# Research on metrics of refugee crises

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**Abstract.** We set up key implicating metrics to evaluate the specific factors which can enable the safe of refugees. The metrics are adapting Gray fuzzy evaluation on the basic of Analytic Hierarchy Process (AHP), involving the physical conditions of the refugees, the number of refugees, the distance of migration, the means of transportation, the level of natural environment, the capacity of reception country, the number of the entry points and social assistance. Among these factors, the number of refugees a country accepts and transportation are the most important, whose results are based on the model.

## 1. Introduction

We are discussing the problem basing on the problem F in 2016 MCM. In recent years, there is always war or turbulence in the Middle East and South Africa, resulting in a growing number of refugees. And the number is still going on as The Middle East Extremist Islamic Organizations taking rampant activities. To seek for a live, these refugees are forced to immigrate to European countries. The large crowd of refugees has exceeded the acceptance of the European countries, causing far-reaching negative influence on the European countries [1].

History has shown us that massing fleeing of populations occurs as a result of major political and social unrest and warfare. Events in the Middle East have caused a massive surge of refugees emigrating from the Middle East into safe haven countries in Europe and parts of Asia, and they often move through the Mediterranean to countries such as Turkey, Hungary, Germany, France, and UK. By consulting relative articles, Germany accepts the largest refugees. In July 2015, within only a month, Europe's borders intercepted 107500 refugees, rising by three times during the same period last year. Hungarian officials said more than 2000 refugees across the border from Serbia to Hungary every day, and then entered without a visa but still freely passed the country. This year, more than 150000 refugees travel into Europe via Hungary, which is the Utopia for those in rags. The UN's refugee agency disclosed that Germany has become the largest country receiving refugees in the western developed countries [2]. .

## 2. The model of metrics of refugee crises

According to the requests of the problem, we look for information and find several metrics of refugee crises which have relationship between each other. Considering their fuzziness, we adopt the Gray fuzzy evaluation on the basic of AHP [3] to quantize and sort them. Furthermore, we can find the importance of each element.

To get metrics of refugee crises, we used analytic hierarchy process in system analysis. First, we stratify the question. The problem is decomposed into different factors. In sorting calculation, each layer of the sorting problem can be simplified to a series of factors in pairs of judgment. According to a certain scale we quantify the judgment and form comparative judgment matrix [4].

Complete the following steps:

(1) Establish a hierarchy. We divide different factors into layers and express the affiliation.

(2) Construct the judgment matric $\boldsymbol{A}$. Judgment matrix element is as following:

$$a_{ij} = \frac{a_{ik}}{a_{jk}} (i, j, l = 1,2, \dots n) \qquad (0.1)$$

 

(3) Hierarchical single sort and consistency check. We define the consistency index:

$$CI = \frac{\lambda_{max} - n}{n - 1} \tag{0.2}$$

Where $\lambda_{max}$ is the latent root of the judgment matric ***A***, n is the order of the judgment matric. We introduce the mean random consistency index ***RI*** of ***A.*** Average random coincidence:

**Tab1:** Average random coincidence indicator

| Name | Contents | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Order | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| RI | 0.00 | 0.00 | 0.58 | 0.90 | 1.12 | 1.24 | 1.32 | 1.41 | 1.45 |

(4) Sort level: Calculate the ordering weights all factors to the top. Ordering weights are: $w_1, w_{2,} \dots w_m$ where *m* is the judgment matric ***A*** include the total number of factors.

(5) Total sorts of consistency check. We define the consistency ratio:

$$CR = \frac{\sum_{j=1}^{m} w_j CI_j}{\sum_{j=1}^{m} w_j CR_j} \tag{0.3}$$

When CR is less than0.10, we can conclude the consequence is consistent.

(6) Establish factors set and comment set respectively : $\boldsymbol{U} = \{u_1, u_2, \dots u_m\}$ *and* $\boldsymbol{V} = \{v_1, v_2, \dots v_p\}$.

(7) Set up the sample matrix ***D*** and determine the gray level. $d_{kj}$ is the judge value. We divide gray level into the following categories: {0~0.2,0.2~0.4,0.4~0.6,0.6~0.8,0.8~1.0}. Next, we calculate gray statistics $n_{ji} = \sum_{k=1}^{p} f_1 d_{kj}$ and total gray statistics $n_j = \sum_{j=1}^{m} n_{ji}$ where $f_i(d_{kj})$ is the weight of the number *i* of rating.

(8) Calculate the gray fuzzy evaluation matrix ***R*** of factors set ***U***:

$$R = \begin{bmatrix} r_{11} & \cdots & r_{1m} \\ \vdots & \ddots & \vdots \\ r_{n1} & \cdots & r_{nm} \end{bmatrix} \tag{0.4}$$

Where $r_{ji} = {}^{n_{ji}}/_{n_j}$ .

(9) Calculate the comprehensive evaluation value of ***U***. We define comprehensive evaluation vector ***B***:

$$B = (b_1, b_2, \dots b_m) = W^T \mathrm{R} = (w_1, w_2, \dots w_n) \begin{bmatrix} r_{11} & \cdots & r_{1m} \\ \vdots & \ddots & \vdots \\ r_{n1} & \cdots & r_{nm} \end{bmatrix} \tag{0.5}$$

Where $W^T = (w_1, w_2, \dots w_n)$ is ordering weights in **3.1.1.**

## 3. Analyzing the comprehensive model

By means of consulting relative books, we determine the metrics of refugee crises including:

- **Refugee's physical condition:** A refugee in good condition makes a big influence on successful rate of immigration because they are the main force in seeking food and marching forward. We define it as ***PC***.
- **The number of refugees:** By looking up some articles, we find that it promotes successful rate of immigration. We also find that the population either too much or too little is harm to the successful rate of immigration. We define it as ***NU***.
- **The length of the journey:** Based on the data, the earlier they arrive on the asylum countries, the greater rescued numbers and the successful rate of immigration will be in the crowd is larger. We define it ***LE***.
- **The transportation:** We define it as ***TR***.

- **The environment:** By consulting relative articles, we find that the weather has big impact on migration. We define it ***EN***.
- **The total claim a country accepts :** The total claim a country accepts is a quantifiable indicator. If the region doesn't grant, the applying fails to settle. We define it RG.
- **The number of entry points:** Entry point number makes a difference on the migration result. The large number of entry points can improve the pass rate of refugees. We define it ***EP***.
- **Social assistance on the way:** Social assistance on the way is a big influence factor. Social assistance includes medical treatment and food security directly influence whether refugees can arrive the country of destination. Adequate medical service and food supply can simulate the travel of refugees. We define it ***SA***.

Judgment matric ***A***

In this question, we define: $a_1$represents *PC*, $a_2$represents NU, $a_3$represents *LE*, $a_4$represents *TR*, $a_5$represents *EN*, $a_6$represents *EP*, $a_7$represents *EP*, $a_8$ represents *SA*. We get the judgment matric *A* as the follow:

$$A = \begin{bmatrix} 1.00 & 0.25 & 0.33 & 0.20 & 0.50 & 0.14 & 0.5 & 0.67 \\ 4.00 & 1.00 & 1.33 & 0.80 & 2.00 & 0.57 & 2.00 & 2.67 \\ 3.00 & 0.75 & 1.00 & 0.60 & 1.50 & 0.43 & 1.50 & 2.00 \\ 5.00 & 1.25 & 1.67 & 1.00 & 2.50 & 0.71 & 2.50 & 3.33 \\ 2.00 & 0.50 & 0.67 & 0.40 & 1.00 & 0.29 & 1.00 & 1.43 \\ 7.00 & 1.75 & 2.33 & 1.40 & 3.50 & 1.00 & 3.50 & 4.67 \\ 2.00 & 0.50 & 0.67 & 0.40 & 1.00 & 0.29 & 1.00 & 1.33 \\ 1.50 & 0.38 & 0.50 & 0.30 & 0.75 & 0.21 & 0.75 & 1.00 \end{bmatrix}$$

In the matric *A*, the maximum is $a_{61}$=7.00 and the minimum is $a_{16} = 0.14$.then we can make this conclusion: In the comparison of two factors, the total claim a country accepts is the more important than refugee's physical condition which has the biggest value above all. These factors are from 0.14 to 7.00 is reasonable and scientific.

**Ordering weights *w***

According to our model, we calculate the values of ordering weights:

$$W = \{w_{1,}w_2, \dots w_8\} = \{0.0392,0.1567,0.1176,0.1961,0.0784,0.2745,0.0784,0.0588\}$$

Where $w_1$represents the weight of *PC*, $w_2$represents the weight of NU, $w_3$represents the weight of *LE*, $w_4$represents the weight of *TR*, $w_5$represents the weight of *EN*, $w_6$represents the weight of *EP*, $w_7$represents the weight of *EP*, $w_8$ represents the weight of *SA*. We denote success rate of immigration $R_{si}$ .Then we can obtain the following figure:

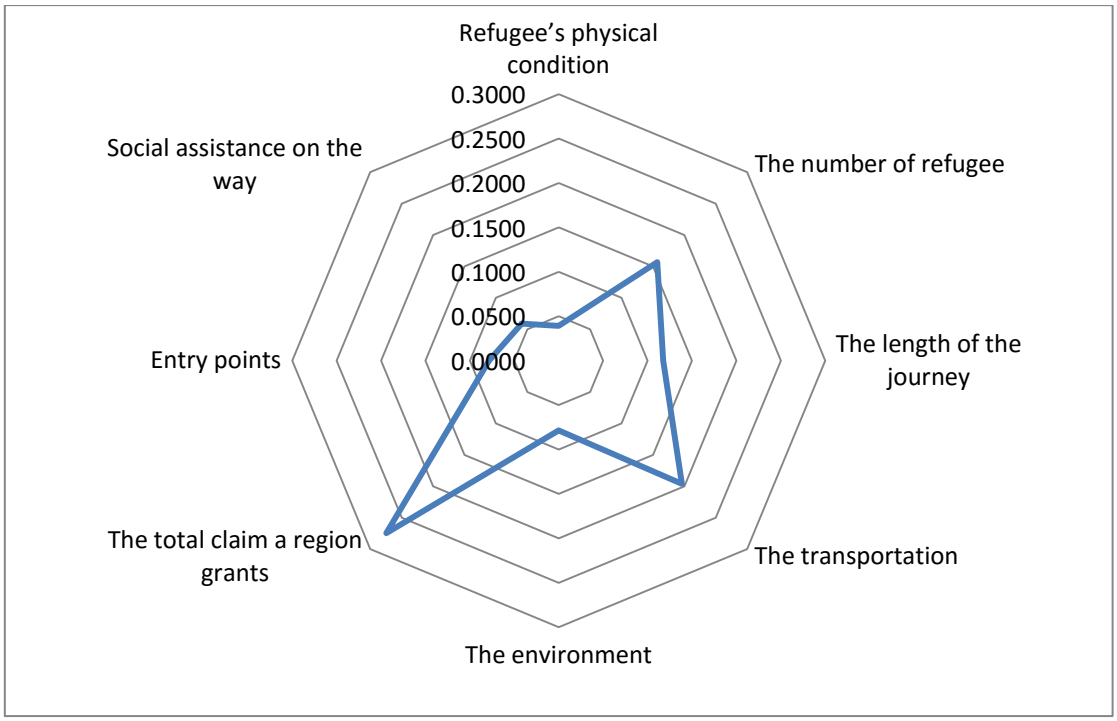


Fig2: The weights of total factors

## 4. Conclusions

According to the Fig2, the biggest weight is the total claim a country accepts which $w_6 = 0.2745$, the smallest weight is the refugee's physical conditions which $w_1 = 0.0392$.

From the result above, we come to a conclusion that the total claim a country accepts and the transportation are the most important factors. Data from the BBC websites shows German, Sweden, France and Italy grant the most asylum claims, so it's no surprise to see a large crowd of refugees going to these countries. For instance, Germany's carrying capacity is 47555 and Sweden's carrying capacity is 33025. As for transportation, we find that a majority of the death were traveling by sea, in particular through the central Mediterranean where the total death reaches 2447. It's consistent with our consumption. While the physical condition of the refugees, entry points, and the environment are less important factors, causing relatively less death.

## Reference

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