Development of Organizational Strategies by Fuzzy Logic and MCDM (FMCDM)
Case Study: Distribution of Book of Marv Eghlim Roshan Company

M. Nasrabadi[1], M. A. Sobhanallahi

[1]Department of Industrial Engineering, Kharazmi University, Tehran, Iran
nasrabadi.mehri1392@gmail.com

Abstract

One of the important factors for success an organization is Utilization and adoption appropriate strategies with regard to internal and external conditions of organization. In this paper is used the SWOT matrix for evaluation of effective internal and external factors on performance of organization. In addition to fuzzy techniques and Linguistic variables is used for the weighting of the criteria, Since the criteria (internal and external factors) are associated with some ambiguities and uncertainties. Finally, we used OWA method (ordered weighted average) for ranking of strategies.

1. Introduction

 Nowadays, Have a competitive advantage is considered as an effective factor in advancement an organization. Organizations have to use varied methods to gain competitive advantage, that correct selection of strategies is one of them. Strategies are comprehensive programs that included activities and prepare resources to achieve to goals. Resources of organization is limited, so organization manager have to use effective methods for selecting the best strategy.There are afew paper for development of strategies, For example, Kurttila [2000] proposed a hybrid method for limits of measurement and evaluation of swot matrix. Swanson [2001] reviewed the relationship between maintenance strategies and performance. Mechefske & wang [2003] used linguistic variables for selecting control strategies. Dyson [2004] used SWOT method. Yuksel & Dagdeviren [2007] used ANP method for designing and development of SWOT strategies. Sevkli [2012] proposed a fuzzy ANP model, according to SWOT analysis. In this paper is used SWOT matrix for evaluation of internal and external factors affecting on performance of organization, and FMCDM for rattting strategies. Most existing models are used ANP method and AHP method for ratting of strategies. In this paper, we use OWA method for ratting of strategies. OWA method determines ratting with expressing mental characteristics of decision makers.

2. SWOT matrix

	Opportunities	**Threats**
Strengths	It's the best time for having an operation	We need to turn threats into opportunities
Weaknesses	We should use desirable conditions and Overcame the Weaknesses of the organization	We should use defensive strategies

3. Multi - criteria decision - making (MCDM)

Multiple- criteria decision- making is a sub-discipline of operations research that explicitly considers multiple criteria in decision-making environments. Whether in our daily lives or in professional settings, there are typically multiple conflicting criteria that need to be evaluated in making decisions.Some MCDM methods are TOPSIS, GP, AHP, ANP, SAW, OWA.

3.1. The ordered weighted average method

This method determines risk taker and risk averse decision makers.

OWA operator of dimension n is a mapping $F: R_n : \to R$ that has an associated collection of weights.

$$W = [w_1, \dots, w_n]$$

W vector lying in the unit interval and summing to one and with

$F(a_1, \dots, a_n) = \sum w_j b_j$, where b_j is the jth largest of the a_i.

By choosing different *W* one can implement different aggregation operators. The OWA operator is a non-linear operator as a result of the process of determining the b_j.

Two features have been used to characterize the OWA operators. The first is the attitudinal character (orness).

This is defined as:

$$A - C(W) = \frac{1}{n-1} \sum_{j=1}^{n} (n-j) w_j.$$

$$A - C(W) \in [0,1].$$

In addition $A - C$ (max) = 1, $A - C$ (ave) = $A - C$ (med) = 0.5 and $A - C$ (min) = 0. Thus the $A - C$ goes from 1 to 0 as we go from Max to Min aggregation. The attitudinal character characterizes the similarity of aggregation to OR operation (OR is defined as the Max).

The weight is calculated through of the following method.

$$Wi = Q\,(i/n) - Q\,(i - 1/n) \quad ,i = 1, \dots ,n \quad (2)$$

n is the number of the indexes and i is the count of the indexes.

$$Q(r) = \begin{cases} 0 & if\ r < a \\ \dfrac{r - a}{b - a} & if\ a \le r \le b \\ 1 & if\ r > b \end{cases}$$

$$a \ge 0, \quad Q(r) = r\alpha$$

The function f is related to the degree of optimism.

$$\int_0^1 Q(r)dr = \int_0^1 r^\alpha\,dr = \frac{1}{\alpha+1}$$

$$A - C\,(W) < 0.5 \ \rightarrow\ 1 > \ \alpha$$

DM is risk averse.

$$\alpha = 1 \quad \rightarrow \quad A - C\,(W) = 0.5$$

DM is neutral

$$\alpha < 1 \quad \rightarrow \quad A - C\,(W) > 0.5$$

DM is risk taking

4. The construction of fuzzy decision matrix

$$D = \begin{bmatrix} X_{11} & \cdots & X_{1n} \\ \vdots & \ddots & \vdots \\ X_{m1} & \cdots & X_{mn} \end{bmatrix}$$

$$W = [w_1, w_2, \dots w_n]$$

$$X\_(ij = 1/K)[Xij1\,(+)\,Xij2\,(+)\ \dots\ (+)\,Xijk]$$

4.1. Scale-up the fuzzy decision matrix with linear method

B is the Set of the positive measures and C is the Set of the negative measures.

$$\boldsymbol{R} = \left[r_{ij}\right]_{m \times n}$$

$$r_{ij} = \left(\frac{a_{ij}}{c_j^*}, \frac{b_{ij}}{c_j^*}, \frac{c_{ij}}{c_j^*}\right) \quad , \qquad j \in B$$

$$Cj *= max\ cij \qquad if \qquad j \in B$$

$$rij = \left(\frac{a_j}{c_{ij}}, \frac{a_j}{b_{ij}}, \frac{a_j}{a_{ij}}\right) \quad , \quad j \in C$$

$$aj = min\ aij \qquad if \qquad j \in C$$

4.2. Construction of Scale up weighted matrix

$$[v\_ij]\_(m \times n) \quad i = 1,2,\dots,m \qquad\qquad j = 1,2,\dots,n$$

$$v\_ij = r\_(ij(.)\ w\_j)$$

4.3. Linguistic variables for weighting

Weight	Fuzzy Set
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)

4.4. Linguistic variables for ranking

Ranking	Fuzzy sets
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)

5. Case study

We use OWA method for development of strategies in distribution of book Company.

We considers two $DMs, k = 2$.

Strengths are s_1, s_2, s_3.

Weaknesses are w_1, w_2, w_3.

Opportunity is O_1.

Threats are t_1, t_2.

The Suggested strategies are $so_1, wo_1, st_1, st_2, wt_1$.

5.1. The internal and external factors affecting on the performance of the company

Weakness	Strenght	
1- poor marketing and don't use of Technology. 2-Inappropriate Location of Company. 3-Lack of expert personnel and interested in working.	1-distribution of book to Most cities and adjacent provinces 2-diversity of Book 3- reputation of Company	
WO 1-employmenting some of skilled marketer	**SO** 1- Establishment of Various exhibitions in different areas of the city	**Opportunity**
WT 1-lending of book	**ST** 2-If you buy some books,you will receive amount of discounts	**Threat**

5.2. Comments of DMs about the impact of the strategies on the internal and external factors

	SO$_1$		SO$_2$		WO$_1$		ST$_1$	ST$_2$	WT$_1$	
	D1	D2	D1	D2	D1	D2	D1	D2	D1	D2
O$_1$	VH	H	H	H	H	VH	H	H	H	VH
T$_1$	H	H	H	MH	H	H	H	VH	H	H
T$_1$	VL	L	L	VL	M	MH	H	H	VH	VH
S$_1$	M	ML	H	VH	MH	M	MH	MH	L	VL
S$_2$	VH	H	H	H	MH	M	H	MH	MH	H
S$_3$	MH	M	M	MH	M	M	ML	ML	M	ML
W$_1$	H	H	H	H	M	ML	H	MH	MH	MH
W$_2$	MH	H	MH	MH	ML	M	ML	M	M	MH
W$_3$	ML	ML	H	MH	ML	ML	L	L	L	ML

5.3. construction of Fuzzy decision matrix

Strategies / Criteria	O$_1$	T$_1$	T$_2$	S$_1$	S$_2$	S$_3$	W$_1$	W$_2$	W$_3$
Index	+	-	-	+	+	+	-	-	-
SO$_1$	(0.8.0.95.1)	(0.7,0.9,1)	(0.15,0.3,0.5)	(0.2,0.4,0.6)	(0.8.0.95.1)	(0.4.0.6,0.8)	(0.7,0.9,1)	(0.1,0.3,0.5)	(0.6,0.8,0.95)
WO$_1$	(0.7,0.9,1)	(0.6,0.8,0.95)	0.05,0.2,0.4)(	(0.8.0.95.1)	0.7,0.9,1)	(0.4.0.6,0.8)	(0.7,0.9,1)	(0.6,0.8,0.95)	(0.5,0.7,0.9)
ST$_1$	(0.8.0.95.1)	(0.7,0.9,1)	(0.6,0.8,0.95)	(0.4.0.6,0.8)	(0.4.0.6,0.8)	(0.3,0.5,0.7)	(0.2,0.4,0.6)	(0.1,0.3,0.5)	(0.2,0.4,0.6)
ST$_2$	(0.7,0.9,1)	(0.6,0.63,0.75)	(0.05.0.05,0.07)	(0.5,0.7,0.9)	(0.6,0.8,0.95)	(0.13,0.38,0.63)	(0.21,0.25,0.33)	(0.13,0.26,1)	(0.33,0.5,1)
WT$_1$	(0.8.0.95.1)	(0.6,0.6,0.67)	(0.05,0.05,0.05)	(0,0.05,0.2)	(0.6,0.8,0.95)	(0.25,0.5,0.75)	(0.22,0.25,0.33)	(0.13,0.26,1)	(0.25,0.33,0.5)

5.4. Scale-up Fuzzy decision matrix with linear method

Criteria / Strategies Index	O_1	T_1	T_2	S_1	S_2	S_3	W_1	W_2	W_3
	+	-	-	+	+	+	-	-	-
SO_1	(0.8.0.95.1)	(0.6,0.67.086)	(0.1,0.17,0.33)	(0.2,0.4,0.6)	(0.8.0.95.1)	(0.5,0.75,1)	(0.2,0.22,0.29)	(0.11,0.17,0.5)	(0.21,0.25,0.33)
WO_1	(0.7,0.9,1)	(0.63,075,1)	(0.13,0.25,1)	(0.8,0.95,1)	0.7,0.9,1)(	(0.5,0.75,1)	(0.2,0.22,0.29)	(0.05,0.06,0.08)	(0.22,0.29,0.4)
ST_1	(0.8.0.95.1)	(0.6,0.67,.086)	(0.05,0.06,0.08)	(0.4.0.6,0.8)	(0.4,0.6,0.8)	(0.38,0.63,088)	(0.33,0.5,1)	(0.11,0.17,0.5)	(0.33,0.5,1)
ST_2	(0.7,0.9,1)	(0.6,0.63,0.75)	(0.05.0.05,0.07)	(0.5,0.7,0.9)	(0.6,0.8,0.95)	(0.13,0.38,0.63)	(0.21,0.25,0.33)	(0.13,0.26,1)	(0.33,0.5,1)
WT_1	(0.8.0.95.1)	(0.6,0.6,0.67)	(0.05.0.05,0.05)	(0,0.05,0.2)	(0.6,0.8,0.95)	(0.25,0.5,0.75)	(0.22,0.25,0.33)	(0.13,0.26,1)	(0.25,0.33,0.5)

5.5. Calculation of the Weights of the criteria

We calculated the weights of the criteria with relations of 1 and 6. Then we calculated value of each option with OWA operator and relation1.

5.6. Score to options

	α	SO_1	WO_1	ST_1	ST_2	WT_1
risk taking	0.1	(0.73,0.89,0.94)	(0.74,0.88,0.97)	(0.73,0.87,0.97)	(0.65,0.83,0.96)	(0.72,0.86,0.94)
	0.6	(0.55,0.63,0.66)	(0.54,0.7,0.57)	(0.48,0.64,0.85)	(0.54,0.69,0.81)	(0.46,0.56,0.7)
Neutral	1	(0.73,0.89,0.94) (0.55,0.63,0.66)	(0.74,0.88,0.97) (0.54,0.7,0.57)	(0.32,0.47,0.7)	(0.37,0.5,0.74)	(0.33,0.44,0.6)
risk averse	1.5	(0.31,0.42,0.58)	(0.33,0.47,0.68)	(0.32,0.46,0.73)	(0.3,0.43,0.7)	(0.24,0.34,0.53)
	2	(0.26,0.34,0.52)	(0.28,0.39,0.62)	(0.25,0.4,0.67)	(0.23,0.37,0.63)	(0.17,0.25,0.47)

5.7. Ranking of options

	risk taking		Neutral	risk averse	
α	0.6	0.1	1	2	1.5
SO_1	1	1	3	4	4
WO_1	4	2	1	1	1
ST_1	3	3	4	2	2
ST_2	2	5	2	3	3
WT_1	5	4	5	5	5

It's clear that in state of decision making with risk, strategy SO_1 and in state of decision making without risk, strategy WO_1 have been selected as the best strategies.

6. Conclusion

In this paper, we presented a multi-criteria fuzzy group decision - making method for development of proper strategies in an organization and used linguistic variables to estimate of the relative ranking of each option than each criterion. Because we determined uncertainty in criteria and the DM's comments, so we reach to better and more accurate results than the similar. Another advantage this paper is that we could determin mental characteristics of decision makers Using OWA method, while other MCDM methods don't have this ability.

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