DIMENSIONAL ANALYSIS UNDER
PYTHAGOREAN FUZZY SET WITH
HESITANT LINGUISTS TERM ENTROPY
INFORMATION

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Villa Silva, Aldo
Joel*
Pérez Domínguez, Luis
Martínez Gómez, Erwin
Romero-López, Roberto
Valles-Rosales, Delia J.

Universidad Autónoma de Cd. Juárez
Ing.aldojvillasilva@gmail.com
Universidad Autónoma de Cd. Juárez
luis.dominguez@uacj.mx
Universidad Autónoma de Cd. Juárez
emartine@uacj.mx
New Mexico State University
dvalles@nmsu.edu

Abstract: Currently Pythagorean Fuzzy Set (PFS), is an
important tool for handling fuzziness and vagueness,
therefore, is able to make decision makers simple to
provide their assessments. In other hand Dimensional
Analysis (DA) is a technique able to criteria capturing
the interrelationship. The aim of this paper is to present
the DA with PFS to overcome limitations to handle
qualitative (intangible) as well as the interactions
between arguments, and entropy measure for linguistic
term sets (HFLTSs) is applied to overcome criteria
weights problems.

Keywords: MCDM, PFS, DA

1 INTRODUCTION

Dimensional Analysis (DA) is a method that captures the
interrelationship between multiples criteria (Perez; Alvarado; Garcia; Valles, 2018), which it is suitable for multi-
criteria decision making (MCDM) problems. In other hand, the theory of
fuzzy sets introduced by Zadeh (1965) has been experimented with great success
in various fields in order to handle that kind of uncertainty (Li & Zeng, 2018).
Since that several extensions of fuzzy set have been developed by some researchers
(Li & Zeng, 2018). In this context, researchers are actively working in the
field of PFS. The motivation to introduce PFS it is because it has greater capacity to
characterize uncertainty and lack of clarity than IFS (Wan, Jin & Dong, 2018).
In addition, entropy measure for hesitant fuzzy linguistic term sets (HFLTSs), is
used to deal when information is incomplete, or lots of information is lost
(Farhadinia, 2016). Basically, this paper

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addresses three problems: evaluate qualitative criteria, DM preferences and interrelation between criteria, we use Dimensional Analysis (DA) and Pythagorean fuzzy set (PFS) in order to overcome those limitations for multi-input arguments.

2 THEORETICAL AND CONCEPTUAL FRAMEWORK

DA it is a method used in the decision-making process, particularly in selection of multiple alternatives. DA assumes that an optimal solution is better than the rest of solutions. DA make a comparison with each alternative to evaluate against ideal solution to generate an index of similarity, to get the highest index of similarity and choose the best alternative to the MCDM problem (Perez et. al, 2018).

PFS is represented by the three values of membership, with membership and indeterminacy, that does not exceed the value of the unit [3], but its square sum must be 1 or less than 1 (Mandal & Ranadive, 2018). For example, $0.8^2 + 0.6^2 < 1$ that is, the PFS is better to evaluate information (Naz, Ashraf & Akram, 2018).

Two main processes are involved in MCDM: (1) get the criteria weights; and (2) get a ranking of alternatives (Gou, Xu & Liao, 2017). Some entropy measures for HFLTSs, are used to treat where information concerning criteria weights is incomplete (Farhadinia, 2016). Decision makers must give their preferences with linguistic labels, using a proper linguistic evaluation scale.

3 METHOD

Methodology of integration of DA and PFSs with HFLTSs is presented:

Step 1: Provide the decision matrix using PFS values.

Step 2: Choose the best ideal alternative according with (BN) or (C) criteria values.

Step 3: Apply hesitant entropy to calculate criteria weights.

Step 4: Standardized matrix.

Step 5: Standardized matrix apply Pythagorean equation of power.

Step 6: Calculate PFIS index.

Step 7: Get the highest index of IS.

Step 8: Order the score values of the alternatives from highest to lowest and select the highest score value.

4 RESULTS

Results reveal that: DA-PFS with Hesitant Entropy, with Fuzzy Weighted and Pythagorean Entropy where we got the same result, where alternative 4 is selected as the best Forklift machine, due rankings are consistent is selected as the best alternative.

5 CONCLUSIONS

In this article we present DA-PFS and Hesitant entropy in eight steps utilized to deal MCDM and overcome the
limitations exist such as characterize uncertainty and lack of clarity and capture the interrelationship between multiples arguments (Wan, Jin & Dong, 2018). In other hand, we use Entropy weight for determining the weights of criteria in order to avoid loss of information in the evaluation process (Biswas & Sarkar, 2019). Furthermore, we proved some useful and interesting results related to weight concepts: in comparison, Hesitant Entropy weight VS Fuzzy weighted VS Pythagorean Entropy we got the same result, however, Hesitant Entropy weight requires few steps while Fuzzy weighted is calculated in four steps and Pythagorean Entropy in six steps, therefore Hesitant Entropy weight it’s more efficient.

In the near future, will apply the conjugation of these tools in different fields of science and engineering.

6 REFERENCES


Abstract: To know how to predict wages by gender and by region is a vital issue for the economic development of a country. At present we observe that salaries in Mexico are in favor of men, regardless of their educational level. We want to know what wages would be in the future by determining gender, so that we can undertake new policies that allow for equity. Using Ordered Weighted Averaging (OWA), the Ordered Weighted Averaging–Weighted Average (OWAWA), the Induced Ordered Weighted Averaging (IOWA), Generalized Ordered Weighted Averaging (GOWA) and introducing a new operator OWA Salary (OWAS), we manage to create predictions for Mexico in their salaries determined by gender.

Keywords: OWA, Salary, gender

1 INTRODUCTION

In this article the focus is in the salary of women and men in Mexico. The salaries differences between men and women are presented in industry and occupations (Blau & Kahn, 2007), in many countries women earn less than men with the same characteristics in their jobs, like New Zealand (Sin, Stillman, & Fabling, 2017). These problems have been studied by many international organizations like Organization for Economic Co-Operation and Development, UN Women, and so others (International Labor Organization, 2018). One of the problems around the economy is analyze the salary by gender, the difference between countries and take policies according to possible predictions. These predictions we can be observed by the operator OWA Ordered Weighted Averaging (Yager, 1988). This paper is focuses on above mentioned, the Ordered Weighted Averaging–Weighted Average OWAWA (Merigó, Guillén, & Sarabia, 2015), the Induced Ordered Weithed Averaging IOWA, and Generalized Ordered Weithed Averaging GOWA (Merigó & Gil-Lafuente, 2009). Given
that OWA operator has many applications in economics and finance. (Merigó & Gil-Lafuente, 2010).

2 THEORETICAL AND CONCEPTUAL FRAMEWORK

In this section we are going to explain some of OWA, OWAWA and GOWA and IOWA operators.

2.1 OWA operator

An OWA operator (Yager, 1988) that help us to verify the parameterized family of aggregation operators, we can define as follows:

Definition 1: Let $I$ denote the closed interval $[0,1]$. An OWA operator of dimension $n$, is a mapping:

$$\mathcal{G}_1 : \mathbb{I}^n \rightarrow \mathbb{I}$$

$$(a_1,\ldots,a_n) \mapsto \sum_{j=1}^{n} w_j b_j$$

With an associated weighing vector $W = (w_1,\ldots,w_n) \in I^n$ such that

1. $\sum_{i=1}^{n} w_i = 1$
2. $b_j$ is the $j$-th largest of the $a_i$
3. $w_i \in [0,1]$

2.2 OWAWA operator

Definition 2: Let $I$ denote the closed interval $[0,1]$. An OWAWA operator of dimension $n$ is a mapping:

$$\mathcal{G}_2 : \mathbb{I}^n \rightarrow \mathbb{I}^n$$

$$(a_1,\ldots,a_n) \mapsto \sum_{j=1}^{n} \tilde{v}_j b_j ,$$

with an associated weighing vector $W = (w_1,\ldots,w_n) \in I^n$ such that:

1. $\sum_{i=1}^{n} w_i = 1$
2. $b_j$ is the $j$-th largest of the $a_i$, i.e. for each $(a_1,\ldots,a_n) \in \mathbb{I}^n$ there is a permutation $\sigma \in S_n$ such that $b_i = a_{\sigma(i)}$
3. $v_i = w_{\sigma(i)}$ and $\tilde{v}_i = \beta w_i + (1-\beta) v_i$ for some $\beta \in I$

2.3 IOWA operator

Definition 3: Let $I$ denote the closed interval $[0,1]$. An IOWA operator of dimension $n$ is a mapping:

$$\mathcal{G}_3 : \mathbb{I}^n \rightarrow \mathbb{I}$$

$$\left(\langle u_1,a_1 \rangle,\ldots,\langle u_n,a_n \rangle \right) \mapsto \sum_{j=1}^{n} w_j b_j ,$$

With an associated weighing vector $W = (w_1,\ldots,w_n) \in I^n$ such that:

1. $\sum_{i=1}^{n} w_i = 1$
2. $b_j$ is the $j$-th largest of the $a_i$, i.e. for each $(a_1,\ldots,a_n) \in \mathbb{I}^n$ and the $a_i$ value of the OWA pair $\langle u_i,a_i \rangle$

2.4 GOWA operator

Definition 4: Let $I$ denote the closed interval $[0,1]$. A GOWA operator of dimension $n$, is a mapping
OWA salary by gender in México

$$M : \square^n \to \square$$

$$M(a_1, \ldots, a_n) = \left( \sum_{j=1}^{n} w_j b_j^\lambda \right) \frac{1}{\lambda}, \quad (8)$$

With an associated weighting vector

$$W = (w_i, \ldots, w_n) \in I^n$$

such that

1. $$\sum_{i=1}^{n} w_i = 1$$
2. $$b_j$$ is the j-th largest of the $$a_i$$
3. $$M(a_1, \ldots, a_n) = (W^TB^\lambda)^{1/\lambda}$$

With a parameter $$\lambda \in [0, 1]$$

3 METHOD

We will use the previous theory to first define the OWA Salary Operator, we will give an example of it, later we will prove 5 theorems:

1. Monotonic
2. Commutativity
3. Boundedness
4. Idempotency
5. No negativity

Families of the OWAS operator will be calculated after that, then the OWAWAS, IOWAS, GOWAS will be defined and their theorems (in their case).

OWA Salary by gender will be calculated step by step (6 in our case) and Mexico’s salary in order to find the prediction about salary gender, it is important to know that it is going to depend of the kind of data basis that we are going to check (ENIGH in ours).

4 RESULTS

Definition 5: Let $$I$$ denote the closed interval $$[0, 1]$$. An OWAS operator of dimension $$n$$, is a mapping

$$OWAS : \square^n \to \square$$

$$(s_1, \ldots, s_n) \mapsto \sum_{j=1}^{n} w_j b_j$$

With an associated weighing vector

$$W = (w_i, \ldots, w_n) \in I^n$$

such that

1. $$\sum_{i=1}^{n} w_i = 1$$
2. $$b_j$$ is the j-th largest of the $$s_i$$ and $$s$$ denote the salary
3. $$w_i \in [0, 1]$$

Example 1: Let the following collection of salary $$S = (20, 57, 45, 25)$$ and

$$W = (0.3, 0.5, 0.1, 0.1)$$

, calculating OWAS

$$\text{OWAS}(S) = (57 \times 0.3) + (45 \times 0.5) + (25 \times 0.1) + (20 \times 0.1) = 44.1$$

The characteristics of OWAS operator can see as follows:

Theorem 1, Monotonic: if $$s_i \geq d_i$$ for all $$i$$, then

$$\text{OWAS}(s_1, \ldots, s_n) \geq \text{OWAS}(d_1, \ldots, d_n)$$

Theorem 2, Commutativity: If we assume that $$\text{OWAS}$$ is a operator, then,

$$\text{OWAS}(s, d) = \text{OWAS}(d, s)$$

(11)

Theorem 3, Boundedness: Let $$f$$ be the $$\text{OWAS}$$ operator, then,

$$\min \left\{ |s_i - d_i| \right\} \leq f(s_1, \ldots, s_n) \leq \max \left\{ |s_i - d_i| \right\}$$

(12)