Vol-2, Issue-12 PP. 1864-1870 ISSN: 2394-5788

GLOBAL JOURNAL OF ADVANCED RESEARCH
(Scholarly Peer Review Publishing System)

LEADERSHIP COMPETENCY EVALUATION BY INTEGRATION OF FUZZY SHANNON'S ENTROPY AND VIKOR METHODS

Majid Moradi
Department of Accounting,
Naser Khosrow Institute of Higher Education, Saveh,
Iran

Masoud Maleki
Student of Operation Research,
Qom University,
Iran

Hamed Azadi Pilehrood
Student of Business Management,
College of Farabi,
University of Tehran,
Iran

ABSTRACT

Leadership competencies have been widely used by organizations to define their leaders capabilities .The purpose of this paper is developing a framework based on the fuzzy multiple criteria decision making approach to identify the best leader. Then fuzzy shanon method is applied to determine the relative importance of these components. Moreover VIKOR method is respectively introduced for the purpose of ranking leaders in terms of leadership competency criteria. In this paper a numerical example demonstrates the application of the proposed method.

Key Words: Leadership Competency, Multiple Criteria Decision Making, Entropy, VIKOR.

1. INTRODUCTION

Several definitions of leadership have been presented over the years. Most definitions include one or more of the elements of goal attainment, group or organization, structure and interpersonal relationships. This indicates a strong link between leadership and organization (Andersen, 2006). Blake and Mouton define leadership as "Processes of leadership are involved in achieving results with and through others" (Blake & Mouton, 1964). The definition of leadership by Tannenbaum, Weschler, and Massarik is "interpersonal influence, exercised in a situation, and directed, through the communication process, toward the attainment of a specified goal or goals" (Tannenbaum, Weschler, & Massarik, 1961). This definition has been generally accepted today and includes the key concepts. Leaders in all organizations where new solutions need to be found and implemented are affected. Organizations are also affected by leadership. In recent years, the emphasis has shifted to include more leader-specific attributes and ensuring that these are acknowledged and integrated at institutional levels. Thus the capability of leadership exists at both the individual and the collective level, which together in their sum, forms organizational leadership (Vlok, 2012). Leadership competencies have been widely used by organizations to define their ledears capabilities (Dai, Tang, & De Meuse, 2011). The competencies for leadership may differ from those used before to craft and achieve business goals. Research on leadership competencies appears to be limited and with little evidence of a cumulative and coherent body of knowledge emerging on the topic. But contributions to the body of knowledge are increasing (Vlok, 2012). Two of the most popular authors on the concept of leadership, Stephen Covey and John Maxwell, claim that leadership is essentially about influence (Covey, 2006; Maxwell, 2005). The transformational leader and the level 5 leader described by Jim Collins of "Good to Great" fame appear to be similar because both emphasize the importance of a clear, compelling, shared vision and leaders who catalyze the creative contributions of people other than themselves towards achievement of the vision (Vlok, 2012). The concepts of management and leadership have different origins but are intertwined and essentially synonymous (Vlok, 2012). Some theorists, however, would limit the definition of leadership to influence resulting in enthusiastic

GLOBAL JOURNAL OF ADVANCED RESEARCH
(Scholarly Peer Review Publishing System)

commitment by followers, as opposed to indifferent compliance or reluctant obedience. Proponents of this view argue that a person who uses authority and control over rewards and punishments to manipulate or coerce followers is not really "leading" them. Leadership is persuasion, not domination. Persons who can require others to do their bidding because of their power are not leaders. The opposing view is that this definition is too restrictive, because it excludes influence processes that are important for understanding why a manager or administrator is effective or ineffective in a given situation (Andersen, 2006). Competency definitions range from abstract psychological constructs to direct observable behavior, to something innovative and may even include something highly desirable (Vlok, 2012). Competency refers to the complete blend of requirements to perform in a given context. It includes being competent in uncertain and unpredictable situations that require more than the skills mastered in a professional area. Competencies can thus be seen as inclusion of skills, knowledge and attitudes, including the patterns of personal competencies and the way they work together for achievement (Andersen, 2006). Leadership competency models focus on behavior rather than personality traits, because personality traits are usually hard to measure accurately. Competency models provide a common language for discussing leadership capabilities and performance (Chung, Beth, Cathy, & Lankau, 2003). Many factors can be found in the literature for the purpose of measuring leadership competency. The main criteria which are used in this study are taken from Atarod et al (2014) and include Follower Retention (C1), Follower OCB (C2), Productivity/ performance outcomes (C3), Corporate Sustainability (C4), Leader Motivation (C5), Leader Relationship (C6) and Leader Resilience (C7).

In this regard, this article proposes a competency evaluation model for assessing leaders based on their leadership capabilities. Thus the research started with a list of leadership competencies from multiple sources, including articles and available leadership development reports. Then fuzzy shanon method is applied to determine the relative importance of these competency components. Finally VIKOR method is applied for the purpose of ranking leaders in terms of leadership competency criteria.

2. RESEARCH METHODOLOGY

The main purpose of this study is developing a suitable model for leadership competency evaluation. According to this, first by studying the literature related to leadership competency models criteria was recognized. Then the weight of each criterion was analyzed by the fuzzy shanon method. Finally, according to these weights, the VIKOR method was applied for the purpose of ranking leaders.

2.1. The Fuzzy and numbers

Fuzzy set theory, which was introduced by Zadeh (1965) to deal with problems in which a source of vagueness is involved, has been utilized for incorporating imprecise data into the decision framework. A fuzzy set $\tilde{A}$ can be defined mathematically by a membership function $\mu_{\tilde{A}}(X)$, which assigns each element x in the universe of discourse X a real number in the interval [0,1]. A triangular fuzzy number $\widetilde{A}$ can be defined by a triplet (a, b, c) as illustrated in figure 1.

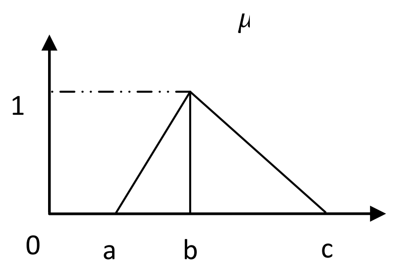

Figure 1. A triangular fuzzy number $\tilde{A}$

GLOBAL JOURNAL OF ADVANCED RESEARCH
(Scholarly Peer Review Publishing System)

The membership function $\mu_{\tilde{A}}(X)$ is defined as

$$\mu_{\tilde{A}}(x) = \begin{cases} \frac{x-a}{b-a} & a \le x \le b \\ \frac{x-c}{b-c} & b \le x \le c \\ 0 & oterwise \end{cases} \tag{1}$$

Basic arithmetic operations on triangular fuzzy numbers $A_1 = (a_1,b_1,c_1)$, where $a_1 \le b_1 \le c_1$, and $A_2 = (a_2,b_2,c_2)$, where $a_2 \le b_2 \le c_2$,can be shown as follows:

Addition: $A_1 \oplus A_2 = (a_1 + a_2, b_1 + b_2, c_1 + c_2)$ (2)

Subtraction: $A_1 \ominus A_2 = (a_1 - c_2, b_1 - b_2, c_1 - a_2)$ (3)

Multiplication: if k is a scalar

$$k \otimes A_1 = \begin{cases} (ka_1, kb_1, kc_1), & k > 0 \\ (kc_1, kb_1, ka_1), & k < 0 \end{cases}$$

$A_1 \otimes A_2 \approx (a_1a_2, b_1b_2, c_1c_2)$, if $a_1 \ge 0$, $a_2 \ge 0$ (4)

Division: $A_1 \oslash A_2 \approx \left(\frac{a_1}{c_2}, \frac{b_1}{b_2}, \frac{c_1}{a_2}\right)$, if $a_1 \ge 0$, $a_2 \ge 0$ (5)

Although multiplication and division operations on triangular fuzzy numbers do not necessarily yield a triangular fuzzy number, triangular fuzzy number approximations can be used for many practical applications (Kaufmann & Gupta, 1988). Triangular fuzzy numbers are appropriate for quantifying the vague information about most decision problems including personnel selection (e.g. rating for creativity, personality, leadership, etc.). The primary reason for using triangular fuzzy numbers can be stated as their intuitive and computational-efficient representation (Karsak, 2002). A linguistic variable is defined as a variable whose values are not numbers, but words or sentences in natural or artificial language. The concept of a linguistic variable appears as a useful means for providing approximate characterization of phenomena that are too complex or ill-defined to be described in conventional quantitative terms (Zadeh, 1975).

2.2. Fuzzy Shannon's Entropy

Hosseinzadeh et al (2010) extend the Shannon entropy for the imprecise data, especially interval and fuzzy data cases. In this paper we obtain the weights of criteria based on their method. The steps of fuzzy Shannon's Entropy explained as follow (Hosseinzadeh et al, 2010):

Step 1: transforming fuzzy data into interval data by using the α-level sets:
The α-level set of a fuzzy variable $\tilde{x}_{ij}$ is defined by a set of elements that belong to the fuzzy variable $\tilde{x}_{ij}$ with membership of at least α i.e., $(\tilde{x}_{ij})_{\alpha} = \{x_{ij} \in R \mid \mu_{\tilde{x}_{ij}}(x_{ij}) \ge \alpha\}$.
The α-level set can also be expressed in the following interval form:

$$[(\tilde{x}_{ij})^{l}_{\alpha}, (\tilde{x}_{ij})^{U}_{\alpha}] = [\min_{x_{ij}}\{x_{ij} \in R \mid \mu_{\tilde{x}_{ij}}(x_{ij}) \ge \alpha\}, \max_{x_{ij}}\{x_{ij} \in R \mid \mu_{\tilde{x}_{ij}}(x_{ij}) \ge \alpha\}] \tag{6}$$

where $0 < \alpha \le 1$. By setting different levels of confidence, namely 1-α, fuzzy data are accordingly transformed into different α -level sets $\{(\tilde{x}_{ij})_{\alpha} \mid 0 < \alpha \le 1\}$, which are all intervals.

Step 2: The normalized values p'_{ij} and p''_{ij} are calculated as:

$$p'_{ij} = \frac{x'_{ij}}{\sum_{j=1}^{m} x''_{ij}}, \quad p''_{ij} = \frac{x''_{ij}}{\sum_{j=1}^{m} x'_{ij}}, \quad j=1,\ldots,m, \ i=1,\ldots,n \tag{7}$$

Step 3: Lower bound h'_i and upper bound h''_i of interval entropy can be obtained by:

GLOBAL JOURNAL OF ADVANCED RESEARCH
(Scholarly Peer Review Publishing System)

$h_i^{'}$ = min {- h$_0 \sum_{j=1}^{m} p_{ij}^{'} . Ln\, p_{ij}^{'}$, - h$_0 \sum_{j=1}^{m} p_{ij}^{''} . Ln\, p_{ij}^{''}$ }, i=1,…,n and

$h_i^{''}$ = max {- h$_0 \sum_{j=1}^{m} p_{ij}^{'} . Ln\, p_{ij}^{'}$, - h$_0 \sum_{j=1}^{m} p_{ij}^{''} . Ln\, p_{ij}^{''}$ }, i=1,…,n (8)

where h_0 is equal to $(Ln\, m)^{-1}$, and $p_{ij}^{'}$.Ln $p_{ij}^{'}$ or $p_{ij}^{''}$.Ln $p_{ij}^{''}$ is defined as 0 if $p_{ij}^{'}$ = 0 or $p_{ij}^{''}$ = 0.

Step 4: Set the lower and the upper bound of the interval of diversification $d_i^{'}$ and $d_i^{''}$ as the degree of diversification as follows:

$$d_i^{'} = 1- h_i^{''} ,\ d_i^{''} = 1- h_i^{'} ,\ i=1,\dots,n \qquad (9)$$

Step 5: Set $w_i^L = \frac{d_i^L}{\sum_{s=1}^{n} d_s^u}$, $w_i^U = \frac{d_i^U}{\sum_{s=1}^{n} d_s^L}$, i=1,…,n as the lower and upper bound of interval weight of attribute i.

2.3. The VIKOR Method

The VIKOR method is a compromise MADM method, developed by Opricovic .S and Tzeng (Opricovic, 1998; Opricovic, S. and Tzeng, G. H., 2002) started from the form of Lp-metric:

$$L_{pi} = \left\{\sum_{j=1}^{n}\left[w_j\left(f_j^* - f_{ij}\right)/\left(f_j^* - f_j^-\right)\right]^p\right\}^{1/p} 1 \le p \le +\infty \,; i = 1,2,\dots I \qquad (10)$$

The VIKOR method can provide a maximum ‘‘group utility’’ for the “majority’’ and a minimum of an individual regret for the ‘‘opponent’’ (Opricovic, 1998; Opricovic, S; Tzeng, G. H., 2002; Serafim Opricovic & Gwo-Hshiung Tzeng, 2004).

2.3.1. Working Steps of VIKOR Method

1) Calculate the normalized value
Assuming that there are m alternatives, and n attributes. The various I alternatives are denoted as x_i. For alternative x_j, the rating of the jth aspect is denoted as x_{ij}, i.e. x_{ij} is the value of jth attribute. For the process of normalized value, when x_{ij} is the original value of the ith option and the jth dimension, the formula is as follows:

$$f_{ij} = x_{ij} / \sqrt{\sum_{j=1}^{n} x_{ij}^2} \quad , i = 1,2,\dots,m \,; j = 1,2,\dots ,n \qquad (11)$$

2) Determine the best and worst values
For all the attribute functions the best value was f_j^* and the worst value was f_j^-, that is, for attribute J=1-n, we get formulas (12) and (13).

$$f_j^* = \max \quad f_{ij} \,, i = 1,2,\dots,m \qquad (12)$$

$$f_j^- = \min \quad f_{ij} \,, i = 1,2,\dots,m \qquad (13)$$

Where f_j^* the positive ideal solution for the jth criteria is, f_j^- is the negative ideal solution for the jth criteria. If one associates all f_j^*, one will have the optimal combination, which gets the highest scores, the same as f_j^-.
3) Determine the weights of attributes
The weights of attribute should be calculated to express their relative importance.
4) Compute the distance of alternatives to ideal solution

This step is to calculate the distance from each alternative to the positive ideal solution and then get the sum to obtain the final value according to formula (14) and (15).

$$S_i = \sum_{j=1}^{n} w_j (f_j^* - f_{ij})/(f_j^* - f_j^-) \tag{14}$$

$$R_i = \max_j \left[w_j (f_j^* - f_{ij})/(f_j^* - f_j^-)\right] \tag{15}$$

Where S_i represents the distance rate of the ith alternative to the positive ideal solution (best combination), R_i represents the distance rate of the ith alternative to the negative ideal solution (worst combination). The excellence ranking will be based on S_i values and the worst rankings will be based on R_i values. In other words, S_i, R_i indicate L_{1i} and L_{*i} of L_p-metric respectively.

5) Calculate the VIKOR values Q_i for i=1,2, … ,m, which are defined as

$$Q_i = v\left[\frac{S_i - S^*}{S^- - S^*}\right] + (1-v)\left[\frac{R_i - R^*}{R^- - R^*}\right] \tag{16}$$

Where $S^- = \max_i S_i$, $S^* = \min_i S_i$, $R^- = \max_i R_i$, $R^* = \min_i, R_i$, and v is the weight of the strategy of "the majority of criteria'' (or ''the maximum group utility''). $[(S - S^*)/(S^- - S^*]$ represents the distance rate from the positive ideal solution of the ith alternative's achievements In other words, the majority agrees to use the rate of the ith.$[(R - R^*)/(R^- - R^*]$ represents the distance rate from the negative ideal solution of the ith alternative; this means the majority disagree with the rate of the ith alternative. Thus, when the v is larger (> 0.5), the index of Q_i will tend to majority agreement; when v is less (< 0.5), the index Q_i will indicate majority negative attitude; in general, v = 0.5, i.e. compromise attitude of evaluation experts.

6) Rank the alternatives by Q_i values

According to the Q_i values calculated by step (4), we can rank the alternatives and to make-decision.

3. EMPIRICAL ANALYSIS

In this paper we consider seven criteria that include Follower Retention (C1), Follower OCB (C2), Productivity/ performance outcomes (C3), Corporate Sustainability (C4), Leader Motivation (C5), Leader Relationship (C6) and Leader Resilience (C7) and we consider four alternatives include A1, A2, A3 and A4. In fuzzy Shannon's Entropy, firstly, the criteria and alternatives' importance weights must be compared. Afterwards, the comparisons about the criteria and alternatives, and the weight calculation need to be made. Thus, the evaluation of the criteria according to the main goal and the evaluation of the alternatives for these criteria must be realized. Then, after all these evaluation procedure, the weights of the alternatives can be calculated. In the second step, these weights are used to VIKOR calculation for the final evaluation. The aggregate decision matrix for Shannon's Entropy can be seen from Table 1.

Table 1. Aggregate decision matrix for fuzzy Shannon's Entropy

DM	C_1	C_2	…	C_6	C_7
A_1	(0.00, 1.00,3.00)	(1.00, 3.00,5.00)	…	(3.00, 5.00,7.00)	(0.00, 1.00,3.00)
A_2	(1.00, 3.00,5.00)	(5.00, 7.00,9.00)	…	(5.00, 7.00,9.00)	(3.00, 5.00,7.00)
A_3	(5.00, 7.00,9.00)	(0.00, 1.00,3.00)	…	(1.00, 3.00,5.00)	(1.00, 3.00,5.00)
A_4	(5.00, 7.00,9.00)	(0.00, 1.00,3.00)	…	(1.00, 3.00,5.00)	(1.00, 3.00,5.00)

According to fuzzy shanon steps, the crisp weight are calculated, as follow:

Wt = (0.1933, 0.1857, 0.1666, 0.1284, 0.0833, 0.1315, 0.1112)

The weights of criteria are calculated by fuzzy shanon up to now, and then these values can be used in VIKOR method. According to VIKOR methodology, the results and final ranking are shown in Table 2.

GLOBAL JOURNAL OF ADVANCED RESEARCH
(Scholarly Peer Review Publishing System)

Table 2. Final evaluation of alternatives

	Q_i	Rank
A_1	1	4
A_2	0.675601	3
A_3	0	1
A_4	0.264161	2

According to Table 2, A3 is the best leader among other persons and other leaders ranked as follow: A3 >A4 >A2 >A1.

4. CONCLUSIONS

The main purpose of this paper is to propose a suitable model for leadership competency evaluation. In this regard, first a framework for leadership competency criteria is constructed through a comprehensive survey of the related literature. First the criteria are recognized. Second the fuzzy Shanon is applied to determine weights of criteria. Finally VIKOR method is used in order to rank the leaders. According to result, A3 is the best leader among other persons.

5. REFERENCES

[1] Andersen, J. (2006). Leadership, personality and effectiveness. *The Journal of Socio-Economics*, *35*, 1078–1091.

[2] Atarod, H., Soleimani, M., Ebrahimi, R (2014). Developing an Integrated Leadership Competency Evaluation Model based on MCDM Methods, Int. j. econ. manag. soc. sci., Vol(3), No (11), pp. 686-692.

[3] Blake, R., & Mouton, J. (1964). *The Managerial Grid.* Houston: Gulf Publishing Co.

[4] Chung, G., B., A., C., & Lankau, M. (2003). A Competencies Model Grooming Future Hospitality Leaders. *Cornell Hospitality Quarterly, 44*, 17-25.

[5] Chung, H., Beth, G., Cathy, A., & Lankau, M. (2003). A Competencies Model Grooming Future Hospitality Leaders. *Cornell Hospitality Quarterly, 44*, 17-25.

[6] Covey, S. (2006). Servant leadership; use your voice to serve others. *Leadership Excellence*, *23*(12), 5-6.

[7] Dai, G., Tang, K., & De Meuse, P. K. (2011). Leadership competencies across organizational levels: a test of the pipeline model. *Journal of Management Development*, 366-380.

[8] Hosseinzadeh Lotfi, F., Fallahnejad, R. (2010). Imprecise Shannon's entropy and multi attribute decision making, Entropy 12, 53-62; doi:10.3390/e12010053.

[9] Karsak, E. E. (2002). Distance-based fuzzy MCDM approach for evaluating flexible manufacturing system alternatives. International Journal of Production Research 40(13), 3167–3181.

[10] Kaufmann, A., and Gupta, M. M. (1988). Fuzzy mathematical models in engineering and management science. Amsterdam: North-Holland.

GLOBAL JOURNAL OF ADVANCED RESEARCH
(Scholarly Peer Review Publishing System)

[11] Opricovic. (1998). "Multi-criteria optimization of civil engineering systems, "Faculty of Civil Engineering, Belgrade.

[12] Opricovic, S., & Tzeng, G. H. (2002). Multicriteria planning of post earthquake sustainable reconstruction, Computer-Aided Civil and Infrastructure Engineering, no.17, pp. 211–220.

[13] Tannenbaum, R., Weschler, I., & Massarik, F. (1961). *Leadership and Organization.* New York: McGraw-Hill.

[14] Vlok, A. (2012). A leadership competency profile for innovation leaders in a science-based research and innovation organization in South Africa. *Procedia - Social and Behavioral Sciences, 41*, 209 – 226.

[15] Zadeh, L. A. (1965). Fuzzy sets. Information and Control, 8(3), 338–353.

[16] Zadeh, L. A. (1975). The concept of a linguistic variable and its application to approximate reasoning-I. Information Sciences, 8(3), 199–249.