THE SELECTION OF PROSPECTIVE EMPLOYEES USING THE SHANNON ENTROPY WEIGHTING METHOD AND ARAS METHOD

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Abstract

This study discusses the selection of prospective employees using the Shannon Entropy weighting method and the Additive Ratio Assessment (ARAS) method which aims to determine the accuracy of the results obtained from the method. The Shannon Entropy method is a weighting method that assigns criteria weights based on the calculation of alternative employee selection data and the Additive Ratio Assessment (ARAS) method is a ranking method that has a utility function. Testing the data in this study using the Mean Absolute Error (MAE) method to get system accuracy results. Based on testing conducted using 6 criteria and 56 alternative data for prospective employees, the accuracy of the method used was 85.34%.

Keywords: *ARAS, Shannon Entropy, MAE*

1. INTRODUCTION

Selection of prospective employees in various companies have different criteria and assessments. Some examples of criteria used in selecting prospective employees, such as the Basic Ability Test (TKD), General Intelligence Test (TIU), Wonderlic Personnel Test (WPT), Dominant, Influencing, Steadiness, Conscientiousness (DISC), KREAPELIN, Observation Test and Interview.

One weighting method used is the Shannon Entropy method used to determine the weighting of data criteria and Fuzzy TOPSIS as a supplier ranking in supplier selection on supply chain risk. The data used in this study is the supplier data in the supply chain [6]. The Shannon Entropy and MADM methods which aim to expand the Shannon Entropy method are inaccurate data, especially in the case of interval and fuzzy data that will obtain or produce interval weights for each criterion [4].

The ARAS ranking method is used to determine the selection of trainers or teaching staff. The process of weighting criteria in the ARAS method will greatly influence the final ranking in the decision support system of the trainer selection [5]. ARAS is applied into a real case study of microclimate evaluation in office space. This case study aims to determine the climate in the location, where people work, and determine the actions that must be taken to improve their environment [7].

The ARAS method has a utility function value that functions to determine alternative priorities or alternatives to the values and weights of the main criteria. While the Shannon Entropy method provides criteria weights based on alternative data selection of prospective employees. Therefore, this study conducted a selection test for prospective employees using the Shannon Entropy weighting method and the ARAS method.

2. RESEARCH METHODOLOGY

The flow of this research can be seen in Figure 1 below:

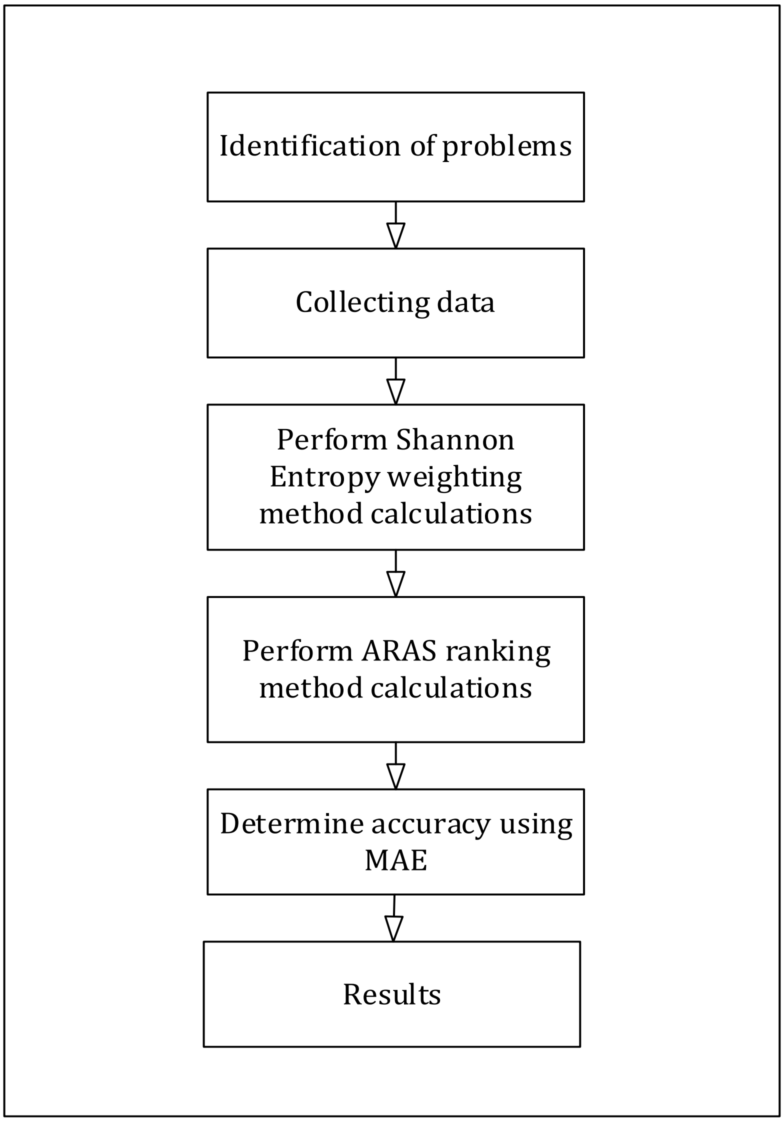

Figure 1. Research flow selection of prospective employees

2.1 Identification of the problem

The initial step in this research is to identify problems by gathering various information related to research needs such as conducting a study of literature studies, observing cases and conducting observations or interviews.

2.2 Collecting Data

Collect and analyze data by conducting interviews with HR, such as assessment criteria and alternative prospective employee data as a reference assessment used in the selection of prospective employees.

2.3 Perform Shannon Entropy weighting method calculations

Calculating the weighting using the Shannon Entropy method was first proposed by Shannon in 1948, and was further developed by Wang and Lee as a weighting method in 2009 that could give weight to a data considered in probability theory. Shannon Entropy's steps are as follows [1]:

a. Determination of the decision matrix

Equation (1) is used to determine the decision matrix based on the prospective employee selection data. Where D is a decision matrix, m is the number of alternative data, n is the number of criteria, and Xij is the alternative value of each criterion.

$$D = \begin{bmatrix} X11 & X1j & \cdots & X1n \\ Xi1 & Xij & \cdots & Xin \\ \vdots & \vdots & \ddots & \vdots \\ Xm1 & Xmj & \cdots & Xmn \end{bmatrix} (i = 1, m\ ; j = 1, n) \quad (1)$$

b. Normalization of decision matrix

Equation (2) is used to normalize the decision matrix (D). Where pij is the normalized value of each alternative to the criteria.

$$p_{ij} = \frac{x_{ij}}{\sum_{j=1}^{m} x_{ij}}\ j = 1,2, \ldots m\ ; i = 1,2, \ldots n \quad (2)$$

c. Calculate the value of entropy

Equation (3) is used to calculate the entropy value of each criterion. Where Ej is the value of entropy criteria and k is a constant value.

$$E_j = -k \sum_{j=1}^{m} p_{ij} . \ln p_{ij}\ \ , k = (lnm)^{-1} \quad (3)$$

d. Determination of the divergence value

Equation (4) is used to determine the divergence value of each criterion. Where dj is the divergence value.

$$d_j = 1 - E_j \quad (4)$$

e. Determination of the weight of the Shannon Entropy criterion

Equation (5) is used to determine the weight of each Shannon Entropy criterion. Where wj is the criteria weight and ds is the calculation of each column dj.

$$w_j = \frac{d_j}{\sum_{s=1}^{n} d_s}\ (j = 1,2, \ldots m) \quad (5)$$

2.4 Perform ARAS ranking method calculations

The ARAS method has a utility function value that determines the relative efficiency of the complex of feasible alternatives directly proportional to the relative effect of the value and weight of the main criteria considered in a project. ARAS steps as follows [2][7]:

a. Formation of decision making matrix

Equation (6) is used to determine the decision matrix based on the prospective employee selection data and in the first row an optional value is added to each criterion with alternative code X0. Where X is a decision matrix, m is the number of alternative data, n is the number of criteria, and Xij is the alternative value of each criterion.

$$X = \begin{bmatrix} X01 & X0j & \cdots & X0n \\ Xi1 & Xij & \cdots & Xin \\ \vdots & \vdots & \ddots & \vdots \\ Xm1 & Xmj & \cdots & Xmn \end{bmatrix} (i = 0, m\ ;\ j = 1, n) \quad (6)$$

Equations (7) and (8) are used if the optimum value of the criterion is unknown, where Xij = the performance value of the alternative to the criterion and X0j = the optimum value of the criterion, then:

$$Xoj = \frac{max}{1} .Xij\ if\ \frac{max}{1} .Xij \quad (7)$$

$$Xoj = \frac{min}{1} .Xij\ if\ \frac{min}{1} .Xij \quad (8)$$

b. Normalization of decision matrix

Equation (9) is used if the criteria are Beneficial, where Xij * is the normalized value of beneficial, then the following normalization is carried out:

$$Xij * = \frac{Xij}{\sum_{i=0}^{m} Xij} \quad (9)$$

Equations (10) and (11) are used if the criteria are Non-Legal, where Rij is the normalized value of non-beneficial, then the following normalization is carried out:

$$Xij * = \frac{1}{Xij} \quad (10)$$

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$$Rij = \frac{Xij*}{\sum_{i=0}^{m} Xij*} \quad (11)$$

c. Determination of normalized weights

Equation (12) is used to determine alternative weights against normalized criteria. Where D is the normalized weight value and wj is the criteria weight.

$$D = [dij]m .n = Rij .wj \quad (12)$$

d. Determination of the value of the optimization function

Equation (13) is used to determine the value of the optimization function of each alternative to the criterion. Where Si is the value of the alternative optimization function i.

$$Si = \sum_{j}^{n} = 1\ dij , (i = 1, 2, \dots m : j = 1, 2, \dots n) \quad (13)$$

e. ARAS alternative ranking

Equation (14) is used to determine alternative rankings on the ARAS method. Where Ki is an alternative ranking value and S0 is the alternative optimization function value to-0.

$$Ki = \frac{Si}{S0} \quad (14)$$

2.5 Determine the accuracy of using MAE

The Mean Absolute Error (MAE) method is used to calculate the level of accuracy or magnitude of error predicted by the system against the real results that the user gives to an item that can be seen in equations (15) and (16). Where MAE is the average value of a calculated error, N is the number of items counted, pi is the predictive value of item i, and qi is the actual rating value of item i.

$$MAE = \frac{\sum_{i=1}^{n}(|pi - qi|)}{N} \quad (15)$$

$$Akurasi = 1 - MAE \quad (16)$$

3. RESULTS AND DISCUSSION

3.1 Results

Data collected through direct interviews with HR in the form of prospective employee selection data consisting of several aspects of assessment such as the Basic Ability Test (TKD), General Intelligence Test (TIU), Wonderlic Personnel Test (WPT), Dominant, Influencing, Steadiness, Conscientiousness (DISC), KREAPELIN, Observation Test and Interview. The data also includes the results of an assessment of each prospective employee consisting of 56 people. The assessment criteria code can be seen in table 1 and alternative prospective employee data can be found in table 2 below:

Table 1 Assessment criteria

Criteria	Kode
Basic Ability Test	TKD
General Intelligence Test	TIU
Wonderlic Personnel Test	WPT
Dominant, Influencing, Steadiness, Conscientiousness	DISC
KREAPELIN	KP
Observation Test and Interview	TO & W

Table 2 Alternative prospective employee data

No	Name	TKD	TIU	WPT	DISC	KP	TO & W	Total	Rank
1	CX1	6	14	11	9	153	74	267	22
2	CX2	7	16	14	9	182	84	312	12
3	CX3	12	28	13	8	187	88	336	8
4	CX4	6	15	6	9	170	79	285	18
5	CX5	8	20	9	10	31	74	152	54
6	CX6	11	13	9	11	216	74	334	11
7	CX7	10	24	11	10	210	70	335	10
8	CX8	9	11	9	9	186	78	302	14
9	CX9	10	20	13	8	327	79	457	1
10	CX10	5	20	9	9	60	75	178	51
...	...	...	...	...	...	...	...	...	...
56	CX56	13	24	16	9	221	88	371	2

3.1.1 Calculation of the Shannon Entropy method

Shannon Entropy calculation steps:

a. Determination of the decision matrix

To determine the decision matrix based on alternative prospective employee data in table 2 and there is a calculation of the valuation of each alternative value against the criteria in the last row. The decision matrix of the Shannon Entropy method can be seen in table 3 below:

Table 3 Shannon Entropy's decision matrix

No	Name	TKD	TIU	WPT	DISC	KP	TO & W
1	CX1	6	14	11	9	153	74
2	CX2	7	16	14	9	182	84

3	CX3	12	28	13	8	187	88
4	CX4	6	15	6	9	170	79
5	CX5	8	20	9	10	31	74
6	CX6	11	13	9	11	216	74
7	CX7	10	24	11	10	210	70
8	CX8	9	11	9	9	186	78
9	CX9	10	20	13	8	327	79
10	CX10	5	20	9	9	60	75
...	...	...	...	...	...	...	...
56	CX56	13	24	16	9	221	88
Total		**427**	**885**	**484**	**573**	**7736**	**4284**

b. Normalization of decision matrix

Normalization of decision matrix is calculated based on alternative value of criteria and calculation of each alternative value of criteria. Normalization of Shannon Entropy's decision matrix can be seen in the following table 4:

Table 4 Normalization of Shannon Entropy matrix

No	Name	TKD	TIU	WPT	DISC	KP	TO & W
1	CX1	0,0141	0,0158	0,0227	0,0157	0,0198	0,0173
2	CX2	0,0164	0,0181	0,0289	0,0157	0,0235	0,0196
3	CX3	0,0281	0,0316	0,0269	0,0140	0,0242	0,0205
4	CX4	0,0141	0,0169	0,0124	0,0157	0,0220	0,0184
5	CX5	0,0187	0,0226	0,0186	0,0175	0,0040	0,0173
6	CX6	0,0258	0,0147	0,0186	0,0192	0,0279	0,0173
7	CX7	0,0234	0,0271	0,0227	0,0175	0,0271	0,0163
8	CX8	0,0211	0,0124	0,0186	0,0157	0,0240	0,0182
9	CX9	0,0234	0,0226	0,0269	0,0140	0,0423	0,0184
10	CX10	0,0117	0,0226	0,0186	0,0157	0,0078	0,0175
...	...	...	...	...	...	...	...
56	CX56	0,0304	0,0271	0,0331	0,0157	0,0286	0,0205

c. Calculate the value of entropy

The entropy value for each criterion is based on a constant value and an alternative normalization value to the criterion. The entropy value for each criterion can be seen in table 5 below:

Table 5 Entropy Value Criteria

	TKD	TIU	WPT	DISC	KP	TO & W
E	0,9871	0,9895	0,9861	0,9965	0,9776	0,9994

d. Determination of the divergence value

To determine the divergence value is calculated based on the entropy value of each criterion and there is a calculation value of each divergence value column. Divergence value for each criterion can be seen in the following table 6:

Table 6 Divergence Value Criteria

	TKD	TIU	WPT	DISC	KP	TO & W	Total
d	0,0129	0,0105	0,0139	0,0035	0,0224	0,0006	0,0637

e. Determination of the weight of the Shannon Entropy criterion
The results of the calculation of the weight value of each criterion of the Shannon Entropy method can be seen in Table 7 obtained based on the divergence value of each criterion and its calculation as follows:

Table 7 Weight of each criterion

	TKD	TIU	WPT	DISC	KP	TO & W	Total
W	0,20186	0,16485	0,21877	0,05427	0,35104	0,00921	1

3.1.2 *Calculation of the ARAS method*

In the calculation of the ARAS method using weights that have been obtained from Shannon Entropy calculations such as the following steps:

a. Determination of the decision matrix
To determine the decision matrix based on alternative prospective employee data in table 2. In the first row there is alternative X0 as the optimal value in each criterion and there is a calculation of the valuation of each alternative value against the criteria in the last row which can be seen in table 8 below:

Table 8 ARAS decision matrix

No	Name	MAX	MAX	MAX	MIN	MAX	MAX
		TKD	TIU	WPT	DISC	KP	TO & W
1	X0	20	30	50	1	400	100
2	CX1	6	14	11	9	153	74
3	CX2	7	16	14	9	182	84
4	CX3	12	28	13	8	187	88
5	CX4	6	15	6	9	170	79
6	CX5	8	20	9	10	31	74
7	CX6	11	13	9	11	216	74
8	CX7	10	24	11	10	210	70
9	CX8	9	11	9	9	186	78
10	CX9	10	20	13	8	327	79
...	...	...	...	...	...	...	...
57	CX56	13	24	16	9	221	88
Total		**447**	**915**	**534**	**574**	**8136**	**4384**

b. Normalization of decision matrix
Normalization of decision matrix is calculated based on alternative value of criteria and calculation of each alternative value of criteria. Normalization of the ARAS decision matrix can be seen in the following table 9:

Table 9 Normalization matrix

No	Name	MAX	MAX	MAX	MIN	MAX	MAX
		TKD	TIU	WPT	DISC	KP	TO & W
1	X0	0,0447	0,0328	0,0936	0,1511	0,0492	0,0228
2	CX1	0,0134	0,0153	0,0206	0,0168	0,0188	0,0169
3	CX2	0,0157	0,0175	0,0262	0,0168	0,0224	0,0192
4	CX3	0,0268	0,0306	0,0243	0,0189	0,0230	0,0201
5	CX4	0,0134	0,0164	0,0112	0,0168	0,0209	0,0180

6	CX5	0,0179	0,0219	0,0169	0,0151	0,0038	0,0169
7	CX6	0,0246	0,0142	0,0169	0,0137	0,0265	0,0169
8	CX7	0,0224	0,0262	0,0206	0,0151	0,0258	0,0160
9	CX8	0,0201	0,0120	0,0169	0,0168	0,0229	0,0178
10	CX9	0,0224	0,0219	0,0243	0,0189	0,0402	0,0180
...	...	...	...	...	...	...	...
57	CX56	0,0291	0,0262	0,0300	0,0168	0,0272	0,0201

c. Determination of nominal weight
The determination of normalized weights is obtained from the multiplication results of the normalization of each alternative and the weight of each criterion which can be seen in table 10 below:

Table 10 Normalized weights

No	Name	MAX	MAX	MAX	MIN	MAX	MAX
		TKD	**TIU**	**WPT**	**DISC**	**KP**	**TO & W**
1	X0	0,00903	0,0054	0,02048	0,0082	0,01726	0,000210
2	CX1	0,00271	0,00252	0,00451	0,00091	0,0066	0,000155
3	CX2	0,00316	0,00288	0,00574	0,00091	0,00785	0,000176
4	CX3	0,00542	0,00504	0,00533	0,00103	0,00807	0,000185
5	CX4	0,00271	0,0027	0,00246	0,00091	0,00733	0,000166
6	CX5	0,00361	0,0036	0,00369	0,00082	0,00134	0,000155
7	CX6	0,00497	0,00234	0,00369	0,00075	0,00932	0,000155
8	CX7	0,00452	0,00432	0,00451	0,00082	0,00906	0,000147
9	CX8	0,00406	0,00198	0,00369	0,00091	0,00803	0,000164
10	CX9	0,00452	0,0036	0,00533	0,00103	0,01411	0,000166
...	...	...	...	...	...	...	...
57	CX56	0,00587	0,00432	0,00655	0,00091	0,00954	0,000185

d. Determination of the value of the optimization function
The value of the optimization function of each alternative data can be seen in Table 11 below:

Table 11 The value of the optimization function

No	Name	S
1	X0	0,06059
2	CX1	0,01741
3	CX2	0,02072
4	CX3	0,02507
5	CX4	0,01628
6	CX5	0,01322
7	CX6	0,02122
8	CX7	0,02337
9	CX8	0,01883
10	CX9	0,02874
...	...	...
57	CX56	0,02738

e. Alternative ranking

Alternative ranking results obtained from the ARAS method ranking using the Shannon Entropy method weights can be seen in table 12 below:

Table 12 Alternative rankings on the ARAS method

No	Name	K	Rank
1	X0	1	-
2	CX1	0,28728	19
3	CX2	0,34197	12
4	CX3	0,41373	3
5	CX4	0,26873	26
6	CX5	0,21813	46
7	CX6	0,35018	11
8	CX7	0,38578	9
9	CX8	0,31084	14
10	CX9	0,47442	1
...	...	...	...
57	CX56	0,45191	2

3.1.3 Calculation of accuracy values

To test the accuracy of the Shannon Entropy-ARAS method, the ranking or ranking results of the method are compared with the results of real data ranking. Ranking in the Shannon Entropy-ARAS method is referred to as a predictive value, while the ranking of real data is referred to as the actual rating value. In addition there is also a calculation of all items and calculation of the absolute value of the difference in prediction of item i and the actual rating value of item to i which can be seen in table 13 below:

Table 13 Testing comparison ranking

No	Name	***Shannon Entropy-ARAS* ranking (pi)**	Ranking Without Method (qi)	|pi-qi|
1	CX09	1	1	0
2	CX56	2	2	0
3	CX03	3	8	5
4	CX19	4	4	0
5	CX30	5	3	2
6	CX38	6	7	1
7	CX23	7	9	2
8	CX49	8	5	3
9	CX07	9	10	1
10	CX43	10	6	4
...	...	...	...	...
57	CX29	56	53	3
	Total		1596	234

Accuracy results from testing the Shannon Entropy-ARAS method get results of 85.34% which can be seen in table 14 below:

Table 14 Results for the accuracy of the Shannon Entropy-ARAS method

|pi-qi|	234	**85,34%**
number of items (N)	1596	
MAE	0,1466	
accuracy (1 - MAE)	0,8534	

3.2 Discussion

The Shannon Entropy method provides weights based on alternative prospective employee data consisting of 6 criteria and as many as 56 data. While the ARAS ranking method has a utility function that functions to determine alternative priorities or alternatives to the values and weights of the main criteria. The accuracy of the Shannon Entropy-ARAS method is 85.34%, this accuracy result is quite high because the results of the prediction ranking when using the method are almost the same as the results of the ranking in real data.

4. CONCLUSION

Accuracy results in this study were 85.34% obtained from the comparison of the Shannon Entropy-ARAS method with the results of the real data of selecting prospective employees. This research can be developed by comparing the weighting method which gives weight not only using alternative data, but also can be compared with the weighting method that influences the weight given by the decision maker.

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