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**A L U A N
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Dr. Zati Aqmar Zaharudin

Thank You!

for being with us,

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for all the dedications and

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Contents

THE APPLICATION OF INTUITIONISTIC FUZZY ANALYTIC HIERARCHY PROCESS (IFAHP) IN SOLVING PERSONNEL SELECTION PROBLEM

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1. Introduction

Skilled and knowledgeable personnel is the best asset to a company since they play a role in ensuring the business's success. Selecting the best personnel for a particular job position is a crucial process and this decision-making process is part of the Multi-Criteria Decision Making (MCDM) problems since this process involves multiple criteria that are often in conflict. Generally, an interview process is conducted to determine and assess if the candidates have what it takes to fulfil the job's scope. However, in this study, an MCDM method is used to solve the problem. Hence, the decision-makers (DMs) will not depend solely on the traditional method to choose the new personnel.

In the study, the Intuitionistic Fuzzy Analytic Hierarchy Process (IFAHP) method is used to solve the personnel selection problem. IFAHP method is an extension of the Analytic Hierarchy Process (AHP) and Fuzzy Analytic Hierarchy Process (FAHP) methods. The AHP method is one of the popular MCDM methods and is known for its simplicity. However, the AHP method is often criticised for its inability to handle the uncertainty and vagueness of human judgment (Xu and Liao, 2013). Hence, the FAHP method is introduced to overcome the shortcomings of the AHP method. FAHP method is a combination of Fuzzy set (FS) theory and AHP method. Zadeh (1965) introduced the FS theory to deal with the vagueness of human judgment based on a degree of membership. FS theory resembles human reasoning in its use to approximate information and to deal with uncertainty while making decisions (Kahraman et al., 2004). The FS theory is then extended to the Intuitionistic fuzzy set (IFS) theory introduced by Atanassov (1986). The IFS theory is characterised by a membership function, a non-membership function, and a hesitation function. In IFSs, it is possible to model unknown information while taking advantage of the degree of hesitation and the hesitancy degree of DMs considered when they cannot easily express their preference for an alternative (Vafadarnikjoo et al., 2015). The traditional AHP and FAHP methods are extended to the Intuitionistic fuzzy environment to develop the IFAHP method. In addition, the IFAHP method can handle the ambiguity of expert opinions and increase the accuracy of the assessment (Yu et al., 2018) and provides a more accurate representation of the decision-making process, giving a significant advantage over AHP and FAHP methods (Xu and Liao, 2013).

To conclude, this study emphasizes the application of the IFAHP method to solve the personnel selection problem since the IFAHP method can handle the hesitancy, ambiguity, and intuition judgments made by DMs.

2. Methodology

Below show the steps in implementing the IFAHP method (Abdullah and Najib, 2016).

Step 1: Perform the data scaling based on the scale of the Intuitionistic fuzzy (IF) judgment shown in Table 1 and then form the pairwise comparison matrix based on the data.

Step 2: Identify the weights of DMs. The importance of the DMs is considered as linguistic variables and these linguistic variables are adapted from Boran et al. (2009). Table 2 shows

Table 1: Linguistic variables for pairwise comparison

AHP Linguistic Variables	AHP Preference Number	TIFNs	Reciprocal TIFNs
Equally important (E)	1	(0.02, 0.18, 0.80)	(0.18, 0.02, 0.80)
Moderately more important (WMI)	3	(0.13, 0.27, 0.60)	(0.27, 0.13, 0.60)
Strongly more important (SMI)	5	(0.33, 0.27, 0.40)	(0.27, 0.33, 0.40)
Very strong more important (VSMI)	7	(0.62, 0.18, 0.20)	(0.18, 0.62, 0.20)
Extreme/absolute more important (AMI)	9	(1.0, 0, 0)	(0, 1.0, 0)

Table 2: Linguistic variables for the importance of decision makers

Linguistic Variables	TIFNs
Very important	(0.90, 0.05, 0.05)
Important	(0.75, 0.20, 0.05)
Medium	(0.50, 0.40, 0.10)
Unimportance	(0.25, 0.60, 0.15)
Very unimportance	(0.10, 0.80, 0.10)

the defined Triangular Intuitionistic Fuzzy Numbers (TIFNs) for the linguistic variables. Next, consider an Intuitionistic fuzzy number to rate the kth decision-maker, $\lambda_k = (\mu_k, v_k, \pi_k)$ where $w_\lambda \in [0, 1]$ and $\sum_{\lambda=1}^{n} w_\lambda = 1$. The weights of the kth decision-maker is obtained by using:

$$\lambda_k = \frac{\left(\mu_k + \pi_k \left(\frac{\mu_k}{\mu_k + v_k}\right)\right)}{\sum_{k=1}^{t} \left(\mu_k + \pi_k \left(\frac{\mu_k}{\mu_k + v_k}\right)\right)} \tag{1}$$

Step 3: Form the aggregated IF judgment matrix based on the DMs. Let $R^{(k)} = (R_{ij}^{(k)})_{m \times n}$ be the IF decision matrix of kth decision maker, $\lambda = \{\lambda_1, \lambda_2, ..., \lambda_n\}$ be the weights of all the DMs and $\sum_{k=1}^{t} \lambda = 1 \in [0, 1]$. The aggregated fuzzy judgment matrix is obtained by using the Intuitionistic Fuzzy Weighted Averaging (*IFWA*) operator proposed by Xu (2007) as shown below:

$$r_{ij} = IFWA_\lambda \left(r_{ij}^{(1)}, r_{ij}^{(2)}, ..., r_{ij}^{(t)}\right) = \lambda_1 r_{ij}^{(1)} \oplus \lambda_2 r_{ij}^{(2)} \oplus ... \oplus \lambda_t r_{ij}^{(t)}$$

$$= \left(1 - \prod_{k=1}^{t} \left(1 - \mu_{ij}^{(k)}\right)^{\lambda_k}, \prod_{k=1}^{t} \left(v_{ij}^{(k)}\right)^{\lambda_k}, \prod_{k=1}^{t} \left(1 - \mu_{ij}^{(k)}\right)^{\lambda_k} - \prod_{k=1}^{t} \left(v_{ij}^{(k)}\right)^{\lambda_k}\right) \tag{2}$$

where $r_{ij} = (\mu_{ij}, v_{ij}, \pi_{ij}), \mu_{ij} = 1 - \prod_{k=1}^{t} \left(1 - \mu_{ij}^{(k)}\right)^{\lambda_k}, v_{ij} = \prod_{k=1}^{t} \left(v_{ij}^{(k)}\right)^{\lambda_k},$

$\pi_{ij} = \prod_{k=1}^{t} \left(1 - \mu_{ij}^{(k)}\right)^{\lambda_k} - \prod_{k=1}^{t} \left(v_{ij}^{(k)}\right)^{\lambda_k} i \in M, j \in N.$

Step 4: Compute the Consistency Ratio (*CR*) of the aggregated IF judgment matrix by using:

$$CR = \frac{CI}{RI} < 0.1 \tag{3}$$

where *CI*, the consistency index is $\dfrac{\lambda_{max} - n}{n - 1}$, $\lambda_{max} - n$ is the average value of the hesitation value ($\pi(x)$) of the aggregated IF matrix of each criterion and alternative, n is the size of the matrix and *RI* is the random index.

Step 5: Compute the IF weight of the aggregated IF judgment matrix. The IF entropy adapted from Vlachos and Sergiadis (2007) is applied to obtain the weight aggregated of IF matrix. The IF entropy of each aggregated of each row of IF matrix is given by:

$$\overline{\overline{w}}_i = -\frac{1}{nln2}(\mu_i ln\mu_i + v_i lnv_i - (1 - \pi_i)ln(1 - \pi_i) - \pi_i ln2) \tag{4}$$

If $\mu_i = 0, v_i = 0, \pi_i = 1$ then $\mu_i ln\mu_i = 0$, $v_i lnv_i = 0$, $(1 - \pi_i)ln(1 - \pi_i) = 0$ and if $\mu_i = 1, v_i = 0, \pi_i = 0$, then $\mu_i ln\mu_i = 0$, $v_i lnv_i = 0$, $(1 - \pi_i)ln(1 - \pi_i) = 0$, respectively. Thus, the final entropy weights of each IF matrix is given by:

$$w_i = \frac{1 - \overline{\overline{w}}_i}{n - \displaystyle\sum_{j=1}^{n} \overline{\overline{w}}_i} \tag{5}$$

where $\displaystyle\sum_{j=1}^{n} w_i = 1$.

Step 6: Compute the relative weight and rank the alternatives by using:

$$W_i = \sum w_i A_{ij} \tag{6}$$

where W_i is the overall relative rating for alternative i, w_i is the average normalized weight for criteria j and A_{ij} is the average normalized weight aggregated matrix for criteria j with respect to alternative i.

3. Result and Discussion

In this study, the IFAHP method is used to solve the personnel selection problem in an electrical service company. The company wanted to choose the best candidate for the senior technician position. There was one (1) decision-maker, six (6) considered criteria, and seven (7) possible candidates involved in the selection process. The findings as depicted in Table 3 and Table 4 shows that the ranking order for the criteria is given by $C_4 > C_6 > C_1 > C_2 > C_5 > C_3$ and the ranking order for the alternatives is given by $A_6 > A_7 > A_4 > A_1 > A_5 > A_3 > A_2$. The decision-maker considered problem-solving skills (C_4) and work experience (C_6) to be the most important criteria, and management skill (C_5) and communication skill (C_3) to be the least important criteria in choosing the new personnel. Meanwhile, candidate A_6 is chosen as the best candidate for the position based on the listed criteria.

Table 3: Final ranking for each criterion

C_n	Criterion	Final entropy weights	Ranking
C_1	Education level	0.1683	3
C_2	Profiling	0.1674	4
C_3	Communication skill	0.1623	6
C_4	Problem-solving skills	0.1694	1
C_5	Management skill	0.1639	5
C_6	Work Experince	0.1687	2

Table 4: Final ranking for each alternative

A_i	Final entropy weights	Ranking
A_1	0.1430	4
A_2	0.1418	7
A_3	0.1422	6
A_4	0.1432	3
A_5	0.1424	5
A_6	0.1440	1
A_7	0.1435	2

4. Conclusion

The IFAHP method is successful to rank and select the best candidates for the senior technician position in an electrical service company. The IFAHP method is implemented to solve the personnel selection problem since the IFAHP method can handle the hesitancy, ambiguity, and intuition judgments made by DMs. This study can be extended to incorporate the Interval-Valued Intuitionistic Fuzzy (IVIF) sets with the AHP method to develop the Interval-Valued Intuitionistic Fuzzy Analytic Hierarchy Process (IVIFAHP) method. The IVIF sets are one step ahead of IF sets since they are effective in handling uncertainty by considering membership and non-membership functions in an interval and have the advantage of modeling and solving more complex problems (Büyüközkan et al., 2020). Thus, integrated IVIF sets with the AHP method can be proposed to solve any complex MCDM problems including personnel selection problems.

References

Abdullah, L. and Najib, L. (2016). Sustainable energy planning decision using the intuitionistic fuzzy analytic hierarchy process: choosing energy technology in malaysia. *International Journal of Sustainable Energy*, 35(4):360–377.

Atanassov, K. T. (1986). Intuitionistic fuzzy sets. *Fuzzy Sets and Systems*, 20(1):87–96.

Boran, F. E., Genç, S., Kurt, M., and Akay, D. (2009). A multi-criteria intuitionistic fuzzy group decision making for supplier selection with topsis method. *Expert systems with applications*, 36(8):11363–11368.

Büyüközkan, G., Havle, C. A., and Feyzioğlu, O. (2020). A new digital service quality model and its strategic analysis in aviation industry using interval-valued intuitionistic fuzzy ahp. *Journal of Air Transport Management*, 86:101817.

Kahraman, C., Cebeci, U., and Ruan, D. (2004). Multi-attribute comparison of catering service companies using fuzzy ahp: The case of turkey. *International journal of production economics*, 87(2):171–184.

Vafadarnikjoo, A., Mobin, M., Allahi, S., and Rastegari, A. (2015). A hybrid approach of intuitionistic fuzzy set theory and dematel method to prioritize selection criteria of bank branches locations. In *Proceedings of the International Annual Conference of the American Society for Engineering Management.*, page 1. American Society for Engineering Management (ASEM).

Vlachos, I. K. and Sergiadis, G. D. (2007). Intuitionistic fuzzy information–applications to pattern recognition. *Pattern Recognition Letters*, 28(2):197–206.

Xu, Z. (2007). Intuitionistic fuzzy aggregation operators. *IEEE Transactions on fuzzy systems*, 15(6):1179–1187.

Xu, Z. and Liao, H. (2013). Intuitionistic fuzzy analytic hierarchy process. *IEEE transactions on fuzzy systems*, 22(4):749–761.

Yu, Y., Darko, A., Chan, A. P., Chen, C., and Bao, F. (2018). Evaluation and ranking of risk factors in transnational public–private partnerships projects: case study based on the intuitionistic fuzzy analytic hierarchy process. *Journal of Infrastructure Systems*, 24(4):04018028.

Zadeh, L. A. (1965). Fuzzy sets. *Information and control*, 8(3):338–353.

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