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Modified Fuzzy Model for Selecting Stakeholder Engagement Strategies of the Company Using Generalized Criterion

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Modified Fuzzy Model for Selecting Stakeholder Engagement Strategies of the Company Using Generalized Criterion

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Abstract. The paper proposes a modified fuzzy model for selection of the most appropriate types of engagement strategies of the organization with its different stakeholders. The decision to choose one or another type of strategy is based on fuzzy weighting factors of applicability of the strategies considered as random variables for the most probable scenarios using a fuzzy generalized criterion that combines mathematical expectation and standard deviation. The principal difference of the model from the previously developed ones by the authors is that fuzzy weight factors of strategies applicability are not calculated by the given formulas but are determined on the basis of the given base of fuzzy inference rules. Herewith, when calculating the mathematical expectation and the standard deviation, the weighting factors of strategies applicability are not defuzzificated beforehand. Accordingly, the partial criteria, the generalized criterion, the level of risk tolerance of the decision-maker are fuzzy. In this case, the ranking of strategy types occurs on the basis of various methods for ordering fuzzy numbers.

1. Introduction

The need to consider the multiple and contradictory interests of stakeholders in making strategic decisions forces organizations choose different ways to choose the proportions to satisfy the competing demands of stakeholders. In a rapidly growing uncertainty, lack of relevant information, which is non-probabilistic, fuzziness, heterogeneity and contradictory of efficiency criteria, the need to make decisions of a qualitative nature, it seems promising to use fuzzy models to solve such problems.

Practical implementation of the chosen proportion of serving the stakeholders' interests is achieved through various engagement strategies with each group of stakeholders. A set of types of engagement strategies depends on the chosen typology of a "stakeholder-organization" relation. Offering a typology of "stakeholder-organization" relations based on the mutual dependence of stakeholders and organizations from each other (power over each other), J. Frooman suggested four types of strategies for stakeholder influence on the organization [1]. The same typology (as well as K. Scholes' approach [2]) is the base for the strategies of an organization's actions to the stakeholders [3].

Obviously, the organization's relations with stakeholders changes over time. As well as these relations depend on the stage of the organization's life cycle. In this regard, there is a number of works with attempts made at each stage of the organization's life cycle: birth (creation), growth, maturity, revival [4-7], to assign to each of the important stakeholders one of the four strategies proposed A. Carroll: response, protection, adaptation, and anticipation [8].

In the work [9] we proposed a different set of types of engagement strategies between the organization and stakeholders: satisfaction of demands, protection, impact, cooperation. They are based on the typology of "stakeholders- organization" relations, which is based not only on the mutual dependence of stakeholders and organizations on each other (power over each other) but also on the mutual desire

for changes in relations. Note that the meaning of "desire for change" is close to "urgency" - one of the three main attributes of stakeholders of the Mitchell's model [10, 11]. However, in our case, we consider not only the desire of a stakeholder for changes (urgency) in relation to the company but also the desire for changes in the relation of a company to a stakeholder. Herewith, the degree of desire for change is a function of satisfaction with resource exchange and expectations about the counterparty.

The works [12, 13] describe the nature of each of the proposed strategy types in detail, prove the advantages of the proposed set of strategy types in comparison with the strategies of A. Carroll, and show that strategies of different types can follow one after another. Later, the proposed set of strategy types was supplemented by the fifth type - restraint [14]. Various crisp and fuzzy one-period and multi-period models of the choice of strategies for the engagement of the organization with stakeholders were proposed, including models for the formation of mixed types of strategies [15]. The models differed from each other in the criteria for choosing the most appropriate type of engagement strategy, the planning horizon, in considering or ignoring the stakeholder relations among themselves. The fuzzy models differed also by variables determined as fuzzy, and at what stage the transition from fuzziness to clarity took place. However, the analytical formulas for calculating the weighting factors of the applicability of engagement strategy types were common in all models.

The aim of this work is to develop a fuzzy model in which the weighting factors of applicability of the engagement strategies are determined on the basis of fuzzy inference rules. As a criterion for choosing the most applicable type of engagement strategy was chosen a fuzzy generalized criterion. Note that before even a fuzzy model used a crisp generalized criterion [14], which greatly simplified the ranking of the strategy types.

2. Model
The following fuzzy variables are considered:

1) estimate of satisfaction of k-th stakeholder with the organization within l-th scenario (U_1^{kl}) and estimate of satisfaction of the organization with k-th stakeholder within l-th scenario (U_2^{kl}) ($k = \overline{1,K}$, $l = \overline{1,L}$);

2) estimate of expectations of k-th stakeholder regarding the organization within l-th scenario (O_1^{kl}) and estimate of expectations of the organization regarding k-th stakeholder within l-th scenario (O_2^{kl});

3) estimate of mutual influence between the organization and k-th stakeholder (V^{kl});

4) probability of the l-th scenario (p_l);

5) appropriateness of application of the strategy of the n-th type in relation to the k-th stakeholder within l-th scenario (w_n^{kl}) ($\overline{n = 1,5}$).

Tables 1-4 show the term sets of the linguistic variables.

Table 1. Term set of the linguistic variable "estimate of satisfaction".

Value of the linguistic variable	Trapezoidal membership function
Complete dissatisfaction (LL)	(-5; -5; -4; -3)
Significant dissatisfaction (L)	(-4.5; -3.75; -2.25; -1.5)
Moderate dissatisfaction (ML)	(-3; -2.25; -0.75; 0)
Partial dissatisfaction and partial satisfaction (M)	(-1.5; -0.75; 0.75; 1.5)
Moderate satisfaction (MH)	(0; 0.75; 2.25; 3)
Significant satisfaction (H)	(1.5; 2.25; 3.75 ;4.5)
Complete satisfaction (HH)	(3; 4; 5; 5)

Table 2. Term set of the linguistic variable "estimate of expectations".

Value of the linguistic variable	Trapezoidal membership function
Will worsen radically (NH)	(-5; -5; -4; -3)
Will worsen significantly (NM)	(-4.5; -3.75; -2.25; -1.5)
Will worsen insignificantly (NL)	(-3; -2.25; -0.75; 0)
Will not change (NE)	(-1.5; -0.75; 0.75; 1.5)
Will improve insignificantly (PL)	(0; 0.75; 2.25; 3)
Will improve significantly (PM)	(1.5; 2.25; 3.75 ;4.5)
Will improve radically (PH)	(3; 4; 5; 5)

Table 3. Term set of the linguistic variable "estimate of mutual influence".

Value of the linguistic variable	Trapezoidal membership function
Stakeholder's influence on the organization is radically greater than the organization's influence on stakeholder (SH)	(-5; -5; -4; -3)
Stakeholder's influence on the organization is significantly greater than the organization's influence on stakeholder (SM)	(-4.5; -3.75; -2.25; -1.5)
Stakeholder's influence on the organization is moderately greater than the organization's influence on stakeholder (SL)	(-3; -2.25; -0.75; 0)
Mutual influence of stakeholder and organization is much the same (NE)	(-1.5; -0.75; 0.75; 1.5)
Organization's influence on the stakeholder is moderately greater than the stakeholder's influence on organization (CL)	(0; 0.75; 2.25; 3)
Organization's influence on the stakeholder is significantly greater than the stakeholder's influence on organization (CM)	(1.5; 2.25; 3.75 ;4.5)
Organization's influence on the stakeholder is radically greater than the stakeholder's influence on organization (CH)	(3; 4; 5; 5)

Table 4. Term set of the linguistic variable "scenario probability" and "appropriateness of application of the type of strategy".

Value of the linguistic variable	Trapezoidal membership function
Large (H)	(0.7; 0.8; 1; 1)
Above average (MH)	(0.5; 0.6; 0.8; 0.9)
Average (M)	(0.3; 0.4; 0.6; 0.7)
Below average (ML)	(0.1; 0.2; 0.4; 0.5)
Small (L)	(0; 0.1; 0.2; 0.3)
Extremely small probability (LL)	(0; 0; 0.1; 0.15)

Table 5 shows a fragment of the fuzzy rule base for estimation of appropriateness of application of the fifth types of engagement strategy according to five input factors. Rule base consists of 16807 (7^5) rules.

Table 5. Fragment of the fuzzy rule base.

№ не-четкого правила	**IF**					**THEN**				
	U_1^{kl}	O_1^{kl}	U_2^{kl}	O_2^{kl}	V^{kl}	w_1^{kl}	w_2^{kl}	w_3^{kl}	w_4^{kl}	w_5^{kl}
1	HH	PH	HH	PH	CH	LL	LL	M	MH	MH
3	HH	PH	HH	PH	CM	L	L	ML	H	M
4	HH	PH	HH	PH	NE	ML	ML	ML	H	ML
7	HH	PH	HH	PH	SH	M	MH	LL	MH	LL
22	HH	PH	HH	NE	CH	LL	LL	MH	MH	H
43	HH	PH	HH	NH	CH	LL	LL	MH	M	H
337	HH	PH	LL	NH	CH	LL	LL	H	M	MH
2065	HH	NH	HH	PH	SH	MH	H	LL	M	LL
16471	LL	NH	HH	PH	SH	H	MH	LL	M	LL
16807	LL	NH	LL	NH	SH	H	MH	M	LL	LL

Let us consider L scenarios of possible changes in the relationships between the organization and each stakeholder group. At the same time, we take into account changes in the external environment and changes in interrelations of stakeholders [15]. Appropriateness of application of types of engagement strategy within scenarios is determined by using a fuzzy rule base and treated as a random variable. Fuzzy mathematical expectation (Mw_n^{kl}) and fuzzy standard deviation (σw_n^{kl}) are calculated for each type of strategy (Table 6).

Table 6. Fuzzy ratios of the appropriateness of application of the strategy types.

Scenarios (probabilities)	Types of engagement strategies				
	Satisfaction of demands	Protection	Impact	Cooperation	Restraint
Scenario 1 (p_1)	w_1^{k1}	w_2^{k1}	w_3^{k1}	w_4^{k1}	w_5^{k1}
…					
Scenario L (p_L)	w_1^{kL}	w_2^{kL}	w_3^{kL}	w_4^{kL}	w_5^{kL}
Mw_n^{kl}	Mw_1^{kl}	Mw_2^{kl}	Mw_3^{kl}	Mw_4^{kl}	Mw_5^{kl}
σw_n^{kl}	σw_1^{kl}	σw_2^{kl}	σw_3^{kl}	σw_4^{kl}	σw_5^{kl}

Let us consider the fuzzy generalized criterion:

$$\eta_n = Mw_n^{kl} - \lambda \sigma w_n^{kl}, \tag{1}$$

where λ characterizes the risk tolerance of the decision-maker. We recall that in the crisp case, if $\lambda > 0$, the decision-maker is not inclined to take risks, if $\lambda < 0$, the decision-maker is inclined to take risks, if $\lambda = 0$, the decision-maker is indifferent to risk [16].

We propose to treat λ as a fuzzy number. Linguistic variable "risk tolerance of the decision-maker" could have the following term set: {extremely high risk taker; high risk taker; average risk taker; low risk taker; extremely low risk taker} [17].

The most appropriate type of engagement strategy is chosen on the basis of ranking of values of fuzzy criteria η_n. Ranking η_n could be based on various methods for ordering fuzzy numbers [18-21].

3. Conclusion

The paper proposes a modified fuzzy model for selection of the most appropriate types of engagement strategies of the organization with its stakeholders. In the model, fuzzy weight factors of strategies

applicability are determined on the basis of the given fuzzy rule base. The decision to choose one or another type of strategy is based on fuzzy weighting factors of applicability of the strategies considered as random variables for the most probable scenarios using a fuzzy generalized criterion that combines mathematical expectation and standard deviation. Fuzzy level of risk tolerance of the decision-maker is also taken into account. The ranking of a multitude of strategy types occurs on the basis of various methods for ordering fuzzy numbers.

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