The Assessment Model to Rank Applicants for Research and Development Job Position in PT ABC

Janice Santoso, Evy Herowati and Joniarto Parung
Industrial Engineering
Faculty of Engineering
University of Surabaya, Indonesia
evy@staff.ubaya.ac.id

Abstract

Staff turnover has a negative impact on an organization's progress and development. Unfortunately, companies commonly experience difficulty replacing departing employees with qualified applicants that fit their job specifications. Staff turnover is influenced by the recruitment and selection process, and effective recruitment and selection reduce employee turnover, which boosts an organization's profitability. Therefore, organizations must consider getting competent people that fit the company's job specifications from the beginning of the recruitment process, demonstrating the importance of a well-organized and methodical hiring process. This article presents an assessment model to rank the applicants for research and development job positions in a company. The methods used in this model are the Fuzzy Analytical Hierarchy Process (F-AHP), Alfares' weighting method, and Fuzzy Technique for Order Preference by Similarity to Ideal Solution (F-TOPSIS). The selection criteria for research and development job positions were classified into subjective, objective, and absolute factors and customized for PT ABC. The expert provided his judgments on the importance of the criteria in fuzzy pairwise comparisons, and the criterion weights were determined using F-AHP. The objective criteria weights were: education 0.039, working experience 0.083, analysis ability 0.274, research ability 0.290, and planning ability 0.312. At the same time, the subjective criteria weights were: interpersonal skills 0.267, software mastery 0.229, problem-solving ability 0.212, English fluency 0.053, and the weight of project management ability 0.239. The Alfares method will be used to weigh the sub-criteria. The criteria/sub-criteria and their weights will be used in the assessment model for ranking the candidates in the research and development job to rank potential applicants using the F-TOPSIS method.

Keywords
Applicants' Ranking, Fuzzy-AHP, Fuzzy-TOPSIS, Research and Development Alfares Weighting.

1. Introduction
Employee turnover is the shifting of workers throughout the labor market between enterprises, occupations, and states of employment and unemployment (Al-Suraihi et al. 2021). Staff turnover has a substantial impact on an organization since it can have a negative effect on its productivity, sustainability, competitiveness, and profitability (Girish 2011). In addition, staff turnover is costly from an organization's perspective due to the replacement costs for new employees. For employees to be replaced productively, the firm must recruit and train new employees (Kessler 2021). Turnover can negatively impact the organization's remaining employees since they must divide their time between training new employees and executing their regular duties, resulting in lower efficiency and productivity (Saraih et al. 2016). In addition, customers will be served by new personnel who are less knowledgeable and have less expertise than their predecessors and are consequently less understanding of the organization's and customers' goals (Holtom and Burch 2016). Appropriate recruitment and selection processes influence employee attrition, which boosts a firm's profitability (Hossain et al. 2015). Therefore, businesses must think about how to find qualified people who match their job requirements from the start of the recruitment process, highlighting the significance of a well-organized and methodical hiring process.

Since there are so many different areas of expertise, companies must define the proper selection criteria for each field of work, including Research and Development (R&D). R&D is a crucial component of a company's success, especially in light of the considerable changes in the competitive environment since the 1990s (Chiesa et al. 2009). R&D is significant for a company to improve the quality of its products and to support the management staff of the organization on how to respond to a fast-paced work environment (Chigozie and Chijioke 2015), and it has been demonstrated from a macro viewpoint that a country's R&D budget size can raise its global competitiveness index, world competitiveness index, and global innovations index (Sofrankova et al. 2018). Due to the importance of R&D, employees in these fields should be carefully selected to minimize the risk of hiring incompetent staff members. which leads to high turnover rates.

A mismatch in the employees' competencies is one reason businesses hire less dependable employees and increase the employees' turnover rate. Numerous studies have examined competency mismatches from a variety of perspectives, including those of job-seekers, employees, and employers as well as the impact of mismatches on employees' pay (Van der Velden and Bijlsma 2019) and employee self-evaluation (Pellizzari and Fichen 2017). In addition, this self-evaluation mismatch has been studied in a variety of professional domains, such as banking services (Setiawan et al. 2021), quality control in production and manufacturing (Herowati et al. 2021), as well as research and development (Ronyastra et al. 2021). All of these studies measured how companies were chosen by job-seekers. However, this measurement tool is also required from the employer's point of view when selecting dependable personnel through an organized and methodical hiring process. From the perspective of employers, a multi-criteria assessment model is needed to determine the ranking of candidates and the weights of the criteria used.

This paper presents, from the company's perspective, a multi-criteria assessment model for ranking the applicants for R&D job positions in a manufacturing company. The Fuzzy Analytical Hierarchy Process (F-AHP), Alfares' weighting method, and Fuzzy Technique for Order Preference by Similarity to Ideal Solution (F-TOPSIS) were utilized to assess prospective employees. F-AHP was first used to determine the weights of the criteria. The experts evaluated the significance of the criteria in pairwise comparisons, and the weights for the criteria were eventually determined. Then, the Alfares method is used to weigh the sub-criteria. Finally, the criteria/sub-criteria and their weights will be used in the assessment model to rank the prospective applicants for R&D positions at company ABC using the F-TOPSIS method.

This paper is organized as follows: after presenting the literature review, the next section discusses the research methodology. Then, we present the result and discussion and conclude this paper in the last section.

1.1 Objectives

A multi-criteria assessment model for ranking applicants for R&D job positions in a manufacturing company is the objective of this study, which focuses on selecting the best applicant from the company's perspective. In this study, alternative applicants were ranked using the F-TOPSIS and F-AHP methods, respectively.
This assessment model was created to facilitate the company's R&D job applicant selection.

2. Literature Review

In this study, a number of key concepts were utilized. F-AHP was used to weigh the main criteria, the Alfares method was used to weigh the sub-criteria, and F-TOPSIS was used to rank the applicants.

2.1 The Fuzzy Analytical Hierarchy Process (F-AHP)

Thomas L. Saaty created the Analytical Hierarchy Process, or AHP, a method for MCDM (Multi-Criteria Decision-Making) (Saaty and Vargas 2012). Using the AHP, a complicated multi-criteria problem will be stated in a hierarchy. The AHP hierarchy is structured in a multi-level format, with the objective as the first level, the criteria occupying the second level, and the alternatives occupying the third level**.** The AHP is further enhanced into the Fuzzy Analytical Hierarchy Process (F-AHP) to address uncertainty issues (Coffey and Claudio 2021). The application of fuzzy AHP can be carried out in the following stages (Büyüközkan et al. 2008):

1. Calculate fuzzy synthetic values, which are defined as Equation (1):

$$Si = \sum_{j=1}^{m} M_{gi}^{j}\left[\sum_{i=1}^{n}\sum_{j=1}^{m} M_{gi}^{j}\right]^{-1} \tag{1}$$

where $\sum_{j=1}^{m} M_{gi}^{j}$ is defined as in Equation (2):

$$\sum_{j=1}^{m} M_{gi}^{j} = \left(\sum_{j=1}^{m} l_j, \sum_{j=1}^{m} m_j, \sum_{j=1}^{m} u_j\right) \tag{2}$$

To get $\left[\sum_{i=1}^{n}, \sum_{j=1}^{m}, m_{g}^{j},\right]^{-1}$, perform the fuzzy summing using the values of M_{gi}^{j} $(j = 1,2 \ldots, m)$ as in Equation (3)

$$\sum_{i=1}^{n}\sum_{j=1}^{m} M_{gi}^{j} = \left(\sum_{i=1}^{n} l_i, \sum_{i=1}^{n} m_i, \sum_{i=1}^{n} u_i\right) \tag{3}$$

Then conduct the vector inverse as in Equation (4)

$$\left[\sum_{i=1}^{n}\sum_{j=1}^{m} M_{gi}^{j}\right]^{-1} = \left(\frac{1}{\sum_{i=1}^{n} u_i}, \frac{1}{\sum_{i=1}^{n} m_i}, \frac{1}{\sum_{i=1}^{n} l_i}\right) \tag{4}$$

2. Calculate the *degree of possibility* of fuzzy number $M_2 \geq M_1$:

$$V(M_2 \geq M_1) = \sup_{y \geq x} \left[\min\left(\mu M_1(x), \mu M_2(y)\right)\right] \tag{5}$$

Define the triangular fuzzy number $M_1 = (l_1, m_1, u_1)$, $M_2 = (l_2, m_2, u_2)$, then:

$$V(M_2 \geq M_1 = hgt(M_1 \cap M_2 = \begin{cases} 1, & m_2 \geq m_1 \\ 0, & l_1 \geq u_2 \\ \frac{l_1 - u_2}{(m_2 - u_2) - (m_1 - l_1)}, & otherwise \end{cases} \tag{6}$$

3. Calculate the degree of possibility for a fuzzy number greater than k fuzzy numbers M_i (i = 1, 2,…, k), which can be defined as Equation (7):

$$V(M \geq M_1, M_2, \ldots, M_k) = V[(M \geq M_1) \text{ and } M \geq M_2 \text{ and } \ldots \text{ and } (M \geq M_k)]$$
$$= \min V(M \geq M_i),\ I = 1, 2, 3, \ldots, k \tag{7}$$

and we get the weight vector as Equation (8):

$$W' = (d'(A_1), d(A_2), \ldots, d'(A_n))^T \tag{8}$$

where A_i *(i* = 1,2, …, *n)* are elements of *n.*

4. Normalize the vector weights as in Equation (9):

$$W = (d(A_1), d(A_2), \ldots, d(A_n))^T \tag{9}$$

W is not a fuzzy number.

2.2 Alfares Weighting Method

The Alfares weighting method was used to obtain the weights for the sub-criteria in the form of a ranking score (Alfares and Duffua 2008), which is depicted in (10) and (11). Then, the values were normalized to produce the weights for the sub-criteria:

$$v_{i,j} = 100 - S_n(r_{i,j} - 1) \tag{10}$$

$$S_n = 3.19514 + \frac{37.75756}{n} \tag{11}$$

where:

$v_{i,j}$: The weights of criteria-*j* assessed by expert-*i* with ranking $r_{i,j}$

S_n : The criteria weight reduction slope for n criteria

n : The number of criteria (maximum 21)

2.3 Fuzzy Technique for Order Preference by Similarity to Ideal Solution (F-TOPSIS)

The F-TOPSIS approach for addressing MCDM problems is based on the concept that the selected alternative must have the shortest distance to the positive ideal solution and the farthest distance to the negative ideal solution (Coffey and Claudio 2021).

The steps in using the F-TOPSIS method for the alternative ranking process are as follows:

1. Choose the proper triangular fuzzy number (TFN $\tilde{x}_{ij} = (a_{ij}, b_{ij}, c_{ij})$) representation of linguistic variables for the importance weight of each criterion, as stated in Table 1.
2. Build the fuzzy decision matrix and the normalized fuzzy decision matrix ($\tilde{R}$) as in Equations (12–14).

$$\tilde{R} = \left[\tilde{r}_{ij}\right]_{m\,x\,n} \tag{12}$$

$$\tilde{r}_{ij} = \left(\frac{a_{ij}}{c_j^*}, \frac{b_{ij}}{c_j^*}, \frac{c_{ij}}{c_j^*}\right) \tag{13}$$

$$c_j^* = \max_i C_{ij} \tag{14}$$

3. Build the weighted normalized fuzzy decision matrix as in Equations (15–17).

$$\tilde{V} = \left[\tilde{v}_{ij}\right]_{m\,x\,n} \tag{15}$$

$$\tilde{v}_{ij} = \tilde{r}_{ij} \times w_j \quad (16)$$

$$W = \{w_{j:}\ j = 1, 2, \ldots n\} \quad (17)$$

4. Define the fuzzy positive ideal solution (FPIS A^*) and fuzzy negative ideal solution (FNIS A^-) as in Equations (18–19):

$$\text{FPIS } A^* = \tilde{v}^*{}_1, \tilde{v}^*{}_2, \ldots, \tilde{v}^*{}_n \quad (18)$$

$$\text{FPIS } A^- = \tilde{v}^-{}_1, \tilde{v}^-{}_2, \ldots, \tilde{v}^-{}_n \quad (19)$$

where $\tilde{v}^*{}_j = w_j \otimes (1, 1, 1)$ and $\tilde{v}^-{}_j = w_j \otimes (0, 0, 0)$, for $j = 1, 2, \ldots, n$

5. Determine the distance ($d^*{}_i$) from the FPIS to each alternative and the distance ($d^-{}_i$) from the FNIS as in Equation (20).

$$d^*{}_i = \sum_{i=1}^{n} d(\tilde{v}^*{}_j, \tilde{v}_{ij}) \text{ and } d^-{}_i = \sum_{i=1}^{n} d(\tilde{v}_{ij}, \tilde{v}^-{}_j) \quad \text{for all } i = 1, 2, \ldots, \text{m} \quad (20)$$

Determine the closeness coefficient (CC) for each alternative as in Equation (21).

$$CC_i = \frac{d^-{}_i}{d^*{}_i + d^-{}_i} \quad \text{for all } i = 1, 2, \ldots, \text{m} \quad (21)$$

6. According to the CC, determine the ranking order of all alternatives.

3. Methods

Figure 1. illustrated the method overview to develop the multi-criteria assessment model from the company's perspective to determine the qualifications of prospective applicants for R&D in manufacturing, described in the following steps.

1. Identify the selection criteria for selecting R&D applicants based on previous research conducted for the same position, and adjust the initial criterion with company ABC's criteria;
2. Use pairwise comparisons to elicit the expert's preference in criteria resulting from step 1 in determining the criteria weights by using the F-AHP method;
3. Determine the sub-criteria weights using the Alfares weighting method and conversion of linguistic variables for criteria weights;
4. Construct the multi-criteria assessment model that will be fulfilled by the company's expert for prospective applicants, and then use F-TOPSIS to rank the prospects;
5. Apply the assessment model to rank the prospective applicants.

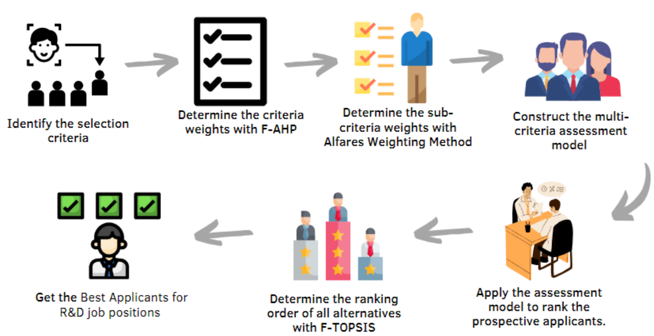

Figure 1. Method Overview

4. Data Collection

4.1 Criteria Identification

The criteria for evaluating prospective workers in the R&D field were generated from previous research (Ronyastra et al. 2021) and adjusted to the R&D conditions at PT ABC, as listed in Table 1. As seen in this table, we categorized the criteria into three groups: objective, subjective, and absolute. A criterion is objective if it can be independently verified. With objective criteria, different individuals measuring a particular applicant will reach the same conclusions. Subjective criteria have to be used with judgment. Therefore, people can differ in their opinion on whether a particular applicant possesses and meets such a criterion. An absolute criterion is a criterion that an applicant must meet. If an applicant does not meet a particular absolute criterion, she or he will get a zero score.

Table 1. The assessment criteria for R&D PT ABC

Objective criteria	Subjective criteria	Absolute criteria
Education	Interpersonal skills	Willingness to be placed anywhere
Working experience	Software mastery	Mastery of 2D and 3D design
Analysis ability	Problem solving ability	Basic material & material costing mastery
Research ability	English fluency	
Planning ability	Project management ability	

4.2 Criteria Weights Determination

An expert who works as a professional in R&D for PT ABC assessed the resulting criteria's level of importance using fuzzy pairwise comparisons to elicit the expert's preferred criteria resulting from step 2 in determining the criteria weights by using the F-AHP method.

The consistency test demonstrated that the degree of significance of the data was consistent with the consistency ratio of the subjective criterion, which was 0.074, and that of the objective criteria was 0.018, which was still below the 0.1 threshold value. The F-AHP method was used to determine the weight of the criteria by using the fuzzy conversion score in Table 2, and the criteria weights are shown in Table 3. The company also sets absolute criteria that must be met by prospective applicants, namely being willing to be placed anywhere, having 2D and 3D design experience, understanding basic material engineering knowledge, and being able to calculate material costs.

Table 2. Fuzzy conversion scale

Linguistic scale	Triangular fuzzy scale	Triangular fuzzy reciprocal scale
Equally strong	(1, 1, 1)	(1, 1, 1)
Moderately strong	(2, 3, 4)	(1/4, 1/3, 1/2)
Strong	(4, 5, 6)	(1/6, 1/5, 1/4)
Very strong	(6, 7, 8)	(1/8, 1/7, 1/6)
Extremely strong	(9, 9, 9)	(1/9, 1/9, 1/9)

Table 3. Criteria weights for PT.ABC

Objective criterion	Criterion weight	Subjective criterion	Criterion weight
Education	0.039	Interpersonal skills	0.267
Working experience	0.083	Software mastery	0.229
Analysis ability	0.274	Problem solving ability	0.212
Research ability	0.290	English fluency	0.053
Planning ability	0.312	Project management ability	0.239

Table 4. Linguistic variables for the importance weight of each criterion

Linguistic variable	Fuzzy weights
Very low (VL)	(0, 0, 0.1)
Low (L)	(0, 0.1, 0.3)
Medium low (ML)	(0.1, 0.3, 0.5)
Medium (M)	(0.3, 0.5, 0.7)
Medium high (MH)	(0.5, 0.7, 0.9)
High (H)	(0.7, 0.9, 1)
Very high (VH)	(0.9, 1, 1)

The company user then confirmed the weight of the criteria found by the F-AHP method. The linguistic variables and triangular fuzzy numbers shown in Table 4 were then given for each criterion. The user-confirmed weights for the objective and subjective criteria are shown in Tables 5 and 6, respectively.

Table 5. Confirmed weights for objective criteria

F-AHP		**F-TOPSIS user's confirmation**	
Objective criterion	**Criterion weight**	**Linguistic variable**	**Fuzzy weight**
Education	0.039	Medium low	(0.1, 0.3, 0.5)
Working experience	0.083	Medium high	(0.5, 0.7, 0.9)
Analysis ability	0.274	High	(0.7, 0.9, 1.0)
Research ability	0.290	High	(0.7, 0.9, 1.0)
Planning ability	0.312	Very high	(0.7, 1.0, 1.0)

Table 6. Confirmed weights for subjective criteria

F-AHP		**F-TOPSIS user's confirmation**	
Subjective criterion	**Criterion weight**	**Linguistic variable**	**Fuzzy weight**
Interpersonal skills	0.039	Very high	(0.7, 1.0, 1.0)
Software mastery	0.083	Medium high	(0.5, 0.7, 0.9)
Problem solving ability	0.274	Medium	(0.3, 0.5, 0.7)
English fluency	0.290	Medium low	(0.1, 0.3, 0.5)
Project management ability	0.312	High	(0.7, 0.9, 1.0)

Table 7. Objective sub-criteria, ranks and weights

No	**Criterion, fuzzy weight**	**Objective sub-criterion**	**Criterion category**	**Rank, local weight**	**Global weight**
1	Education, (0.1, 0.3, 0.5)		Industrial Eng.–S1 Chemical Eng.–S1 Mechanical Eng.–S1 Other Engineering–S1 Non-engineering–S1	1, 100 %	(0.100, 0.300, 0.500)
2.	Teamwork experience, (0.5, 0.7, 0.9)		Yes, No	1, 100%	(0.500, 0.700, 0.900)
3.	Analysis ability (0.7, 0.9, 1)	Production Planning & Control score	A, AB, B, BC, C	4, 19.15%	(0,134, 0.172, 0.192)
		Marketing Management score	A, AB, B, BC, C	1, 30.85%	(0.216, 0.278, 0.308)
		Quality Management System score	A, AB, B, BC, C	2, 26.95%	(0.189, 0.243, 0.269)
		Engineering Economy score	A, AB, B, BC, C	3, 23.05%	(0.161, 0.207, 0.231)
4.	Research ability (0.7, 0.9, 1)	Manufacturing Process score	A, AB, B, BC, C	2, 26.95%	(0.189, 0.243, 0.269)
		Cost Analysis score	A, AB, B, BC, C	1, 30.85%	(0.216, 0.278, 0.308)
		Statistics II score	A, AB, B, BC, C	3, 23.05%	(0.161, 0.207, 0.231)
		Industrial Electronics score	A, AB, B, BC, C	4, 19.15%	(0,134, 0.172, 0.192)
5.	Planning ability (0.9, 1,1)	Production Planning & Control score	A, AB, B, BC, C	4, 19.15%	(0.172, 0.192, 0.192)
		Industrial Planning score	A, AB, B, BC, C	2, 26.95%	(0.243, 0.269, 0.269)
		Project Management score	A, AB, B, BC, C	1, 30.85%	(0.278, 0.308, 0.308)
		Operations Research score	A, AB, B, BC, C	3, 23.05%	(0.207, 0.231, 0.231)

4.3 Sub-criteria weights determination

The Alfares method was used to determine the weights of the sub-criteria. Information about rankings is gathered from the user, or the business's owner. The local weight of each sub-criterion is calculated using Equations (10) and (11). Multiplying the local weight by the fuzzy weight of each criterion yields the global weight. Table 7 depicts the weight of the objective sub-criteria, while Table 8 depicts the weight of the subjective sub-criteria.

5. Results and Discussion

5.1 Multi-criteria Assessment Model

Two company professionals evaluated the criteria/sub-criteria categories to design all of the values assigned to the model using the linguistic rating in Table 9, and this resulted in Tables 10 and 11. The multi-criteria assessment model is composed of the weighted criteria/sub-criteria from Tables 7 and 8 and the design values from Tables 10 and 11.
The model consists of five sections: personal data, absolute criteria, objective criteria, subjective criteria, and the ranking outcomes for prospective applicants. The output of the multi-criteria assessment model is a ranking of prospective applicants. If the ranking results are higher, it can be assumed that prospective applicants have an excellent chance of being accepted as potential employees in PT ABC's R&D field.

Table 8. Subjective sub-criteria, ranks and weights

No	Criterion, fuzzy weights	Subjective sub-criterion	Rank	Local weight	Global weight
1	Interpersonal skills, (0.7,1,1)	Ability to work under pressure	6	9.95%	(0.070, 0.099, 0.099)
		Ability to work cooperatively	5	11.11%	(0.078, 0.111, 0.111)
		Innovative and creative	2	14.61%	(0.102, 0.146, 0.146)
		Logical	1	15.77%	(0.110, 0.158, 0.158)
		Energetic	9	6.45%	(0.045, 0.064, 0.064)
		Works in detail	3	13.44%	(0.094, 0.134, 0.134)
		High initiative person	4	12.28%	(0.086, 0.123, 0.123)
		Always responsive	8	7.61%	(0.053, 0.076, 0.076)
		Analyzes the system quickly & precisely	7	8.78%	(0.061, 0.088, 0.088)
2.	Software mastery, (0.5, 0.7, 0.9)	Ability to use M. Office	4	19.15%	(0.096, 0.134, 0.172)
		Ability to use 2D and 3D	1	30.84%	(0.154, 0.216, 0.278)
		Ability to use simulation software	2	26.95%	(0.135, 0.189, 0.243)
		Ability to use cloud integrated software	3	23.05%	(0.115, 0.161, 0.207)
3.	Problem solving ability (0.1, 0.3, 0.5)	Ability in brainstorming	1	39.57%	(0.040, 0.119, 0.198)
		Targeted problem-solving capacity	2	33.33%	(0.033, 0.100, 0.167)
		Ability in problem solving	3	27.09%	(0.027, 0.081, 0.135)
4.	English fluency, (0.1, 0.3, 0.5)		1	100%	(0.100, 0.300, 0.500)
5.	Project management ability, (0.7, 0.9, 1)	Project management practice	1	39.57%	(0.277, 0.356, 0.396)
		Project management administration	3	27.09%	(0.190, 0.244, 0.271)
		Risk analysis	2	33.33%	(0.233, 0.300, 0.333)

Table 9. Linguistic variables for the ratings

Linguistic variable	Fuzzy number
Very poor (VP)	(0, 0, 1)
Poor (P)	(0, 1, 3)
Medium poor (MP)	(1, 3, 5)
Fair (F)	(3, 5, 7)
Medium good (MG)	(5, 7, 9)
Good (G)	(7, 9, 10)
Very good (VG)	(9, 10, 10)

Table 10. The values assigned for the objective criteria/sub-criteria categories

Criterion	**Category**	**Values**	
		Expert-1	**Expert-2**
Education	Industrial Eng.–S1	Very good	Very good
	Chemical Eng.–S1	Good	Good
	Mechanical Eng.–S1	Very good	Good
	Other Engineering–S1	Medium good	Good
	Non-engineering–S1	Good	Fair
Teamwork experience	Yes	Very good	Very good
	No	Very poor	Poor
Analysis ability Research ability Planning ability	A	Very good	Very good
	AB	Good	Medium good
	B	Medium poor	Fair
	BC	Very poor	Medium
	C	Very poor	Poor

Table 11. The value assigned for each subjective sub-criterion

Likert scale	**Expert 1**	**Expert 2**
1	Very poor	Very poor
2	Very poor	Poor
3	Very poor	Medium poor
4	Good	Fair
5	Very good	Very good

5.2 Model Application

The multi-criteria assessment method was applied to five applicants at PT ABC. Figure 2 displays the data received from one of the company's expert users who contributed to the assessment.

The closeness coefficient (CC) is computed as the applicants' preference values and serves as the basis for ranking the applicants. The results of each applicant's preference scores are displayed in Table 12. CCo is the objective CC and CCs is the subjective CC. The company used this assessment model and assigned subjective and objective weights of 0.50 and 0.50, respectively.

Table 12. Closeness coefficient matrix

Subject	**CCs**	**CCo**	**CC**	**Rank**
A1: Applicant 1	0.865	0.670	0.768	3
A2: Applicant 2	0.651	1	0.826	1
A3: Applicant 3	0.375	0.134	0.254	5
A4: Applicant 4	0.459	0.895	0.677	4
A5: Applicant 5	0.798	0.755	0.776	2

Table 13 illustrates how the applicants would have been ranked differently if the weights of the objective and subjective criteria had been modified as in Equation (22).

$$CC = \alpha.CCo + (1- \alpha).CCs \quad (22)$$

Table 12 shows that A2 with an advantage on the objective criteria will always be the first choice if the weight of the objective criteria is greater than 37.38%. If the percentage of the objective importance level is less than 37.38%, then the best candidate is A1. Thus, it can be concluded that the change in the percentage level of importance of the objective and subjective criteria is highly sensitive and plays an important role in the process of accepting prospective applicants.

Table 13. Applicants ranking for various weights

	Applicants Ranking				
α	**A1**	**A2**	**A3**	**A4**	**A5**
0 %	**1**	3	5	4	2
37.38 %	**1**	2	5	4	3
39.33 %	2	**1**	5	4	3
44.36 %	3	**1**	5	4	2
64.34 %	4	**1**	5	3	2
70.69 %	4	**1**	5	2	3
100 %	4	**1**	5	2	3

The Assessment Model to Rank Applicants for Research and Development Job Position PT ABC — EXPERT - 1

	Applicant 1	Applicant 2	Applican 3	Applicant 4	Applicant 5
Name	FR	SN	R	ML	CS
Male/Female	Male	Male	Male	Male	Male
Age	21	21	22	21	21
Range IPK	3.00 - 3.50	> 3.50	3.00 - 3.50	> 3.50	3.00 - 3.50
Willingness to be placed anywhere	Yes Continue	No Sorry, not suitable	No Sorry, not suitable	No Sorry, not suitable	No Sorry, not suitable
Mastery in 2D and 3D design	No Sorry, not suitable	No Sorry, not suitable	Yes Continue	Yes Continue	Yes Continue
Basic material & Material Costing	Yes Continue	Yes Continue	Yes Continue	Yes Continue	Yes Continue
EDUCATION					
Education	S1 Industrial Engineering	S1 Industrial Engineering	S1 Industrial Engineering	S1 Industrial Engineering	S1 Industrial Engineering
WORK EXPERIENCE					
Working Experience in a team	Yes	Yes	Yes	Yes	Yes
ANALYSIS ABILITY					
Production Planning and Control Score	AB	A	AB	A	AB
Marketing Management Score	A	A	AB	A	A
Quality Management System Score	AB	A	A	A	AB
Engineering Economy Score	B	A	D	AB	AB
RESEARCH ABILITY					
Manufacturing Process Score	AB	AB	BC	AB	AB
Cost Analysis Score	A	A	B	AB	A
Statistics 2 Score	B	A	BC	B	B
Industrial Electronics Score	C	A	A	A	A
PLANNING ABILITY					
Production Planning and Control Score	AB	A	AB	A	AB
Industrial Planning Score	A	A	A	A	AB
Operations Research Score	B	AB	D	AB	B
INTERPERSONAL SKILLS *Score 1-5 (Not Competent - very competent)*					
Ability to work under pressure and target	4	4	4	4	5
Ability to work cooperatively	4	4	3	4	4
Inovative and creative	5	5	4	4	5
Logical	5	3	4	3	5
Energetic	4	5	3	4	5
Works in detail	5	3	4	3	3
High Initiative Person	4	3	4	5	4
Responsive any time	4	4	4	4	4
Analyzes the System quickly and precisely	4	3	4	3	4
SOFTWARE MASTERY *Score 1-5 (Not Competent - very competent)*					
Ablility to use Microsoft Office	5	5	4	4	5
Ability to use Software 2D & 3D	4	4	4	3	4
Ability to use Simulation Software	5	4	4	2	3
Ability to use *cloud integrated Software*	4	4	3	5	4
PROBLEM SOLVING ABILITY *Score 1-5 (Not Competent - very competent)*					
Ability in brainstorming	4	4	4	4	5
Targeted Problem Solving Capacity	4	3	4	4	5
Ability in Problem Solving	5	5	4	4	4
ENGLISH FLUENCY *Score 1-5 (Not Competent - very competent)*					
English Fluency	4	5	2	4	5
PROJECT MANAGEMENT ABILITY *Score 1-5 (Not Competent - very competent)*					
Project Management application	4	4	3	4	4
Project Management Administration	5	4	3	4	4
Risk Analysis	4	4	4	3	4
RANKING					
	Applicant 1	Applicant 2	Applicant 3	Applicant 4	Applicant 5

Figure 2. Model application for 5 applicants

6. Conclusion

In this study, a multi-criteria assessment model was developed that would enable an organization to reduce staff turnover by implementing a well-organized and structured recruitment process. Subjective and objective criteria for the R&D field derived from a previous study have been adapted to the PT ABC condition and resulted in five criteria for each. The weights of the criteria were established using the F-AHP method, while the weights of the sub-criteria were obtained using the Alfares method. Finally, F-TOPSIS was used to calculate the closeness coefficient, and the applicants were ranked as follows: A2 in position 1, followed by A5, A1, A4, and A3.

7. Future Research

The multi-criteria assessment method can use methods other than the existing methods in this research, and the company can set new subjective and objective weights according to future needs. Finally, another form of assessment for the model application can be used.

Acknowledgment

This research was fully funded by the Directorate of Higher Education in the Ministry of Education, Culture, Research, and Technology Republic of Indonesia, under contract number 167/E4.1/AK.04.PT/2021, 12th July 2021, 003/AMD-SP2H/LT-MULT1PDPWLL7/2021, 15th July 2021, and 005/SP-Lit/AMD/LPPM-01/Dikbudristek/Multi/FT/VII/2021, 15th July 2021.

References

Alfares, H. K. and Duffuaa, S. O. Assigning cardinal weights in multi-criteria decision making based on ordinal ranking. *Journal of Multi-Criteria Decision Analysis*, vol. 5, no. 5–6, pp. 125–133, 2008.

Al-Suraihi, W.A., Samikon, S.A., Al-Suraihi, A.H.A. and Ibrahim, I., Employee turnover: Causes, importance and retention strategies. *European Journal of Business and Management Research*, vol. 6, no. 3, pp. 1–10, 2021.

Büyüközkan, G., Feyzioğlu, O. and Nebol, E., Selection of the strategic alliance partner in logistics value chain. *International Journal of Production Economics*, vol. 113, no. 1, pp. 148–158, 2008.

Chiesa, V., Frattini, F., Lazzarotti, V. and Manzini, R., Performance measurement of research and development activities. *European Journal of Innovation Management*, vol. 12, no. 1, pp. 25–61, 2009.

Chigozie, M.P. and Chijioke, E., Effects of Research and Development on organizational product quality. *Asia Pacific Journal of Research in Business Management*, vol. 6, no. 3, March 2015.

Coffey, L. and Claudio, D., In defense of group fuzzy AHP: A comparison of group fuzzy AHP and group AHP with confidence intervals. *Expert Systems with Applications*, vol. 178, 2021.

Girish, M., Exploring the Term 'Employee Turnover', *Journal of Advances and Scholarly Researches in Allied Education*, vol. II, no. II, pp. 1–7, 2011.

Herowati, E., Parung, J., Limantara, S., Wahyudi, R. D. and Ronyastra, I. M., A Self-Assessment Model for Measuring the Fitness Level of Industrial Engineering Graduates Competence to a Quality Control Job Position, *Proceedings of the 4th International Conference on Engineering and Technology for Sustainable Development*, Jogjakarta, Indonesia, October 13th, 2021.

Holtom, B.C. and Burch, T. C., A model of turnover-based disruption in customer services, *Human Resource Management Review*, vol. 26, no. 1, pp. 25–36, 2016.

Hossain, S.M., Rahman, T., Labony, S.S., Effects on Recruitment and Selection Process on Employee Turnover and Its Consequence on Organization's Profitability – A Study on Financial Sector of Bangladesh, *European Journal of Business and Management*, vol. 7, no.35, 2015.

Kessler, L., Employee Turnover: Causes, Importance and Retention Strategies, *European Journal of Business and Management Research,* vol. 6, no.3, 2021.

Pellizzari, M. and Fichen, A. A new measure of skill mismatch: theory and evidence from PIAAC. *IZA, Journal of Labor Economy*, vol. 6, no. 1, pp. 1–30, 2017.

Ronyastra, I.M., Herowati, E., Wahyudi, R.D., Parung, J. and Henadi, C., Assessing Individual Fitness for Research and Development Position using Fuzzy AHP and Pareto: Case Study in Manufacturing Industry, *Proceedings of the 4th International Conference on Applied Science and Technology*, Samarinda, Indonesia, October 23-24, 2021.

Saaty, T.L. and Vargas, L.G., *Model, Method, Concepts, and Applications of the Analytical Hierarchy Process*, Springer Science Business Media, New York, 2012.

Saraih, U., Zuraini Zin Aris, A. and Ahmad, R., Factors Affecting Turnover Intention Among Academician in the Malaysian Higher Educational Institution, *Review of Integrative Business and Economics Research*, vol. 6, no. 1, pp. 1–15, 2016.

Setiawan, C. H., Herowati, E., Wahyudi, R.D. and Ronyastra, I.M., MCDM-Based Instrument for Fresh Graduate's Competencies Conformity in Banking Service Field, *Proceedings of the 17th International Conference on Quality in Research,* Jakarta, Indonesia, October 13-15, 2021.

Sofrankova, B., Kiselakova, D., Cabinova, V. and Onuferova, E., The Importance of Research and Development Spending In the Context of Global Competitiveness and the Innovation Potential of the V4 Countries, *Journal of Eastern Europe Research in Business & Economics,* vol. 2018, pp.1–13, 2018.

Van der Velden, R. and Bijlsma, I., Effective skill: A new theoretical perspective on the relation between skills, skill use, mismatches, and wages, *Oxford Economic Papers*, vol. 71, no. 1, pp. 145–165, Jan. 2019.

Biographies

Janice Santoso is a junior researcher in the Department of Industrial Engineering, Faculty of Engineering, University of Surabaya. Currently, she is a first-semester master's student of Industrial and Information Management at National Cheng Kung University, Taiwan. She received a S.T. in Industrial Engineering Department from the University of Surabaya in 2022. Her research interests include decision analysis and sustainable supply chain management.

Evy Herowati is an associate professor of Industrial Engineering, Faculty of Engineering, University of Surabaya, Indonesia. She earned B.S. in Electronic Engineering, Masters and Doctor in Industrial Engineering Department from The Sepuluh Nopember Institute of Technology (ITS), Surabaya, Indonesia. Her research interests include decision sciences and aplication, operations research, cost analysis & estimation. Evy Herowati is the corresponding author and can be contacted at: evy@staff.ubaya. ac.id

Joniarto Parung is a professor of Supply Chain Management of Industrial Engineering Department, University of Surabaya, Indonesia. He graduated from Universitas Hasanuddin-Makassar, Obtained his Master degree from ITB Bandung, Indonesia and PhD from University of Strathclyde, Glasgow, UK. His research interests include logistics & supply chain management and application of digital technology on this area, decision sciences, and performance analysis. He is a member of the board of industrial engineering chapter - the institute of Indonesian engineers (BKTI-PII), Indonesian Supply Chain & Logistics Institute (ISLI), Society of Industrial Engineering, and Operations Management (IEOM), the Institute of Electrical and Electronics Engineers (IEEE) and European Operations Management Association (EUROMA). He has presented some of his research and has delivered invited seminars around the world and around Indonesia.