The Eurasia Proceedings of
Educational & Social Sciences (EPESS)
ISSN: 2587-1730

The Eurasia Proceedings of Educational & Social Sciences (EPESS), 2017

Volume 8, Pages 73-79

IConSE 2017: International Conference on Science and Education (IConSE)

PERSONNEL SELECTION WITH ARAS-G

Halil Sen
Mehmet Akif Ersoy University

Abstract: Due to the increasing competition, selection of the most appropriate personnel is one of the key factors for an organization's success. The importance and complexity of the personnel selection problem call for the methods combining both subjective and objective assessments rather than just subjective decisions. This paper considers the personnel selection for a new IT consultant by using an additive ratio assessment method with gray values (ARAS-G). Analysis of the candidates by ARAS-G method allows determining value of candidate' in compared with the optimal candidate. As a result, the closest candidate to the optimal candidate was selected using this method.

Keywords: Personnel selection, multi criteria decision making, additive ratio assessment method, grey values

Introduction

Personnel selection is the process of choosing individuals who match the qualifications required to perform a defined job in the best way. It determines the input quality of personnel and plays a decisive role in human resource management. Increasing competition in global markets urges organizations to put more emphasis on personnel selection process. Important issues such as changes in organizations, work, society, regulations, and marketing have an influence on personnel selection and recruiting. Organizations differ with respect to the procedures and budgets for recruiting, selecting, and orienting people (Karsak, 2001). Some firms make a strategic decision to choose the best candidate by utilizing rigorous and costly selection procedures, while others decide to fill positions quickly and inexpensively based only on the information stated on the application forms. Nonetheless, the growing importance attached to personnel selection process has paved the way for analytical decision making approaches. (Dursun & Karsak, 2009). Accurate personnel selection, taking into account the company circumstances, allows managers to optimize production costs and achieve corporative goals (Canos & Liern, 2008).

Personnel selection is a typical multi-criteria decision-making problem. It appears that different methods are used in the literature to solve this problem. Some of these methods are Grey-TOPSIS (Wang, 2009), Fuzzy Multi-Objective Boolean Linear Programming (Karsak, 2000), AHP (Gibney and Shang, 2007), Fuzzy GDSS (Chen and Cheng, 2005), Fuzzy AHP (Lazarevic-Petrovic, 2001), Fuzzy TOPSIS (Kelemenis and Askounis, 2010), Fuzzy ANP (Ayub et al., 2009), Minimally Biased Weighted Multiple Criteria Analysis (Jessop, 2004), Artificial Neural Networks and Genetic Algorithm (Gargano Michael, Marose Robert, and von Kleeck, 1991). This paper considers the personnel selection for a new IT consultant by using an additive ratio assessment method with gray values (ARAS-G).

Methods

Grey Numbers

Many systems, such as those that are social, economic, agricultural, industrial, ecological, or biological in nature, are named based on the fields and ranges to which the research subjects belong. In contrast, the name grey systems was chosen based on the colors of the subjects under investigation. For example, in control theory, the darkness of colors has been commonly used to indicate the degree of clarity of information. One of the most

- Selection and peer-review under responsibility of the Organizing Committee of the conference

*Corresponding author: Halil Sen- E-mail: halilsen@mehmetakif.edu.tr

well accepted representations is the so-called "black box." It stands for an object with its internal relations or structure totally unknown to the investigator. Here, we use the word "black" to represent unknown information, "white" for completely known information, and "grey" for that information which is partially known and partially unknown. Accordingly, we name systems with completely known information as white systems, systems with completely unknown information as black systems, and systems with partially known and partially unknown information as grey systems, respectively.

In our daily social, economic, and scientific research activities, we often face situations involving incomplete information. For example, in some studies of agriculture, even though all the information related to the area which is planted, the quality of seeds, fertilizers, irrigation, etc., is completely known, it is still difficult to estimate the production quantity and the consequent annual income due to various unknown or vague information related to labor quality, level of technology employed, natural environment, weather conditions, etc. (Liu et. Al., 2006).

There are four possibilities for incomplete information of systems.

1. The information of elements (or parameters) is incomplete.
2. The information on structure is incomplete.
3. The information on boundary is incomplete.
4. The behavior information of movement is incomplete

Having "incomplete information" is the fundamental meaning of being "grey". In different circumstances and from different angles, the meaning of being "grey" can still be extended. For more details, see Table 1 (Liu et. Al., 2006).

Table 1. Comparison between black, grey and white systems

	Black	Grey	White
Information	Unknown	Incomplete	Known
Appearance	Dark	Grey	Bright
Process	New	Replace old with new	Old
Property	Chaos	Complexity	Order
Methodology	Negative	Transition	Positive
Attitude	Indulgence	Tolerance	Serenity
Conclusion	No result	Multiple solution	Unique solution

Probability and statistics, fuzzy mathematics, and grey systems theory have been the three most-often applied theories and methods employed in studies of non-deterministic systems. Even though they study objects with different uncertainties, the commonality of these theories is their ability to make meaningful sense out of incompleteness and uncertainties. The comparison of these three theories is in the following Table 2 (Liu et. Al., 2006).

Table 2. Comparison between grey systems theory, probability, statistics and fuzzy mathematics

	Grey systems theory	Probability, statistics	Fuzzy mathematics
Objects of study	Poor information Uncertainty	Stochastic Uncertainty	Cognitive Uncertainty
Basic sets	Grey hazy sets	Cantor sets	Fuzzy sets
Methods	Information coverage	Probability distribution	Function of affiliation
Procedure	Grey series generation	Frequency distribution	Marginal sampling
Requirement	Any distribution	Typical distribution	Experience
Emphasis	Intention	Intention	Extension
Objective	Laws of reality	Laws of statistics	Cognitive expression
Characteristics	Small samples	Large samples	Experience

Grey number represents that the information of the number is insufficient and incomplete, and it belongs to a range instead of crisp value. A grey number g denotes by $\otimes g$.

$$\otimes g = [g^{-}, g^{+}] \quad (6)$$

Where g-, g+ represent the lower and upper bound of the interval. Let $\otimes g1$ and $\otimes g2$ be two grey numbers, and be a crisp number, then the grey number arithmetic operations can be shown as follows:

$$\otimes g_1 = [g_1{}^{-}, g_1{}^{+}] \quad (7)$$

$$\otimes g_2 = [g_2^-, g_2^+] \quad (8)$$

Grey number addition

$$\otimes g_1 + \otimes g_2 = [g_1^-, g_1^+] + [g_2^-, g_2^+] = [g_1^- + g_2^-, g_1^+ + g_2^+] \quad (9)$$

Grey number subtraction

$$\otimes g_1 - \otimes g_2 = [g_1^-, g_1^+] - [g_2^-, g_2^+] = [g_1^- - g_2^+, g_1^+ - g_2^-] \quad (10)$$

Grey number multiplication

$$\otimes g_1 . \otimes g_2 = [g_1^-, g_1^+][g_2^-, g_2^+] = [\min\{g_1^- g_2^-, g_1^- g_2^+, g_1^+ g_2^-, g_1^+ g_2^+\}, \max\{g_1^- g_2^-, g_1^- g_2^+, g_1^+ g_2^-, g_1^+ g_2^+\}] \quad (11)$$

Grey number division

$$\frac{\otimes g_1}{a} = \left[\frac{g_1^-}{a}, \frac{g_1^+}{a}\right] \quad (12)$$

$$\frac{a}{\otimes g_1} = \left[\frac{a}{g_1^+}, \frac{a}{g_1^-}\right] \quad (13)$$

Where $g_1^- > 0,\ g_1^+ > 0,\ g_2^- > 0,\ g_2^+ > 0,\ a > 0.$

An Additive Ratio Assessment Method with Grey Values (ARAS-G)

ARAS method (Zavadskas and Turskis, 2010, Zavadskas et al., 2010a; Tupenaite et al., 2010) is based on the argument that phenomena of complicated world could to be understood by using simple relative comparisons. It is argued that the ratio of the sum of normalized and weighted values of criteria, which describe alternative under consideration, to the sum of the values of normalized and weighted criteria, which describes the optimal alternative, is degree of optimality, which is reached by the alternative under comparison.

According to the ARAS method a utility function value determining the complex relative efficiency of a reasonable alternative is directly proportional to the relative effect of values and weights of the main criteria considered in a project.

The first stage is grey decision-making matrix (GDMM) forming. In the GMCDM of the discrete optimization problem any problem to be solved is represented by the following DMM of preferences for m reasonable alternatives (rows) rated on n criteria (columns): where m – number of alternatives, n – number of criteria describing each alternative, $\otimes x_{ij}$ – grey value representing the performance value of the i alternative in terms of the j criterion, $\otimes x_{0j}$ – optimal value of j criterion.

$$\tilde{X} = \begin{bmatrix} \otimes x_{01} & \cdots & \otimes x_{0j} & \cdots & \otimes x_{0n} \\ \vdots & \ddots & \cdots & \ddots & \vdots \\ \otimes x_{i1} & \cdots & \otimes x_{ij} & \cdots & \otimes x_{in} \\ \vdots & \ddots & \ddots & \ddots & \vdots \\ \otimes x_{m1} & \cdots & \otimes x_{mj} & \cdots & \otimes x_{mn} \end{bmatrix} \quad (14)$$

$$i = \overline{0,m};\ j = \overline{1,n}.$$

If optimal value of *j* criterion is unknown, then $\otimes x_{0j}$= max $\otimes x_{ij}$, if the criterion is benefit criterion; $\otimes x_{0j}$= min $\otimes x_{ij}$, if the criterion is cost criterion. The system of criteria as well as the values and initial weights of criteria are determined by experts. The information can be corrected by the interested parties by taking into account their goals and opportunities.

The second stage the initial values of all the criteria are normalized-defining values $\otimes \overline{X_{ij}}$ of normalized decision-making matrix $\otimes \overline{X}$:

$$\otimes \bar{X} = \begin{bmatrix} \otimes \bar{x}_{01} & \cdots & \otimes \bar{x}_{0j} & \cdots & \otimes \bar{x}_{0n} \\ \vdots & \ddots & \cdots & \ddots & \vdots \\ \otimes \bar{x}_{i1} & \cdots & \otimes \bar{x}_{ij} & \cdots & \otimes \bar{x}_{in} \\ \vdots & \ddots & \ddots & \ddots & \vdots \\ \otimes \bar{x}_{m1} & \cdots & \otimes \bar{x}_{mj} & \cdots & \otimes \bar{x}_{mn} \end{bmatrix} \quad (15)$$

$i = \overline{0,m};\ j = \overline{1,n}.$

The criteria, whose preferable values are maxima, are normalized as follows:

$$\otimes \bar{x}_{ij} = \frac{\otimes x_{ij}}{\sum_{i=0}^{m} \otimes x_{ij}} \quad (16)$$

The criteria, whose preferable values are minima, are normalized by applying two stage procedure:

$$\otimes x'_{ij} = \frac{1}{\otimes x_{ij}} \quad ; \quad \otimes \bar{x}_{ij} = \frac{\otimes x'_{ij}}{\sum_{i=0}^{m} \otimes x'_{ij}} \quad (17)$$

The third stage is defining normalized-weighted matrix – $\otimes \bar{\bar{X}}$. Only well-founded weights should be used because weights are always subjective and influence the solution. The values of weight *wj* are usually determined by the expert evaluation method.

$$\sum_{j=1}^{n} w_j = 1, \quad (18)$$

$$\otimes \bar{\bar{x}}_{ij} = \otimes \bar{x}_{ij} \times w_j\,, \quad (19)$$

$$\otimes \bar{\bar{X}} = \begin{bmatrix} \otimes \bar{\bar{x}}_{01} & \cdots & \otimes \bar{\bar{x}}_{0j} & \cdots & \otimes \bar{\bar{x}}_{0n} \\ \vdots & \ddots & \cdots & \ddots & \vdots \\ \otimes \bar{\bar{x}}_{i1} & \cdots & \otimes \bar{\bar{x}}_{ij} & \cdots & \otimes \bar{\bar{x}}_{in} \\ \vdots & \ddots & \ddots & \ddots & \vdots \\ \otimes \bar{\bar{x}}_{m1} & \cdots & \otimes \bar{\bar{x}}_{mj} & \cdots & \otimes \bar{\bar{x}}_{mn} \end{bmatrix} \quad (20)$$

$i = \overline{0,m};\ j = \overline{1,n}.$

The following task is determining values of optimality function:

$$\otimes S_i = \sum_{ij}^{n} \otimes x_{ij}; \quad (21)$$

$$i = \overline{0,m},$$

where $\otimes S_i$ is the value of optimality function of i alternative. The biggest value is the best, and the least one is the worst. The result of grey decision making for each alternative is grey number $\otimes S_i$. There are several methods for transforming grey values to crisp values. The centre-of-area is the most practically and simple to apply:

$$S_i = \frac{1}{2}\left(S_{i\alpha} + S_{i\gamma}\right). \quad (22)$$

The degree of the alternative utility is determined by a comparison of the variant, which is analyzed, with the ideally best one S_0. The equation used for the calculation of the utility degree K_i of an alternative i is given below (Turskis and Zavadskas, 2010):

$$K_i = \frac{S_i}{S_0}; i = \overline{0, m} \quad (23)$$

If the current method is developed for group decision making, the following equation can be used for the calculation of the utility degree Ki of an alternative i is given below:

$$K_i = \sqrt[D]{\prod_{d=1}^{D} K_i^d} \quad (24)$$

K_i^d : d is the decision maker d, i is the alternative i, D is the number of decision makers.

Results and Findings

In this case personnel selection is problem for a new IT consultant by using an additive ratio assessment method with gray values (ARAS-G). KS is one of the leading cosmetic companies of Turkey. SAP has been used within the company for nearly 10 years. It has been actively used in production planning, accounting and sales departments and a transition is considered also for the human resources department. The company owns two web sites operating in the e-commerce field. Two web design and software specialists maintain these sites and they report to the marketing manager. The IT consultant will be employed within the company and will work as software project manager. The Software Project manager will be responsible for SAP and other software projects. He/she will manage the project resource planning, project control and project budget. He/she will coordinate with the finance manager, sales manager, production planning manager and marketing manager of the company in these projects. The two web design and software specialists will report to the software project manager. After preliminary interviews, the Human Resources department has determined 3 candidates and has requested to include in the process, the managers to work with the person to be employed in this position in the future; as the position has a complex structure.

Company benefit should be maximized whereas possible regret should be minimized in this process. In this case, the human resources manager preferred interval-valued interactive group decision making. The decision-makers are:

- Human resources manager
- Finance manager
- Sales manager
- Production Planning manager
- Marketing Manager.

Our criteria have been determined by the human resources manager after consulting with the decision-makers. The criteria are as follows:

- Education: Graduated from engineering faculties of universities (preferably from Industrial, Computer, Management Engineering etc.) and highly-fluent English.
- Experience: Has minimum 2 years of experience in SAP Project management, has a command of ASAP project management methodology, and has experience in planning and budgeting.
- Analytical thinking: Able to think analytically and has an effective problem solving approach.
- Teamwork: Prone to teamwork and has strong human relations, motivates her/his team, has strong communication, organization, time-management skills.
- Able to adapt to flexible working hours and intense pace of work.
- Able to travel domestically and internationally.

The decision-makers will assess the candidates according to the benefit they provide in accordance with these criteria. The group leader determined the weights of the criteria. After that, first step is establish the grey decision-making matrix ($\widetilde{X}$) for all decision makers. Decision making matrix for decision maker 1 is as shown in Table 3. The second step, the initial values of all the criteria are normalized-defining values $\otimes \overline{X_{ij}}$ of normalized decision-making matrix $\otimes \overline{X_{ij}}$ as shown in Table 4 for decision maker 1.

Table 3. Decision maker 1 initial grey decision making matrix

Criteria	Education	Experience	Analytical thinking	Teamwork	Able to adapt to flexible working	Able to travel domestically and

									hours and intense pace of work.		internationally	
	C_1		**C_2**		**C_3**		**C_4**		**C_5**		**C_6**	
Optimum	**max**		**max**		**max**		**max**		**max**		**max**	
W	α	γ	α	γ	α	γ	α	γ	α	γ	α	γ
	0,25	0,25	0,2	0,2	0,15	0,15	0,2	0,2	0,1	0,1	0,1	0,1
A_0	1	1	1	1	1	1	1	1	1	1	1	1
A_1	0,8	1	0,4	0,6	0,4	0,6	0,4	0,6	0,6	0,8	0,4	0,6
A_2	0,6	0,8	0,6	0,8	0,6	0,8	0,6	0,8	0,4	0,6	0,4	0,6
A_3	0,8	1	0,4	0,6	0,6	0,8	0,4	0,6	0,8	1	0,6	0,8

Table 4. Decision maker 1 normalized decision-making matrix

Criteria	**C_1**		**C_2**		**C_3**		**C_4**		**C_5**		**C_6**	
Optimum	**max**		**max**		**max**		**max**		**max**		**max**	
w	α	γ	α	γ	α	γ	α	γ	α	γ	α	γ
	0,25	0,25	0,2	0,2	0,15	0,15	0,2	0,2	0,1	0,1	0,1	0,1
A0	0.31	0.26	0.42	0.33	0.38	0.31	0.36	0.29	0.36	0.29	0.42	0.33
A_1	0.25	0.26	0.17	0.20	0.15	0.19	0.29	0.29	0.21	0.24	0.17	0.20
A2	0.19	0.21	0.25	0.27	0.23	0.25	0.21	0.24	0.14	0.18	0.17	0.20
A3	0.25	0.26	0.17	0.20	0.23	0.25	0.14	0.18	0.29	0.29	0.25	0.27

The third step is defining normalized-weighted matrix – $\otimes \overline{\overline{\mathbf{X}}}$. Then S, K_i ; are calculated. The calculated values for decision maker 1 as shown in Table 5.

Table 5. Results for decision maker 1

	S	K^1
A0	0,334	1
A1	0,225	0,673408205
A2	0,217	0,648073957
A3	0,224	0,668680505

The final step, K value for all alternatives calculated from K^i values as shown in Table 6.

Table 6. Results for all decision maker and the group

	K^1	**K^2**	**K^3**	**K^4**	**K^5**	**K**
A_1	0.67	0.65	0.60	0.67	0.63	0.593917214
A_2	0.64	0.66	0.59	0.61	0.61	0.564840015
A_3	0.66	0.71	0.65	0.65	0.70	0.617914062

Conclusion

Personnel selection problem turns into a complicated problem that one decision-maker cannot handle as amount of the investment increases. In this case, personal expertise is not enough and the subject should be examined from different angles. Therefore, the problem was handled by group decision making method as the information and experience provided by the persons would be more than one person's information and experience and this would increase the effectiveness of the decision. As a result of the study, Candidate 3 has received the highest benefit value as a result of the process. The method was developed to include group decision-making.

References

Ayub, M., Kabir, M. J., & Alam, M. G. R. (2009, December). Personnel selection method using Analytic network Process (ANP) and fuzzy concept. In Computers and Information Technology, 2009. ICCIT'09. 12th International Conference on (pp. 373-378). IEEE.

Canós, L., & Liern, V. (2008). Soft computing-based aggregation methods for human resource management. European Journal of Operational Research, 189(3), 669-681.

Chen, L. S., & Cheng, C. H. (2005). Selecting IS personnel use fuzzy GDSS based on metric distance method. European journal of operational research, 160(3), 803-820.

Dursun, M., & Karsak, E. E. (2010). A fuzzy MCDM approach for personnel selection. Expert Systems with applications, 37(6), 4324-4330.

Gargano, M. L., Marose, R. A., & von Kleeck, L. (1991, October). An application of artificial neural networks and genetic algorithms to personnel selection in the financial industry. In Artificial Intelligence Applications on Wall Street, 1991. Proceedings., First International Conference on (pp. 257-262). IEEE.

Gibney, R., & Shang, J. (2007). Decision making in academia: A case of the dean selection process. Mathematical and Computer Modelling, 46(7), 1030-1040.

Jessop, A. (2004). Minimally biased weight determination in personnel selection. European Journal of Operational Research, 153(2), 433-444.

Karsak, E. E. (2000). A fuzzy multiple objective programming approach for personnel selection. In Systems, Man, and Cybernetics, 2000 IEEE International Conference on (Vol. 3, pp. 2007-2012). IEEE.

Karsak, E. E. (2001). Personnel selection using a fuzzy MCDM approach based on ideal and anti-ideal solutions. In Multiple criteria decision making in the new millennium (pp. 393-402). Springer, Berlin, Heidelberg.

Kelemenis, A., & Askounis, D. (2010). A new TOPSIS-based multi-criteria approach to personnel selection. Expert systems with applications, 37(7), 4999-5008.

Liu, S., & Forrest, J. Y. L. (2010). Grey systems: theory and applications. Springer.

Petrovic-Lazarevic, S. (2001). Personnel selection fuzzy model. International Transactions in Operational Research, 8(1), 89-105.

Tupenaite, L., Zavadskas, E. K., Kaklauskas, A., Turskis, Z., & Seniut, M. (2010). Multiple criteria assessment of alternatives for built and human environment renovation. Journal of Civil Engineering and Management, 16(2), 257-266.

Turskis, Z., & Zavadskas, E. K. (2010). A novel method for multiple criteria analysis: grey additive ratio assessment (ARAS-G) method. Informatica, 21(4), 597-610.

Wang, D. (2009, September). Extension of TOPSIS method for R&D personnel selection problem with interval grey number. In Management and Service Science, 2009. MASS'09. International Conference on (pp. 1-4). IEEE.

Zavadskas, E. K., & Turskis, Z. (2010). A new additive ratio assessment (ARAS) method in multicriteria decision making. Technological and Economic Development of Economy, 16(2), 159-172.

Zavadskas, E. K., Turskis, Z., & Vilutiene, T. (2010). Multiple criteria analysis of foundation instalment alternatives by applying Additive Ratio Assessment (ARAS) method. Archives of civil and mechanical engineering, 10(3), 123-141.