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Azarova A. O.
candidate of technical sciences, professor
Vinnitsa national technical University
Kukuruza M. I.
student bachelor
Vinnitsa national technical University
Ivchuk K. V.
student bachelor
Vinnitsa national technical University
Novitska O. V.
tech Institute of management
Vinnitsa national technical University

MATHEMATICAL MODEL AND LEVEL IDENTIFICATION METHOD OF STRATEGIC MANAGEMENT OF THE ENTERPRISE ON THE FUZZY SETS VEHICLE BASE

Problem statement. Further development of national economy needs new approaches in management of enterprises . A considerable role here belongs to the strategic aspect of management of an enterprise, namely to forming and realization of strategy on an enterprise as the instrument of effective activity providing not only for the current situation but also for a long-term perspective [1].

Enterprise development strategy forming requires throughout examination of production and technical possibilities, aims and economic subject key problems determination, choice and ultimate solution grounding, actions program drafting and its realization verification [2].

Modern globalized market economy forms new requirements to the enterprises. They are predetermined by the presence of hard competition and necessity to react flexibly on the ambiguous situation changes on markets and in industries of enterprises activity. Thus enterprise success will depend on ability to adapt oneself to the changes of their activity environment: to foresee and change

business structure, to develop and apply new types of products into industry, to determine directions of investments according to different types of activity correctly etc., to achieve success and provide enterprise prosperity in a prospect. This actually is the principal task of strategic management.

Analysis of the last researches and publications. There are many different methods in a theory and practice of strategic management enterprises (SME) in Ukraine. In particular it is possible to distinguish such, as SWOT - analysis, PEST -analysis, model of five competition forces Porter, matrix of "Evrokip" and other among them. However, none of existent approaches is effective enough both on the analyzable information plenitude criterion and accuracy and speed of result receipt on an enterprise. These methods of level analysis SME contain a limit amount of components which are elected for description. This causes their inadequacy and substantially limits their practical application [3].

Among leading researchers, who were studying matters analyzed in scientific work we should signify such abroad scientists as I. Ansoff, B. Berman, P. Druker, A. Tomphson, A. Chandler and also native scientists: O. Vikhansky, V. Herasymchuk, Z. Kindrats'ka and other.

Task statement. The research aim is optimal decision determination in relation to the enterprise strategic management and native enterprises activity stimulation in relation to the achievement of their long-term aims by a structural and mathematical design SME.

Tasks that are being handled in the given article:

- mathematical level evaluation model development of strategic management of an enterprise;
- such model mathematical formalization method construction on the base of fuzzy sets vehicle;
- strategic management level evaluation.

A research object is a process of strategic management of an enterprise.

The research subject is mathematical models and estimating methods of strategic management of an enterprise level.

Basic research material exposition. For the problems removal that arise up during application of the generally accepted approaches to the strategic development level evaluation, the authors offer their own mathematical model, that substantially allows to simplify such process, making it transparent, clear, automated and makes possible further reasonable recommendations development according to the improvement of the strategic planning at native enterprises [4].

In the table 1 [5, c. 56] the great number of the indexes, formed on the plenitude, minimality and effectiveness criteria according to which we should estimate the strategic enterprise development level is presented.

Table 1

Indices that are being used for the SME level estimation

Strategy kinds	Indexes
Economic strategy	➢ Profitability of outlay; ➢ Return on Total Assets; ➢ Return on Equity.
Financial enterprise strategy	➢ An average annual rate of own financial resources increase that are formed out of inner sources; ➢ A particle of property asset; ➢ Removing coefficient of the fixed assets; ➢ Cover ratio.

The source: it is developed by the authors

Selected indices of the mathematical model formation are given in the table 2 [5; 6].

Table 2

Selected indices of the SME level estimation structured model formation

Shortened index name	Full index name
Economic strategy	
X_{11}	Profitability of outlay;
X_{12}	Return on Total Assets;
X_{13}	Return on Equity.
Financial enterprise strategy	

X_{21}	An average annual rate of own financial resources increase that are formed out of inner sources;
X_{22}	A particle of property asset;
X_{23}	Removing coefficient of the fixed assets;
X_{24}	Cover ratio;

The source: it is developed by the authors

On the basis of parameter set x_i union of transformation functions are formed: economic and social function. In turn each function is estimated on the basis of x_{ij} chain.

Profitability of spending is an index that represents enterprise profit attitude toward the charges of the enterprise:

$$x_{11} = \frac{l_1}{l_2} \cdot 100\% \quad (1)$$

where l_1 – a profit of the enterprise;

l_2 – general charges of the enterprise.

Return on Total Assets (ROTA) is a financial coefficient that characterizes efficiency of the all enterprise assets use:

$$x_{12} = \frac{l_1}{l_3} \cdot 100\%, \quad (2)$$

where l_2 – assets that are at the enterprise disposal.

Return on equity (ROE) is a financial coefficient that characterizes efficiency of the property asset use. It shows returns (profit norm) on the inlaid property asset.

$$x_{13} = \frac{l_1}{l_4} \cdot 100\%, \quad (3)$$

where l_4 – a property asset of the enterprise.

An average annual rate of own financial resources increase is an index that shows how much the volume of financial resources changed in current and report periods.

$$x_{31} = \frac{l_{12}}{l_{13}}, \quad (4)$$

where l_{12} – a size of financial resources in the base period;

l_{13} – a size of financial resources in the report period.

A particle of property asset is a part of facilities that are at subject's holding disposal for realization of activity with the profit-making aim.

$$x_{32} = \frac{l_{14}}{l_4}, \quad (5)$$

where l_{14} – the fixed assets of the enterprise.

Removing coefficient of the fixed assets is a particle of cost of the fixed assets that is written-off on the production charges during previous periods.

$$x_{33} = \frac{l_{15}}{l_{16}} \cdot 100\%, \quad (6)$$

where l_{15} – a removal of the fixed assets;

l_{16} – an original cost of the fixed assets, hrn.

Cover ratio is a coefficient that shows sufficiency of enterprise resources which can be used for redemption of its current liabilities.

$$x_{34} = \frac{l_{17}+l_{18}}{l_{19}+l_{20}}, \quad (7)$$

where l_{17} – current assets;

l_{18} – future periods' charges;

l_{19} – a current liabilities sum;

l_{20} – future periods proceed.

For formalization of foregoing mathematical model authors suggest applying the mathematical vehicle of fuzzy logic. Advantage of this vehicle is its simplicity and wide application spectrum.

The authors offer to estimate the presented groups of indexes according to three terms: L - low, M - middle, H - high on the basis of the concerted expert knowledge (table 3). The function belonging graphics of such terms for the selected multiplicity of estimating parameters are represented on pict. 1.

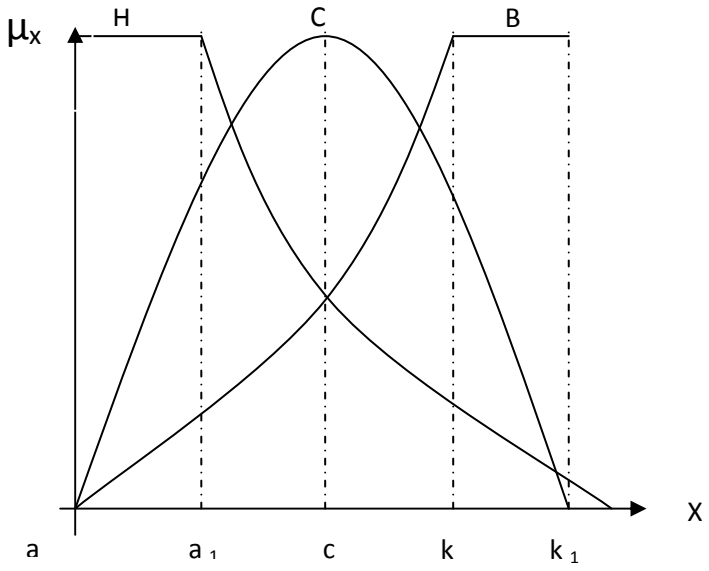
Table 3

Expert estimations of characteristic points of linguistic therms.

Characteristic points	Characteristic points' meaning for the therms				
	a	a_1	C	K	k_1
1	2	3	4	5	6
Economic strategy					

X_{11}	0	0,5	0,7	0,8	1
X_{12}	0	0,4	0,5	0,8	1
X_{13}	0	0,6	0,8	0,9	1
Financial enterprise strategy					
X_{21}	0	0,3	0,4	0.8	1
X_{22}	0	0,3	0,5	0,9	1
X_{23}	0	0,3	0,6	0,9	1
X_{24}	0	0,2	0,4	0,7	1

Source: it is made authors on basis [7]



Pic. 1. General view of belonging function chart for 3 unclear therms

Source: it is made by authors on basis [7]

On the basis of the represented chart in picture 1 dependences for 3 unclear therms look like this:

$$\mu^{H} = \begin{cases} 1 \in [a; a_1) \\ (\frac{1-x}{a_1})^n, x \in [a_1; 1] \end{cases}$$

$$\mu^{C}(x_{11}) = \frac{1}{1 + (\frac{x-c}{4})^2}, [0; 1]$$

$$\mu^{B}(x_{11}) = \begin{cases} (\frac{x}{k})^n \\ 1, x \in (k; 1] \end{cases}, x \in [a; k]$$

On the basis of expert data we form such knowledge matrices (table. 4, 5) [7; 8].

Table 4

Matrices of knowledge for economic strategy

X_{11}	X_{12}	X_{13}	f_1
H	H	H	H
H	H	M	
M	M	H	
H	H	M	AA
M	M	H	
H	M	H	
M	L	M	M
L	M	L	
M	L	L	
M	M	L	BA
L	M	L	
M	L	M	
M	M	L	L
L	L	M	
L	L	L	

Source: it is created by authors

Table 5

Matrices of knowledge are for enterprise financial strategy

X_{31}	X_{32}	X_{33}	X_{34}	f_2
H	H	H	H	H
H	M	M	H	
M	H	M	M	
H	H	H	H	AA
M	M	M	B	
H	M	H	M	
L	M	M	L	M
M	L	L	L	
M	M	M	M	
L	L	M	M	BA
M	M	L	L	
M	L	L	M	
L	L	M	L	L
M	L	L	L	
L	L	L	L	

Source: it is created by authors

Logical equation for the group of indexes f_1 (economic strategy)

$$\mu^B(f_1) = \mu^B(x_{11}) \cdot \mu^B(x_{12}) \cdot \mu^B(x_{13}) \cup \mu^C(x_{13}) \cdot \mu^C(x_{17}) \cdot \mu^B(x_{18});$$
$$\mu^{BC}(f_1) = \mu^C(x_{11}) \cdot \mu^B(x_{12}) \cdot \mu^B(x_{13}) \cup \mu^B(x_{11}) \cdot \mu^C(x_{12}) \cdot \mu^B(x_{13});$$
$$\mu^C(f_1) = \mu^C(x_{11}) \cdot \mu^H(x_{12}) \cdot \mu^C(x_{13}) \cup \mu^H(x_{11}) \cdot \mu^C(x_{12}) \cdot \mu^H(x_{13});$$
$$\mu^{HC}(f_1) = \mu^C(x_{11}) \cdot \mu^C(x_{12}) \cdot \mu^H(x_{13}) \cup \mu^H(x_{11}) \cdot \mu^C(x_{12}) \cdot \mu^C(x_{13});$$
$$\mu^H(f_1) = \mu^C(x_{11}) \cdot \mu^H(x_{12}) \cdot \mu^H(x_{13}) \cup \mu^H(x_{11}) \cdot \mu^H(x_{12}) \cdot \mu^H(x_{13}).$$

Logical equation for the group of indexes f_2 (enterprise financial strategy):

$$\mu^B(f_2) = \mu^B(x_{21}) \cdot \mu^B(x_{22}) \cdot \mu^B(x_{23}) \cdot \mu^B(x_{24}) \cup \mu^B(x_{21}) \cdot \mu^C(x_{22}) \cdot \mu^C(x_{23}) \cdot \mu^B(x_{24}) \cup$$
$$\cup \mu^C(x_{21}) \cdot \mu^B(x_{22}) \cdot \mu^C(x_{23}) \cdot \mu^C(x_{24});$$
$$\mu^{BC}(f_2) = \mu^B(x_{21}) \cdot \mu^B(x_{22}) \cdot \mu^B(x_{23}) \cdot \mu^B(x_{24}) \cup \mu^C(x_{21}) \cdot \mu^C(x_{22}) \cdot \mu^C(x_{23}) \cdot \mu^B(x_{24}) \cup$$
$$\cup \mu^B(x_{21}) \cdot \mu^C(x_{22}) \cdot \mu^B(x_{23}) \cdot \mu^C(x_{24});$$
$$\mu^C(f_2) = \mu^H(x_{21}) \cdot \mu^C(x_{22}) \cdot \mu^C(x_{23}) \cdot \mu^H(x_{24}) \cup \mu^C(x_{21}) \cdot \mu^H(x_{22}) \cdot \mu^H(x_{23}) \cdot \mu^H(x_{24}) \cup$$
$$\cup \mu^C(x_{21}) \cdot \mu^C(x_{22}) \cdot \mu^C(x_{23}) \cdot \mu^C(x_{24});$$
$$\mu^{HC}(f_2) = \mu^H(x_{21}) \cdot \mu^H(x_{22}) \cdot \mu^C(x_{23}) \cdot \mu^C(x_{24}) \cup \mu^C(x_{21}) \cdot \mu^C(x_{22}) \cdot \mu^H(x_{23}) \cdot \mu^H(x_{24}) \cup$$
$$\cup \mu^C(x_{21}) \cdot \mu^H(x_{22}) \cdot \mu^H(x_{23}) \cdot \mu^C(x_{24});$$
$$\mu^H(f_3) = \mu^H(x_{21}) \cdot \mu^H(x_{22}) \cdot \mu^C(x_{23}) \cdot \mu^H(x_{24}) \cup \mu^H(x_{21}) \cdot \mu^H(x_{22}) \cdot \mu^H(x_{23}) \cdot \mu^H(x_4).$$

In turn each of entry primary parameters of x_{ij} is introduced as a corresponding dependence on the row of entry primary parameters (see table. 2).

The last stage is defuzzification, where strategic management level identification is fulfilled according to such dependence:

$$\mu^{y_S} = \max \mu^{y_S}(f_1, ..., f_2).$$

Conclusions and further researches. Existent SME methods are based on internal and external enterprise environment research, statistical and administrative data. However they are imperfect, as they don't take into account a lot of factors that influence on its strategic development. Therefore a SME level evaluation mathematical model is worked out by the authors, the peculiarity of which is that it takes into account the great numbers of primary entry parameters, the great number of criteria, and also combined function decomposition of SME level estimation, that allows clearly to represent great number of entry estimating parameters on the great number of initial decisions.

Offered articles are a mathematical model and identification method of SME level on the base of fuzzy sets mathematical vehicle allows taking into account economic subjects with the different types of estimating parameters not

including all the possible combinations of their values that substantially cuts prime cost of the made decision and diminishes persons' sentinel charges. In addition, it becomes possible to get estimation, using the natural language of experts' conclusions formulation [8].

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