International Journal of Wireless and Ad Hoc Communication (IJWAC) *Vol. 04, No. 02, PP. 50-60, 2022*

Information error-based Pythagorean fuzzy cloud technique for managing road traffic risk

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Abstract

This research proposes a novel procurement process for road traffic analysis by using the information error-based Pythagorean fuzzy cloud (PFC) method. First, a 20-factor assessment index method for road traffic was developed. The notion of PFCs was devised to represent the assessment information of an indication. Concurrently, the PFC-weighted Bonferroni mean (PFCWBM) operator was created to aggregate the evaluation data of multiple indications. Then, a method for evaluating and selecting road traffic based on the PFCWBM operator was developed. Furthermore, an application for demonstrating the efficacy of the suggested method was provided. Finally, the effectiveness of the proposed method was evaluated. Results demonstrate that our algorithm can define and assess complicated data with relatively high susceptibility and environmental adaptation.

Keywords: Pythagorean fuzzy cloud; road traffic; information error; risk analysis

1. Introduction

Individuals regularly participate in dangerous behaviors, some of which are voluntary, such as cigarette smoking or snowboarding, in which risk is an integral part of the activity's appeal. Other forms of danger, such as eating or traveling to work or school, are inseparable from everyday activities, and they cannot be readily avoided. If the risk perceptions of people are correct (i.e., knowledge of the real effect of danger they will have to confront), then they can make educated choices and subject themselves to the optimum degree of risk.

Numerous research has attempted to assess the mortality risk of people [1], and empirical data reveal that individuals have an inaccurate sense of mortality hazards. This bias affects not only the capacity of people to make well-informed choices but also the optimum allocation of resources by policymakers, who may base their judgments on objective risk metrics or expert evaluations. Additionally, skewed risk perception may influence choice elicitation. For example, if people overestimate the mortality rate, then the monetary estimates of lowering the risk of mortality may be favorably skewed [2],[3]. Therefore, understanding user risk perception is crucial not only from a research standpoint but from a political one.

People overestimate and underestimate the likelihood of medium and large probabilities with respect to risk belief [4]–[9]. In fact, Benjamin and Dougan [10] found that perceived risk is impartial to age after re-examining the data from Lichtenstein et al. [6], albeit an individual's risk perception is likely more accurate when danger is related to their age group. Benjamin et al. [11] support the aforementioned findings. By contrast, Armantier [9] claims that people are influenced by the "anchoring effect," but the "salient and robust phenomena" also confirm Benjamin and Dougan's [10] previous finding that people perceive the danger of their age group as being more correct.

Doi: https://doi.org/10.54216/IJWAC.040201
Received: January 11, 2022 Accepted: May 10, 2022

Previous assumptions and theories suggest that the assessment value of a certain indication cannot have an evaluation value larger than 1, thereby restricting the range of possible representations of uncertainty indicators [12]. FS and IFS cannot handle a situation in which decision makers must separately provide the MD and NMD with an indication, suggesting that the total weight of decisions may exceed 1. In view of addressing this gap, the Pythagorean fuzzy set (PFS) was developed by Yager [13], in which the total weight may exceed 1 but not over 1.5. The PFS is a better representation of uncertainty and complexity compared with the FS and IFS, which have more constrained ways of expressing membership grades. The following are some of the angles from which academics have examined the PFS.

PFS is expanding in terms of its structure and fundamental features. The rules for division and subtraction in PFS were established by Peng and Yang [12], while the cosine and centroid functions were recommended by Verma and Merigo [15]. Singh and Ganie improved the correlation coefficient between two PFSs [16] previously built by Chen [17]. As a result, the interval value PFS was established by Peng and Yang [18], who then expanded the real number PFS to include the interval value PFSs. Two-tuple linguistic Pythagorean fuzzy was proposed by Zhang et al. [19], and the novel “soft, rough Pythagorean m-polar FSs” was introduced by Riaz and Hashmi [20]. The Pythagorean language preference links were studied by Mandal et al. [21], and the Pythagorean fuzzy linguistic set interval with the two-tuple Pythagorean interval was investigated by Xian et al. [22]. In addition, Lang et al. [23] used three-way group conflict theory to compute the PFS’s positive, neutrality, and negative alignments. Gou et al. [24] also presented a new approach to aggregate continuous information from discrete information in a manner that is consistent with the Pythagorean fuzzy function’s continuity and derivatives and its differentiation.

Fuzzy theory, in combination with MCDM approaches [25]–[28], is a strong and effective tool for generating trustworthy decisions in a variety of decision-making domains [29]–[31]. According to Stoji et al. [32], specific elements must be defined and fulfilled beforehand in a decision-making process, particularly when dealing with complicated situations. Multi-criteria decision-making (MCDM) occupies a specific role in science. According to Zavadskas et al. [33], an acceptable solution may be more precisely determined via fuzzy MCDM approaches, which are particularly useful because of the difficulty and time required to examine them given a variety of circumstances. Group decision-making procedures [34] also reflect this outlook. Related to the theme of the current research, numerous elements should be considered when calculating the danger level of a road stretch. Variables need to be appraised clearly and exactly after acquiring experimental data. On this basis, fuzzy linguistic scales can be established via quantification in TFNs.

The remainder of the paper is organized as follows. The related work is presented in Section 2. The preliminaries for developing this study are provided in Section 3. The Pythagorean fuzzy cloud (PFC)-weighted Bonferroni mean (PFCWBM) is described in Section 4. An analysis of a sample used in this research is presented in Section 5. The summary and learnings and the recommendations for further study are discussed in Section 6.

2. Related Work

Traffic accidents and dangerous conditions are caused by several variables, but one of the most essential considerations is the road itself. Simply relying on geometric factors is insufficient in giving the prospective scenarios or risk levels of road users, although car collisions often occur in certain parts of roads due to their geometric qualities. Regarding injuries to pedestrians, cyclists, and motorcyclists in metropolitan settings, unequal income and poverty are primary considerations. Morency et al. [35] found that poor neighborhoods have a higher number of pedestrian, cycling [36], and motorcycle accidents compared with the wealthy ones. They also determined that pavement quality and the route’s geometric qualities are the two road elements that most commonly influence accident rates. Causative elements were used to calculate the risk level of 200-meter road portions. Nenadi [37] used seven criteria to evaluate parts of three sites. The optimality criteria were designed such that the safest sections could be examined instead of the ones with the greatest risk. A fuzzy technique similar to the work of Bao et al. [38] was adopted. Moreover, an enhanced layered fuzzy TOPSIS model for road safety performance evaluate was adopted. Khorasani et al. [39] assessed safety performance indicators as a methodological MCDM challenge. Haghighat [40] utilized the TOPSIS approach in conjunction with other methodologies to determine the defensive backfield of roads in Bushehr Province, Iran.

Doi: https://doi.org/10.54216/IJWAC.040201
Received: January 11, 2022 Accepted: May 10, 2022

3. Mathematical Equations for the Cloud of Pythagorean

First, create the normal stochastic numbers of the MD and NMD functions and their respective expected and error values in the PFCNs.

Then, generate the normal stochastic numbers *x* and *y* and their expectations *a* and *z*.

Determine the number of cloud droplets based on the real demand. The number of cloud droplets is calculated as

$$\gamma = e^{-\frac{(x-y)^2}{2*y}}$$

$$\gamma = e^{-\frac{(a-b)^2}{2*b}}$$

where γ is the number of cloud droplets, which is determined based on the actual demand.

Define the PFCN MD and NMD cloud droplets (γ,γ). γ is the value of the MD or NMD cloud in this domain, and *gxi* is the measure of how closely the MD or NMD cloud fits into γ on the time interval.

Repeat the four steps mentioned above until the number of available cloud droplets is reached. Then, calculate the overall expectations of the MD and NMD clouds based on the total number of cloud droplets.

Definition 1: Let $A \leq (x,y,z);(a,b,c) >$, $A_1 \leq (x_1,y_1,z_1);(a_1,b_1,c_1) >$, and $A_2 \leq (x_2,y_2,z_2);(a_2,b_2,c_2) >$ be three PFCNs, and $\lambda,\lambda_1,\lambda_2 > 0$. The corresponding operations are

$$A_1 \oplus A_2 = \begin{pmatrix} \sqrt[2]{x_1^2 + x_2^2 - x_1^2 x_2^2}, y_1 + y_2, z_1 + z_2; \\ a_1 a_2, b_1 + b_2, c_1 + c_2 \end{pmatrix}$$

$$A_1 \otimes A_2 = \begin{pmatrix} x_1 x_2, y_1 y_2, z_1 z_2 \\ \sqrt[2]{a_1^2 + a_2^2 - a_1^2 a_2^2}, b_1 + b_2, c_1 + c_2; \end{pmatrix}$$

$$\lambda A = \left(\sqrt[2]{1-(1-x)^\lambda}, \lambda y, \lambda z, a^\lambda, \lambda b, \lambda c\right)$$

$$A^\lambda = (x^\lambda, y^\lambda, z^\lambda; \sqrt[2]{1-(1-a^2)^\lambda}, b^\lambda, c^\lambda)$$

Definition 2: Let $A = <(x,y,z);(a,b,c)>$ be the score function, which can be represented as follows:

$$S(A) = \frac{1}{r^2}\sum_{e=1}^{r} x \sum_{e=1}^{r} \gamma - \frac{1}{r^2}\sum_{e=1}^{r} a \sum_{e=1}^{r} \gamma$$

$$\gamma = e^{-\frac{(x-y)^2}{2*y}}$$

$$\gamma = e^{-\frac{(a-b)^2}{2*b}}$$

Theorem 1: Let $A = <(x,y,z);(a,b,c)>$, $A_1 = <(x_1,y_1,z_1);(a_1,b_1,c_1)>$, and $A_2 = <(x_2,y_2,z_2);(a_2,b_2,c_2)>$, and $w = w_1, w_2, \ldots\ldots w_r$ is the weight. The compute value of PFCWBN calculated as follows:

$$PFCWBN(A_1, A_2, \ldots\ldots A_r)$$

Doi: https://doi.org/10.54216/IJWAC.040201
Received: January 11, 2022 Accepted: May 10, 2022

$$\left(\begin{array}{c}\left(\begin{array}{c}\left(1-\left(\otimes_{e\neq f}^{r}e,f=1(1-(1-(1-x^{2})^{rw_{r}})^{h}(1-(1-x^{2})^{rw_{f}})^{g})\right)\right)\\ \left(\frac{1}{r(r-1)}\otimes_{e\neq f}^{r}e,f=1(yrw_{e})^{g}\right)^{\frac{1}{h+g}},\left(\frac{1}{r(r-1)}\otimes_{e\neq f}^{r}e,f=1(zrw_{e})^{g}\right)^{\frac{1}{h+g}}\end{array}\right)^{\frac{1}{r(r-1)}}\\ \left(\begin{array}{c}1-\left(1-\left(\otimes_{e\neq f}^{r}e,f=1(1-(1-(1-a^{rw_{i}})^{2})^{h}(1-(1-a^{rw_{i}})^{r2})^{g})\right)\right)^{\frac{1}{r(r-1)}}\\ \left(\frac{1}{r(r-1)}\otimes_{e\neq f}^{r}e,f=1(brw_{e})^{g}\right)^{\frac{1}{h+g}},\left(\frac{1}{r(r-1)}\otimes_{e\neq f}^{r}e,f=1(crw_{e})^{g}\right)^{\frac{1}{h+g}}\end{array}\right)^{\frac{1}{h+g}}\end{array}\right)^{\frac{1}{(h+g)^{2}}}$$

$$(A_{e}rw_{e})^{h}\otimes\left(A_{f}rw_{f}\right)^{g}$$

$$\left(\begin{array}{c}\left(\begin{array}{c}\sqrt{(1-(1-x^{2})^{rw_{e}})^{h}}\,\sqrt{(1-(1-x^{2})^{rw_{f}})^{g}},(y_{e}rw_{e})^{h},\left(y_{f}rw_{f}\right)^{g},\left(z_{e}rw_{f}\right)^{h}\\ ,\left(z_{f}rw_{f}\right)^{g};\end{array}\right)\\ \sqrt{\begin{array}{c}(1-(1-a^{2}rw_{e})^{1})^{h}+(1-(1-a^{2}rw_{e})^{g})^{g}-\\ (1-(1-a^{2}rw_{e})^{1})^{h}(1-(1-a^{2}rw_{e})^{g})^{g}\end{array}},\\ (brw_{e})^{h}(brw_{e})^{g}.\left(crw_{f}\right)^{h}\left(crw_{f}\right)^{g}\end{array}\right)$$

$$\sum_{\substack{e,f=1\\ e\neq f}}^{r}(A_{e}rw_{e})^{h}\otimes\left(A_{f}rw_{f}\right)^{g}$$

$$\left(\begin{array}{c}\left(\begin{array}{c}\sqrt{1-\prod_{\substack{e,f=1\\ e\neq f}}^{r}(1-(1-x^{2})^{rw_{e}})^{h}(1-(1-x^{2})^{rw_{f}})^{g}}\\ \sum_{\substack{e,f=1\\ e\neq f}}^{r}(y_{e}rw_{e})^{h}\left(y_{f}rw_{f}\right)^{g},\sum_{\substack{e,f=1\\ e\neq f}}^{r}\left(z_{e}rw_{f}\right)^{h}\left(z_{f}rw_{f}\right)^{g}\end{array}\right);\\ \prod_{\substack{e,f=1\\ e\neq f}}^{r}\sqrt{(1-(1-a^{2}rw_{e})^{1})^{h}}\sqrt{(1-(1-a^{2}rw_{e})^{g})^{g}}\\ \sum_{\substack{e,f=1\\ e\neq f}}^{r}(brw_{e})^{h}(brw_{e})^{g}\sum_{\substack{e,f=1\\ e\neq f}}^{r}\left(crw_{f}\right)^{h}\left(crw_{f}\right)^{g}\end{array}\right)$$

$$\frac{1}{r(r-1)}\sum_{\substack{e,f=1\\ e\neq f}}^{r}(A_{e}rw_{e})^{h}\otimes\left(A_{f}rw_{f}\right)^{g}$$

Doi: https://doi.org/10.54216/IJWAC.040201
Received: January 11, 2022 Accepted: May 10, 2022

$$\left(\begin{array}{c}\left(\begin{array}{c}\sqrt{1-\prod_{\substack{e,f=1\\e\neq f}}^{r}(1-(1-x^{2})^{rw_e})^{h}(1-(1-x^{2})^{rw_f})^{g}}\\ \sum_{\substack{e,f=1\\e\neq f}}^{r}(y_e rw_e)^{h}(y_f rw_f)^{g},\ \sum_{\substack{e,f=1\\e\neq f}}^{r}(z_e rw_f)^{h}\,(z_f rw_f)^{g}\end{array}\right)^{\frac{1}{r(r-1)}}\quad ;\\ \prod_{\substack{e,f=1\\e\neq f}}^{r}\sqrt{(1-(1-a^{2}rw_e)^{1})^{h}}\sqrt{(1-(1-a^{2}rw_e)^{g})^{g}}^{\frac{1}{r(r-1)}}\\ \sum_{\substack{e,f=1\\e\neq f}}^{r}(brw_e)^{h}(brw_e)^{g}\sum\nolimits_{\substack{e,f=1\\e\neq f}}^{r}(crw_f)^{h}(crw_f)^{g^{\frac{1}{r(r-1)}}}\end{array}\right)$$

$$\frac{1}{r(r-1)}\sum_{\substack{e,f=1\\e\neq f}}^{r}(A_e rw_e)^{h}\otimes(A_f rw_f)^{g^{\frac{1}{h}+g}}$$

$$\left(\begin{array}{c}\left(\left(\begin{array}{c}\sqrt{1-\prod_{\substack{e,f=1\\e\neq f}}^{r}(1-(1-x^{2})^{rw_e})^{h}(1-(1-x^{2})^{rw_f})^{g}}\\ \left(\frac{1}{r(r-1)}\sum_{\substack{e,f=1\\e\neq f}}^{r}((y_e rw_e)^{h}(y_f rw_f)^{g}),\ \sum_{\substack{e,f=1\\e\neq f}}^{r}(z_e rw_f)^{h}\,(z_f rw_f)^{g}\right)^{\frac{1}{h+g}}\end{array}\right)^{\frac{1}{r(r-1)}}\right)^{1/h+g}\quad ;\\ \left(1-\left(1-\left(\prod_{\substack{e,f=1\\e\neq f}}^{r}\sqrt{(1-(1-a^{2}rw_e)^{1})^{h}}\sqrt{(1-(1-a^{2}rw_e)^{g})^{g}}^{\frac{1}{r(r-1)}}\right)\right)^{\frac{1}{h}+g}\right)\\ \left(\left(\frac{1}{r(r-1)}\left(\sum_{\substack{e,f=1\\e\neq f}}^{r}(brw_e)^{h}(brw_e)^{g}\right)\right)^{\frac{1}{h+g}}\left(\frac{1}{r(r-1)}\sum\nolimits_{\substack{e,f=1\\e\neq f}}^{r}(crw_f)^{h}(crw_f)^{g}\right)^{\frac{1}{h}+g}\right)^{\frac{1}{r(r-1)}}\end{array}\right)$$

4. Road Traffic Risk Analysis using the PFCWBM Operator

Road traffic was evaluated using one of the many different schemes, i.e., $A = (A1, A2, A3, \ldots, Am)$. Then, n indices $E = (E1, E2, E3, \ldots, En)$ were picked to assess the m options, taking into account the real elements, such as resource input, performance, anticipated benefits, and service level. The optimum solution was selected based on the evaluation findings. Regarding the assessment procedure, a panel of experts was instructed to rate the evaluation indices, which correlate with the MD and NMD of the PFC. The higher the value, the more significant the degree. Furthermore, the MD and NMD error and their distribution features were determined based on a certain percentage.

Doi: https://doi.org/10.54216/IJWAC.040201
Received: January 11, 2022 Accepted: May 10, 2022

The value of each answer corresponded to the evaluation value of the first index of the i-th solution. Thus, the evaluation index would be given various weights, and the weight vector of the index should be set. Finally, the evaluation information matrix based on the expert assessment was obtained.

After obtaining the results of the presented data, an information error-based PFC method was implemented to evaluate and select the road traffic situation. Figure 1 shows the steps conducted of the study. The calculation involved the following steps:

i. Establish the road traffic evaluation index systems.
ii. Use an index system for a matrix with a type of PCF to evaluate the options.
iii. Use the suggested PFCWBM operator to aggregate the assessment data.
iv. Calculate the score of $S(A)$ for each option.
v. Rank each solution in order of preference according to $S(A)$.

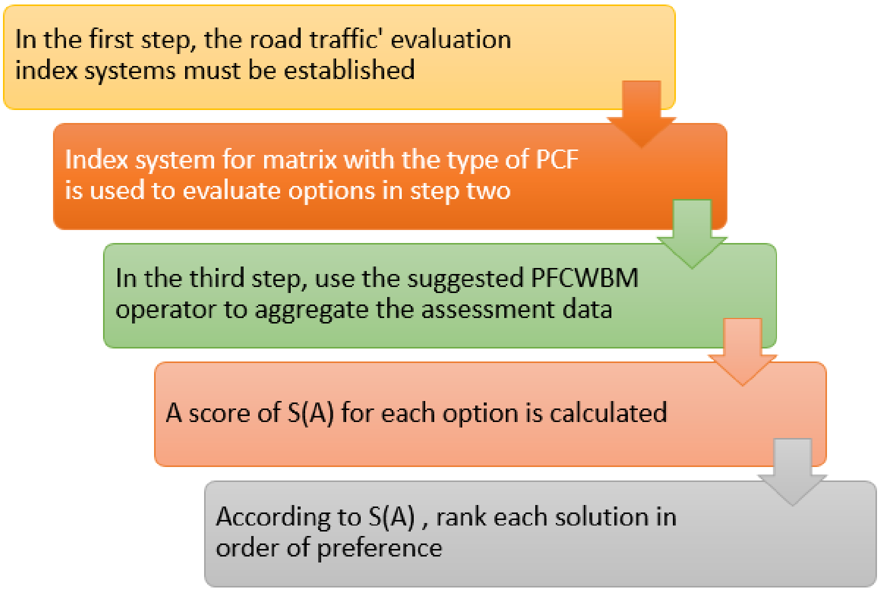

Figure 1: Steps of the study.

5. Analysis of a Sample

Twenty road traffic samples were considered for selecting the best road by using six main criteria: increase or decrease in length of a road's longitudinal gradient, number of entry points (left and right) on each segment, number of fatal and nonfatal accidents, type of injuries (minor and/or severe), and material damage. The assessment index method was used to select the best road from four options and subsequently obtain the necessary data.

Table 1: Information evaluation matrix.

	C1						**C2**					
A1	0.48	0.04	0.004	0.43	0.039	0.003	0.47	0.05	0.004	0.37	0.03	0.003
A2	0.69	0.06	0.005	0.47	0.042	0.004	0.67	0.06	0.005	0.41	0.04	0.003
A3	0.69	0.06	0.005	0.47	0.042	0.004	0.69	0.06	0.005	0.47	0.04	0.004
A4	0.69	0.06	0.005	0.47	0.042	0.004	0.69	0.06	0.005	0.47	0.04	0.004
A5	0.48	0.04	0.004	0.43	0.039	0.003	0.69	0.06	0.005	0.47	0.04	0.004
A6	0.69	0.06	0.005	0.47	0.042	0.004	0.69	0.06	0.005	0.47	0.04	0.004
A7	0.67	0.06	0.005	0.41	0.037	0.003	0.69	0.06	0.005	0.47	0.04	0.004

Doi: https://doi.org/10.54216/IJWAC.040201
Received: January 11, 2022 Accepted: May 10, 2022

A8	0.69	0.06	0.005	0.47	0.042	0.004	0.70	0.06	0.005	0.63	0.06	0.005
A9	0.69	0.06	0.005	0.47	0.042	0.004	0.69	0.06	0.005	0.47	0.04	0.004
A10	0.52	0.05	0.004	0.34	0.031	0.005	0.67	0.06	0.005	0.41	0.04	0.003
A11	0.69	0.06	0.005	0.47	0.042	0.004	0.52	0.05	0.004	0.34	0.03	0.005
A12	0.67	0.06	0.005	0.41	0.037	0.003	0.48	0.04	0.004	0.43	0.04	0.003
A13	0.69	0.06	0.005	0.47	0.042	0.004	0.69	0.06	0.005	0.47	0.04	0.004
A14	0.69	0.06	0.005	0.47	0.042	0.004	0.69	0.06	0.005	0.47	0.04	0.004
A15	0.69	0.06	0.005	0.47	0.042	0.004	0.69	0.06	0.005	0.47	0.04	0.004
A16	0.52	0.05	0.004	0.34	0.031	0.005	0.69	0.06	0.005	0.47	0.04	0.004
A17	0.69	0.06	0.005	0.47	0.042	0.004	0.67	0.06	0.005	0.41	0.04	0.003
A18	0.69	0.06	0.005	0.47	0.042	0.004	0.69	0.06	0.005	0.47	0.04	0.004
A19	0.69	0.06	0.005	0.47	0.042	0.004	0.69	0.06	0.005	0.47	0.04	0.004
A20	0.69	0.06	0.005	0.47	0.042	0.004	0.69	0.06	0.005	0.47	0.04	0.004
	C3						**C4**					
A1	0.69	0.06	0.005	0.47	0.042	0.004	0.70	0.06	0.005	0.63	0.06	0.005
A2	0.48	0.04	0.004	0.43	0.039	0.003	0.48	0.04	0.004	0.43	0.04	0.003
A3	0.67	0.06	0.005	0.41	0.037	0.003	0.52	0.05	0.004	0.34	0.03	0.005
A4	0.67	0.06	0.005	0.41	0.037	0.003	0.70	0.06	0.005	0.63	0.06	0.005
A5	0.69	0.06	0.005	0.47	0.042	0.004	0.69	0.06	0.005	0.47	0.04	0.004
A6	0.48	0.04	0.004	0.43	0.039	0.003	0.47	0.05	0.004	0.37	0.03	0.003
A7	0.70	0.06	0.005	0.63	0.057	0.005	0.67	0.06	0.005	0.41	0.04	0.003
A8	0.69	0.06	0.005	0.47	0.042	0.004	0.69	0.06	0.005	0.47	0.04	0.004
A9	0.69	0.06	0.005	0.47	0.042	0.004	0.69	0.06	0.005	0.47	0.04	0.004
A10	0.69	0.06	0.005	0.47	0.042	0.004	0.69	0.06	0.005	0.47	0.04	0.004
A11	0.69	0.06	0.005	0.47	0.042	0.004	0.69	0.06	0.005	0.47	0.04	0.004
A12	0.47	0.05	0.004	0.37	0.033	0.003	0.52	0.05	0.004	0.34	0.03	0.005
A13	0.69	0.06	0.005	0.47	0.042	0.004	0.67	0.06	0.005	0.41	0.04	0.003
A14	0.69	0.06	0.005	0.47	0.042	0.004	0.67	0.06	0.005	0.41	0.04	0.003
A15	0.69	0.06	0.005	0.47	0.042	0.004	0.69	0.06	0.005	0.47	0.04	0.004
A16	0.48	0.04	0.004	0.43	0.039	0.003	0.69	0.06	0.005	0.47	0.04	0.004
A17	0.69	0.06	0.005	0.47	0.042	0.004	0.70	0.06	0.005	0.63	0.06	0.005
A18	0.69	0.06	0.005	0.47	0.042	0.004	0.70	0.06	0.005	0.63	0.06	0.005
A19	0.69	0.06	0.005	0.47	0.042	0.004	0.67	0.06	0.005	0.41	0.04	0.003
A20	0.67	0.06	0.005	0.41	0.037	0.003	0.52	0.05	0.004	0.34	0.03	0.005
	C5						**C6**					
A1	0.69	0.06	0.005	0.47	0.042	0.004	0.70	0.06	0.005	0.63	0.06	0.005
A2	0.52	0.05	0.004	0.34	0.031	0.005	0.48	0.04	0.004	0.43	0.04	0.003
A3	0.52	0.05	0.004	0.34	0.031	0.005	0.67	0.06	0.005	0.41	0.04	0.003
A4	0.69	0.06	0.005	0.47	0.042	0.004	0.47	0.05	0.004	0.37	0.03	0.003
A5	0.69	0.06	0.005	0.47	0.042	0.004	0.69	0.06	0.005	0.47	0.04	0.004
A6	0.69	0.06	0.005	0.47	0.042	0.004	0.70	0.06	0.005	0.63	0.06	0.005

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A7	0.69	0.06	0.005	0.47	0.042	0.004	0.69	0.06	0.005	0.47	0.04	0.004
A8	0.69	0.06	0.005	0.47	0.042	0.004	0.69	0.06	0.005	0.47	0.04	0.004
A9	0.67	0.06	0.005	0.41	0.037	0.003	0.47	0.05	0.004	0.37	0.03	0.003
A10	0.52	0.05	0.004	0.34	0.031	0.005	0.48	0.04	0.004	0.43	0.04	0.003
A11	0.52	0.05	0.004	0.34	0.031	0.005	0.69	0.06	0.005	0.47	0.04	0.004
A12	0.69	0.06	0.005	0.47	0.042	0.004	0.69	0.06	0.005	0.47	0.04	0.004
A13	0.69	0.06	0.005	0.47	0.042	0.004	0.69	0.06	0.005	0.47	0.04	0.004
A14	0.67	0.06	0.005	0.41	0.037	0.003	0.70	0.06	0.005	0.63	0.06	0.005
A15	0.52	0.05	0.004	0.34	0.031	0.005	0.69	0.06	0.005	0.47	0.04	0.004
A16	0.67	0.06	0.005	0.41	0.037	0.003	0.48	0.04	0.004	0.43	0.04	0.003
A17	0.67	0.06	0.005	0.41	0.037	0.003	0.69	0.06	0.005	0.47	0.04	0.004
A18	0.69	0.06	0.005	0.47	0.042	0.004	0.69	0.06	0.005	0.47	0.04	0.004
A19	0.69	0.06	0.005	0.47	0.042	0.004	0.48	0.04	0.004	0.43	0.04	0.003
A20	0.52	0.05	0.004	0.34	0.031	0.005	0.67	0.06	0.005	0.41	0.04	0.003

Table 1 shows the results of the expert assessment by using the PFC form with four different options. The previously presented method was used to evaluate and make decisions based on the data presented above. The computation process involves the following steps:

Step 1: Construct an indicator system for road traffic assessment.

Step 2: Form an evaluation information matrix after gathering the expert assessment information (refer to Table 3).

Step 3: Compile the results using the PFCWBM operator.

Step 4: Use the PFCWBM operator to merge the data (refer to Table 2).

Step 5: Determine the S(A) score value for each solution (refer to Table 3).

Figure 2 shows the ranking of the alternatives.

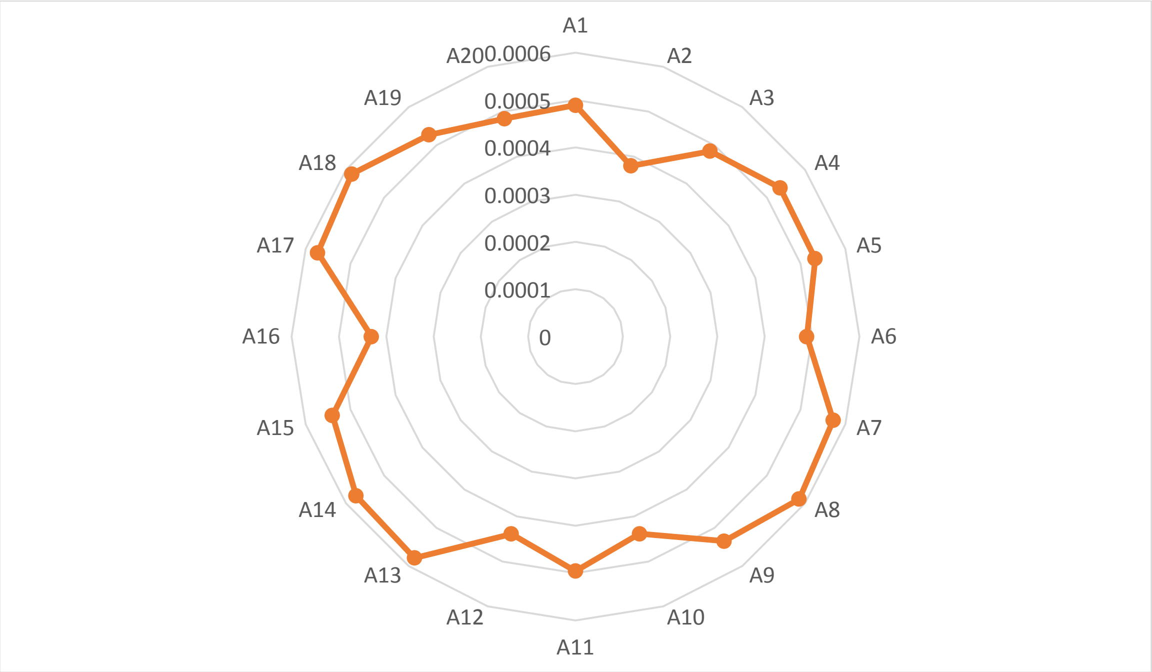

Figure 2: Ranks of alternatives.

Table 2: Data matrix for in-depth evaluation.

	C1	**C2**	**C3**	**C4**	**C5**	**C6**

A1	4.6E-05	5.4E-05	9.7E-05	9.7E-05	9.7E-05	9.7E-05
A2	9.7E-05	9.2E-05	4.6E-05	4.6E-05	5.3E-05	4.6E-05
A3	9.7E-05	9.7E-05	9.2E-05	5.3E-05	5.3E-05	9.2E-05
A4	9.7E-05	9.7E-05	9.2E-05	9.7E-05	9.7E-05	5.4E-05
A5	4.6E-05	9.7E-05	9.7E-05	9.7E-05	9.7E-05	9.7E-05
A6	9.7E-05	9.7E-05	4.6E-05	5.4E-05	9.7E-05	9.7E-05
A7	9.2E-05	9.7E-05	9.7E-05	9.2E-05	9.7E-05	9.7E-05
A8	9.7E-05	9.7E-05	9.7E-05	9.7E-05	9.7E-05	9.7E-05
A9	9.7E-05	9.7E-05	9.7E-05	9.7E-05	9.2E-05	5.4E-05
A10	5.3E-05	9.2E-05	9.7E-05	9.7E-05	5.3E-05	4.6E-05
A11	9.7E-05	5.3E-05	9.7E-05	9.7E-05	5.3E-05	9.7E-05
A12	9.2E-05	4.6E-05	5.4E-05	5.3E-05	9.7E-05	9.7E-05
A13	9.7E-05	9.7E-05	9.7E-05	9.2E-05	9.7E-05	9.7E-05
A14	9.7E-05	9.7E-05	9.7E-05	9.2E-05	9.2E-05	9.7E-05
A15	9.7E-05	9.7E-05	9.7E-05	9.7E-05	5.3E-05	9.7E-05
A16	5.3E-05	9.7E-05	4.6E-05	9.7E-05	9.2E-05	4.6E-05
A17	9.7E-05	9.2E-05	9.7E-05	9.7E-05	9.2E-05	9.7E-05
A18	9.7E-05	9.7E-05	9.7E-05	9.7E-05	9.7E-05	9.7E-05
A19	9.7E-05	9.7E-05	9.7E-05	9.2E-05	9.7E-05	4.6E-05
A20	9.7E-05	9.7E-05	9.2E-05	5.3E-05	5.3E-05	9.2E-05

Table 3: S(A) values.

	Values
A1	0.000489
A2	0.00038
A3	0.000484
A4	0.000535
A5	0.000533
A6	0.000489
A7	0.000573
A8	0.000584
A9	0.000535
A10	0.000439
A11	0.000496
A12	0.000439
A13	0.000579
A14	0.000573
A15	0.00054
A16	0.000431
A17	0.000573
A18	0.000584
A19	0.000527
A20	0.000484

6. Conclusion

The PFC model in this study can solve assessment information representation problems in complex uncertain contexts. When the sum of MD and NMD is greater than 1, the PFC model can effectively characterize the types of assessment data given by experts. Subsequently, road traffic can be evaluated, and the error characteristics in the evaluation, including the error and hyper-error of the

Doi: https://doi.org/10.54216/IJWAC.040201
Received: January 11, 2022 Accepted: May 10, 2022

MD and NMD, can be effectively investigated. Owing to this new capacity, experts are able to offer two opposing viewpoints on the same issue with equal independence and accuracy. Furthermore, the opposition degree in our method does not exceed 1x when the approval degree is x. Thus, the drawback of FS or IFS can be avoided.

Owing to the inclusion of additional factors, the PFC model can address the MD and NMD assessment value problems and increase the overall precision of the evaluation.

By using the PFCWBM operator framework, road traffic risk in a complex environment can be analyzed and solved, and assessment and decision-making processes can be optimized. An intricate index method for evaluating and choosing road traffic, including 2 tiers, 20 aspects, and 6 sub-indicators, has been utilized in this study. Inevitably, associations may exist between the various levels and their sub-indices.

Funding: This research received no external funding.

Conflicts of Interest: The authors declare no conflict of interest.

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Doi: https://doi.org/10.54216/IJWAC.040201
Received: January 11, 2022 Accepted: May 10, 2022