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The 1st Workshop on Environmental Science, Society, and Technology Journal of Physics: Conference Series 1363 (2019) 012073 IOP Publishing
doi:10.1088/1742-6596/1363/1/012073 1 HFLTS-TOPSIS With Pseudo-distance in Determining The Best Lecturers Dahlan Abdullah^{1*}, H Hartono², Kundharu Saddhono³, Nuning Kurniasih⁴, Akbar Iskandar⁵, Dian Rianita⁶, Purwarno⁷, Rianti Setyawasih⁸, Erwinsyah Satria⁹, Tato Nuryanto¹⁰, Lilik Herawati¹¹, Sujinah¹² and I Ketut Sudarsana¹³
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Abstract.

Decision making is sometimes faced with a situation where assessment is given in the form of linguistic variables, which have a certain range of values so that decision making cannot be given in the form of numerical values. One approach commonly used is Hesitant Fuzzy Linguistic Term Sets (HFLTS) which is a multi-criteria and multi-alternative decision making method.

In TOPSIS which has the concept of distance measurement, basically the chosen one is the best alternative is an alternative that has the closest distance to a positive solution and the farthest distance with a negative solution. The incorporation of HFLTS-TOPSIS has the advantage that decision making can be done in the form of variable linguistics and also a situation where there are benefit criteria and cost criteria.

This study will use the HFLTS-TOPSIS approach that has been modified in the distance calculation section so that distance calculation is based on the difference of preference degree between the two HFLTS. The results of research conducted by a number of researchers show that using pseudo-distance will provide advantages compared to the standard HFLTS-TOPSIS.

Pseudo-distance HFLTS-TOPSIS will be applied in the selection of the best lecturers. The criteria used in this study are: Student Satisfaction, Research, Number of late, and number of complaints from students. The 1st Workshop on Environmental Science, Society, and Technology Journal of Physics: Conference Series 1363 (2019) 012073 IOP Publishing doi:10.1088/1742-6596/1363/1/012073 2 1. Introduction Research on decision support systems has attracted widespread attention from a number of researchers.

[1] have used a knowledge-based system to support decision making on PPVC implementation. The application of decision support systems is also not uncommon in the industrial world, where one of them is in the field of production process planning. This has an impact on improving efficiency in the industrial world[2]. Application of decision-making is also not uncommon in other fields, one of which is medicine.

The rapidly growing field of medicine is expected to interact with other fields, one of which is the field of computer science with rapid development in the field of decision support systems. The application of decision support systems in the field of medicine is expected to improve the accuracy of diagnosis[3]. Problems that require a decision support system are often found in everyday life, not merely a complete problem.

Social problems also require decision support systems such as problems for the application of justice in the field of law. The existing system can help impose penalties to be more precise so as to avoid mistakes from judges in giving inappropriate verdicts[4]. To guarantee the accuracy of decisions made through a decision support system, it can be done by conducting a measurement process through an accurate benchmarking method to obtain a comprehensive picture of the success of the application of a decision support system that has been designed previously[5].

If the benchmarking results still show weaknesses, the existing system can be improved[6]. The benchmarking process can also be done to determine the level of efficiency of the application of decision support systems. If the decision support system to be implemented turns out to be inefficient, it must be considered about how much input is used and how much output is produced[7].

Inefficiency basically shows that the input needed is much greater than the output produced. If the application of a decision support system is not efficient it will bring unfavorable results. One method commonly used in decision making is the Fuzzy Linguistic Term Sets (HFLTS) Hesitant method.

This method can be used in decision making that contains elements of uncertainty and hesitant[8]. Another advantage of Fuzzy Linguistic Term Sets (HFLTS) is that decision making allows assessment to be given in the form of linguistic variables and does not require that ratings be given in the form of numerical values[9]. The integration of the Fuzzy method with the TOPSIS method has been carried out by a number of researchers.

One of them is research from Jha et al.[10]. In TOPSIS which has the concept of distance measurement, basically the chosen one is the best alternative is an alternative that has the closest distance to a positive solution and the farthest distance with a negative solution[11]. Ren et al.

has proposed a new approach from HFLTS-TOPSIS through a new definition of how to find a distance based on the preference degree between the two HFLTS[12]. HFLTS-TOPSIS With Pseudo-distance in this study will be used to determine the best lecturers. The criteria used in this study are: Student Satisfaction, Research, Number of late, and number of complaints from students. 2.

Related Works Liu and Rodriguez have used HFLTS in decision making involving multi criteria and multi alternatives, The research they did used the concept of fuzzy envelope[13]. A more detailed membership function determination is one of the keys to success in implementing HFLTS, one of which is by processing the existing partition function, which can be done using fuzzy grid partition so that the results obtained will be more satisfying and retrieval.

decisions will be more appropriate to avoid mistakes in the decision-making process[14]. The application of HFTLS-TOPSIS is intended to benefit from the assessment using variable linguistics in circumstances that contain doubts which are the

advantages of fuzzy hesitant and on the other hand can make decisions by using the benefit criteria and cost criteria which are the advantages of TOPSIS[15]. Pei et al.

also using a pseudo-distance calculation to determine relative closeness in the HFLTS-TOPSIS method and proven to be used in hesitant linguistic decision making[16]. The application of this pseudo-distance concept provides many conveniences including distance measurement to be more accurate because it is based on the preference degree obtained by each alternative so that it will base on the results of the assessment given by each decision maker using linguistic variables.

The 1st Workshop on Environmental Science, Society, and Technology Journal of Physics: Conference Series 1363 (2019) 012073 IOP Publishing doi:10.1088/1742-6596/1363/1/012073 3 3. Research Methodology The research methodology can be seen in figure 1. Figure 1. Research Methodology In Figure 1 it can be seen that the decision-making process with HFLTS TOPSIS begins with defining the existing alternatives and also determining the criteria that will be used as a basis for the assessment of each alternative. The process of determining alternatives and these criteria needs to be done well.

Existing criteria also need to be grouped into benefit criteria and also cost criteria so that they can be well determined by the results of the assessment of each alternative. After that, the decision maker involved in the research will be asked to provide an assessment. Assessment is given in the form of linguistic values which can involve several decision makers. Assessment results will be presented in the form of a decision matrix.

The next step is to form the positive-ideal separation matrix and negative-ideal separation matrix to then determine the distance to PIS and NIS for further ranking of each alternative based on relative closeness. 4. Result and Discussion 4.1. Hesitant Fuzzy Suppose that X is a reference set, a Fuzzy Hesitant Set on X is defined as a function of h that returns a subset of membership values $[0,1]$.

To facilitate our understanding, an HFS can be represented using equation 3. $h = \{ \langle \mu, h(\mu) \rangle \mid \mu \in X \}$ (1) Where $h(\mu)$ is a set of several membership values that have a value range of 0 to 1, which indicates the possible membership or set h (s) ita Fuzzy me (HFE) and H is a set of all HFE members.

For comparison of HFE, linguistic evaluation scale is used, which transforms linguistic variables into linguistic scales. To do that is used discrete set of linguistic scale as: $h = \{ \mu \mid \mu = -1, 0, 1, \dots \}$ (2) For example, a discrete set of linguistic scales

containing 7 (sen)mbes (= is aollow ?? = { ?? 0 = ?????? h ?? , ?? 1 = ?????? ?? , ?? 2 = ?? , ?? 3 = ?????? , ?? 4 = h The concept of fuzzy hesitant that uses linguistic variables is a concept that is generally more acceptable to humans, because basically humans give judgment rarely done using numerical values The 1st Workshop on Environmental Science, Society, and Technology Journal of Physics: Conference Series 1363 (2019) 012073 IOP Publishing doi:10.1088/1742-6596/1363/1/012073 4 and are more often done using linguistic values.

Linguistic values expressed in several scales provide clear guidelines for the decision maker to be able to state well the results of their observations of the values obtained for each alternative for each of the criteria that have been determined previously. 4.2. Hesitant Fuzzy Linguistic Term Sets (HFLTS) HFLTS is a method that is currently developing rapidly and is used by many parties in decision making because of its ability to overcome hesitancy and was first introduced by Rodriguez et al.[17]. In the HFLTS there are several steps taken, as follows[18]. 1.

Determine the upper bound $??$ for each alternative. $?? + (??) = \{?? + 1 (??), \dots, ?? + ?? (??)\}, ?? \{1, \dots, ??\}$ (3) 2. Determine the lower bound $?? -$ for each alternative. $?? - (??) = \{?? - 1 (??), \dots, ?? - ?? (??)\}, ?? \{1, \dots, ??\}$ (4) 3. Obtain minimum linguistic for upper bound $?? + (??) = \{?? + ?? (??)\} | ?? \{1, \dots, ??\}, ?? \{1, \dots, ??\}$ (5) 4.

Obtain maximum linguistic for lower bound $?? - (??) = \{?? - ?? (??)\} | ?? \{1, \dots, ??\}, ?? \{1, \dots, ??\}$ (6) 5. Determine the envelope of the HFLTS $?? (??) = [?? - , ?? +]$ 4.3. TOPSIS TOPSIS is a method for multi-criteria decision making that is used to determine solutions in the form of selecting the best alternative from a set of alternatives.

Standard TOPSIS is developed based on distance measurements[19]. The steps in using the TOPSIS method are as follows. 1. Build a normalized matrix $?? = (??) (7)$ 2. Determine the Positive Ideal Solution (PIS) and Negative Ideal Solution (NIS) $?? \{??\} \{??\} ? O ?? , m 1 = ?? = ?? \{??\} ? O c$, (8) $?? - = \{?? 1 - , ?? 2 - , \dots, ?? - \} = (m 1 = ?? = ?? \{??\} ? O ?? , m 1 = ?? = ?? \{??\} ? O c)$, (9) 3.

Calculate the distance of each alternatif from the PIS and NIS as follows. $?? + = v ?? ? ? . ? (?? - ?? +) 2 ?? = 1 , ?? = 1 , 2 , \dots , ?? (10) ?? - = ?? -) 2 ?? = 1 , ?? = 1 , 2 , \dots , ?? (11)$ 4. Calculate the relative closeness as follows. (12) 5. Rank alternative according to the relative closeness.

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doi:10.1088/1742-6596/1363/1/012073 5 4.4. HFLTS-TOPSIS with Pseudo-Distance The HFLTS-TOPSIS with Pseudo-Distance steps as follows. 1. Determining the alternative and criteria

2. Combining the opinion of decision maker with the following equation ??

$$d_{ij} = \frac{1}{n} \sum_{k=1}^n (m_{ijk} - m_{ik}) \quad (13) \quad (14) \quad 3.$$

Determining PIS and NIS (15) (16) Using Pseudo-distance to calculate the distance to PIS and NIS.

$$n1, C(c1) + ? + d(e_{nr}, C(c_r)) \quad (17) \quad n1, H(c1) + ? + d(e_{nr}, H(c_r)) \quad (18)$$

Where d_{ij} (??, ??) is the pseudo-distance between $d_{ij} = [d_{ij}^{(1)}, d_{ij}^{(2)}, \dots, d_{ij}^{(n)}]$ 5. Calculate The Relative Closeness. $CC_i = \frac{d_{ij}^{(1)} + d_{ij}^{(2)} + \dots + d_{ij}^{(n)}}{d_{ij}^{(1)} - d_{ij}^{(n)}} = 1, 2, \dots, n$ (19) 4.5.

HFLTS-TOPSIS with Pseudo-Distance for Determining The Best Lecturer For Example $A = \{a_1, a_2, a_3\}$ be a set of alternatives and $C = \{c_1, c_2, c_3, c_4\}$ be set of criteria: Student Satisfaction, Research, Number of late, and number of complaints from students. Three decision makers $M = \{m_1, m_2, m_3\}$ with weights $W = \{0.3, 0.4, 0.3\}$.

3} use linguistic terms $\{s_0 = \text{Very Low}, s_1 = \text{Low}, s_2 = \text{Medium}, s_3 = \text{High}, s_4 = \text{Very High}\}$. The assesment result will be showed in Table 1. Table 1. The Assesment Result by Decision Makers

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doi:10.1088/1742-6596/1363/1/012073 6 $\{s_3, s_4\} \{s_2, s_3, s_4\} \{s_3, s_4\} \{s_4, s_5\} \{s_1, s_2, s_3, s_4, s_5\}$

3) $\{s_4, s_5\} \{s_3, s_4\} \{s_4, s_5\} \{s_5, s_6\} \{s_2, s_3, s_4\} \{s_5, s_6\} \{s_3, s_4\} \{s_3, s_4\} \{s_3, s_4, s_5\} \{s_4, s_5\} \{s_3, s_4, s_5\} \{s_5, s_6\}$

6} Table 1 shows the assessments given by each assessor in the form of linguistic variables that have a range of values as stated in the HFLTS. Assessment is given for each criterion for each alternative.

Build a decision matrix that can be shown as follows $D_1 = ([s_5, s_6] [s_5, s_6] [s_4, s_6] [s_4, s_6] [s_4, s_6] [s_5, s_6] [s_5, s_6] [s_4, s_6] [s_4, s_6] [s_1, s_3] [s_4, s_6] [s_6, s_6])$ $D_2 = ([s_5, s_6] [s_4, s_5] [s_4, s_5] [s_3, s_5] [s_3, s_4] [s_2, s_4] [s_5, s_6] [s_3, s_5] [s_4, s_5] [s_2, s_3] [s_3, s_4] [s_4, s_5])$ $D_3 = ([s_4, s_5] [s_3, s_4] [s_3, s_4] [s_5, s_6] [s_3, s_5] [s_4, s_5] [s_4, s_5] [s_4, s_5] [s_5, s_6] [s_3, s_4] [s_3, s_4] [s_3, s_5] [s_5, s_6])$ The decision matrix formed is a summary of the assessment results that have been given by each assessor stated in Table 1.

The decision matrix shows the range of linguistic rating scales in the form of the lowest value and the largest value given. The existence of this range of values basically shows that the assessor is sometimes less sure to state an appraisal appropriately using one of the linguistic scales, and this is facilitated by the application of HFLTS which can provide a range of linguistic scoring scales.

Determining the positive ideal solution and negative ideal solution that can be seen in Table 2. Table 2. Positive and Negative Ideal Solution

4) $z_1 = [0.5, 0.6]$, $z_2 = [0.4, 0.5]$, $z_3 = [0.5, 0.6]$, $z_4 = [0.4, 0.5]$, $z_5 = [0.3, 0.4]$, $z_6 = [0.2, 0.4]$, $z_7 = [0.3, 0.4]$, $z_8 = [0.2, 0.3]$, $z_9 = [0.3, 0.4]$, $z_{10} = [0.4, 0.5]$, $z_{11} = [0.5, 0.6]$, $z_{12} = [0.5, 0.6]$, $z_{13} = [0.3, 0.4]$, $z_{14} = [0.3, 0.4]$, $z_{15} = [0.5, 0.6]$, $z_{16} = [0.5, 0.6]$, $z_{17} = [0.3, 0.5]$, $z_{18} = [0.3, 0.5]$, $z_{19} = [0.3, 0.5]$, $z_{20} = [0.2, 0.3]$

Agregating the result of z_1 , z_2 , and z_3 that can be shown as follows.

D= The 1st Workshop on Environmental Science, Society, and Technology Journal of Physics: Conference Series 1363 (2019) 012073 IOP Publishing
doi:10.1088/1742-6596/1363/1/012073 7 The aggregating process is carried out based on the determination of the pre-existing weights, where the decision maker 1 has a weight of 0.3, the decision maker 2 has a weight of 0.4, and the decision maker 3 has a weight of 0.3.

Then the existing weight will be multiplied by the value that has been given by each decision maker in giving an assessment of each alternative for each existing criterion. Calculating pseudo-distance for positive-ideal separation matrix d_1^+ and negative-ideal separation matrix d_1^-

$$d_1^+ = (0.3 \times (0.5, 0.6), (0.5, 0.6)) + 0.4 \times (0.4, 0.5), (0.5, 0.6) + 0.3 \times (0.5, 0.6), (0.5, 0.6) + 0.3 \times (0.4, 0.5), (0.5, 0.6) + 0.3 \times (0.3, 0.4), (0.5, 0.6) + 0.3 \times (0.2, 0.4), (0.5, 0.6) + 0.3 \times (0.3, 0.4), (0.5, 0.6) + 0.3 \times (0.2, 0.3), (0.5, 0.6) + 0.3 \times (0.3, 0.4), (0.5, 0.6) + 0.3 \times (0.4, 0.5), (0.5, 0.6) + 0.3 \times (0.5, 0.6), (0.5, 0.6) + 0.3 \times (0.3, 0.5), (0.5, 0.6) + 0.3 \times (0.3, 0.5), (0.5, 0.6) + 0.3 \times (0.3, 0.5), (0.5, 0.6) + 0.3 \times (0.2, 0.3), (0.5, 0.6) = (0.672, 1)$$

5) It can be seen that for a positive ideal solution, the best results are given by alternative z_1 because having the closest distance with positive ideal solution, then followed by z_3 , and then z_2 . However, this does not mean we can easily state that alternative z_1 is the best, because there are other aspects that need to be considered,

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