and countless wildlife are sold every year. The wildlife trade is quantified based on the whole organism equivalent (WOE). For example, five skulls represent five WOE, while assuming that four ears are from two animals and therefore represent two WOE. The global trade volume of endangered wildlife in the past 40 years is shown in Figure 6.



**Figure 6.** Global wildlife exports

Due to global market demand, wildlife is rapidly declining due to being bought, sold, smuggled, slaughtered, or hunted, facing the greatest crisis of survival, with some species being elevated to critically endangered status. Currently, wild elephants, pangolins, and rhinos are among the species most severely affected by illegal trade, urgently requiring action [7]. The quantities of smuggled pangolins, the weight of illegally obtained rhino horns, and the poaching volume in Africa (ivory) are illustrated in Figure 7.



**Figure 7.** Global wildlife exports

## 4.2. Content of our project

### Wild for life

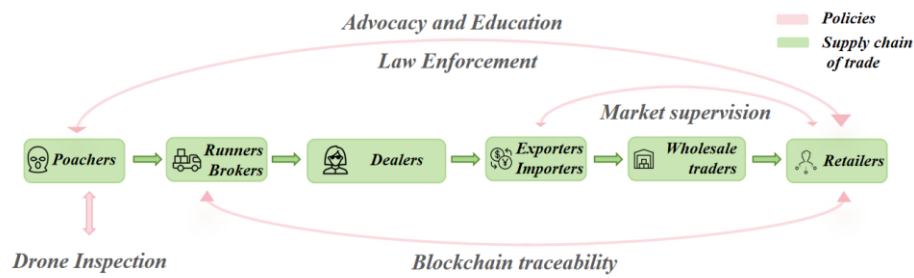
-- An integrated and coordinated 0 wildlife crime project

#### (1) Project Background

Illegal wildlife trade is a serious transnational crime, estimated to be worth up to \$20 billion a year on the black market. More than 2,000 species of animals and plants are threatened by wildlife trade, many of which face the risk of extinction.

Currently, illegal wildlife trade forms a supply chain and value chain of activities from illegal poaching, transportation, smuggling to the final market transactions, involving multiple countries and regions [8]. It is urgent to stop the problem of illegal wildlife trade.

(2) **Project Objectives:** To prevent crime from the links of the illegal trade supply chain and value chain, significantly reduce illegal wildlife trade within five years, lower the cost of wildlife protection, promote global fairness, achieve ecological sustainability, and ultimately strive to establish a world without wildlife crime by 2030. The implementation process of the project is shown in Figure Figure 8.



**Figure 8.** Specific implementation process and purpose of the project

(3) **Key area:** Illegal wildlife trade

(4) **Project data:** Data on the volume and types of illegal wildlife trade, law enforcement actions, and smuggling profits

(5) **Project advantages:** We use a linear regression model to predict the impact of different strategies and resource allocation on reducing the volume of illegal wildlife trade. We use a linear programming model to achieve optimal resource allocation. We forecast that, our project can significantly reduce the number of illegal wildlife trade by using a time series model according to the plan.

(6) **Strategy recommendations:**

- **Publicity strategy:** Use the official websites of international organizations such as ICCWC to promote wildlife protection.

- **Law enforcement strategy:** Establish a global wildlife law enforcement network.

- **Technology strategy:** Use the drone patrol system in wildlife protection areas to monitor illegal wildlife trade[9], and combine blockchain traceability technology to track the dynamics of illegal wildlife trade[10]. In addition, combine big data and artificial intelligence to achieve automation of the drone system.

- **Sustainability strategy:** Monitor market behavior and identify problems; adopt incentive policies for legal trade to intervene.

(7) **Implementation plan:** As shown in the Figure 9:

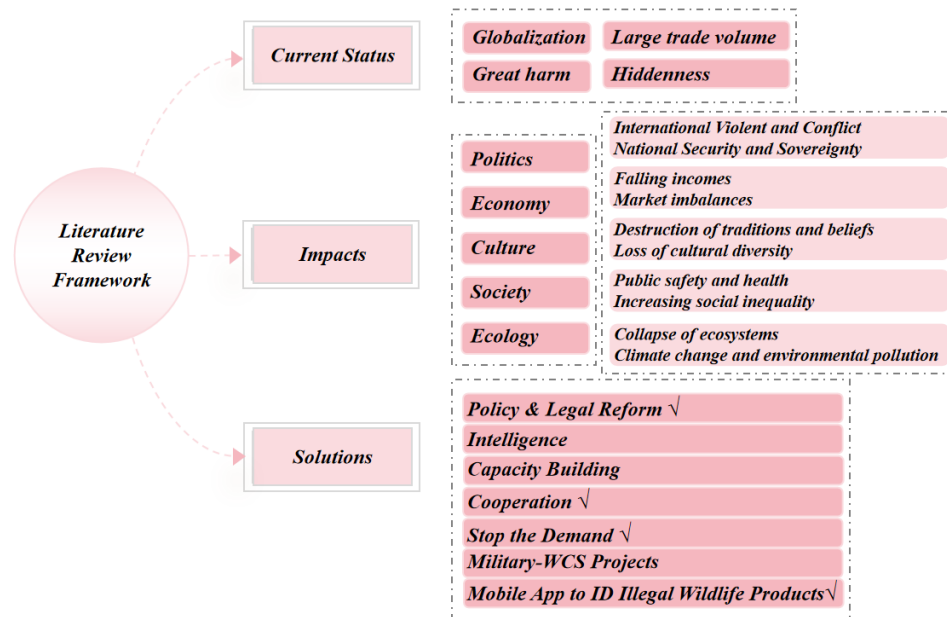


**Figure 9.** Project plan

(8) **Expected results:** A significant reduction in illegal wildlife trade within five years; To form a sound strategy system to combat illegal wildlife trade; Zero wildlife crime by 2030.

### 4.3. Project Support

Through reading the literature, we conclude that the current situation of illegal wildlife trade is severe, the impact of illegal wildlife trade is huge and widespread, and the prevention and control measures of illegal wildlife trade have a great overlap with our project. The framework can be seen from the following figure 10:



**Figure 10.** Literature review framework (✓ indicates that it is consistent with our project)

## 5. Conclusions

The study successfully applied the AHP-TOPSIS model to evaluate and select the most suitable international organizations to collaborate with in combating illegal wildlife trade. The comprehensive analysis identified ICCWC as the optimal partner, due to its high scores in power, assets, interest, and global influence, which are crucial for the project's success. The findings underscore the significance of a strategic approach in partner selection, emphasizing the model's effectiveness in incorporating various criteria for a holistic evaluation. This research contributes valuable insights into decision-making processes in environmental conservation projects, offering a replicable methodology for similar initiatives aiming to tackle the illegal wildlife trade. It highlights the importance of collaborative efforts, informed by rigorous analytical methods, in addressing complex global challenges such as wildlife crime.

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