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THE MATHEMATICAL MODEL OF ENTERPRISES INNOVATION ATTRACTIVENESS ON THE LOGIC OF FUZZY LOGIC THEORY

The mathematical model of enterprises innovation attractiveness on the basic of fuzzy logic theory is proposed in the article.

Keywords: innovation attractiveness, fuzzy logic, innovative attractiveness, fuzzy logic, matrix of knowledge, mathematical model.

In conditions of modern development of market relations an important indicator of the efficiency of production, increase its competitiveness, ensuring the stable growth of subjects of different forms of ownership and management is the automation of the processes of managing the innovation attractiveness of the enterprise by means of mathematical modeling.

Problems of innovative attractiveness were studied in the fundamental works of such domestic and foreign scientists as R. Akof, O. Bakayev, N. E. Boytsun, M. P. Buslenk, V. V. Vitlinsky, S. G. Diorits, F. Emmer, P. Whitfield, P. Drucker, M. A. Kizim, T. S. Klebanov, V. F. Kovalchuk, N. I. Kostina, Y. G. Lysenko, A. M. Mariuta, A. Galchinsky, B. Grinev, O. Lapko, V. F. Sitnik, M. I. Skrypnichenko, V. M. Tomashevsky and others. However, existing models and approaches to assessing the level of PPI are too limited, they do not take into account a wide range of different parameters of the influence of external and internal environment, and are poorly formalized.

The purpose of this work is to develop a mathematical model for assessing the level of innovative activity of the enterprise, which would allow for a clear formalization of expert assessments, has a flexible structure and high adaptability, and takes into account all factors of influence.

To form the set of input parameters should be taken into account for assessing the level of innovation attractiveness of the enterprise components such as those in table. 1 [1].

Table 1

Components that affect the innovative attractiveness of the enterprise

Innovative attractiveness of the enterprise		
Enterprise infrastructure	Financial status	Organizational characteristics
- industrial infrastructure; - innovation infrastructure; - information infrastructure; - social infrastructure;	- venture capital; - financial independence; - liquidity level of assets; - solvency level; - purposeful use of money; - external sources of financing of financial activity; - high quality management at the enterprise.	- staff turnover; - motivation; - labor discipline; - corporate culture; - productivity; innovation infrastructure.

For our model, as universal sets for the terms of linguistic variables, we take ranges of possible values of the corresponding indicators of the estimation of the level of PPI.

The set L of the primary input l_c $(c=\overline{1,C})$; makes it possible to determine the set $X=\{x_{ij}\}$, $i=\overline{1,n}$, n=3, j=$\overline{1,L}$, $J=17$ evaluation parameters. In turn X is the basis for identifying the set of functions *f1* ... *f3*, on the basis of which the estimation of innovation attractiveness of the enterprise by a set of output parameters $ID=(ID_k), k=\overline{1,K}, K=3$.

Thus, the mathematical model of such a process takes the form of [2]:

$$L \xrightarrow{F_1} X \xrightarrow{F_2} ID_k, F_1: J \to X; F_2 = F(f_1, f_2, f_3), \quad (1)$$
$$f_1 = g_1(x_{11}...x_{14}), f_2 = g_2(x_{21}...x_{27}), f_3 = g_3(x_{31}...x_{36})$$

The set of input and output parameters, all the functions of transformation in their consistent execution is described in the structural model of evaluation of the innovation attractiveness of the enterprise (fig. 1).

On the basis of multiple parameters x_{ij}, $i=\overline{1,3}$;$X_j=\overline{1,17}$ formed set of transformation functions: *f1* – function of enterprise infrastructure; *f2* – function of the financial condition of the enterprise; *f3* – function of organizational characteristics of the enterprise.

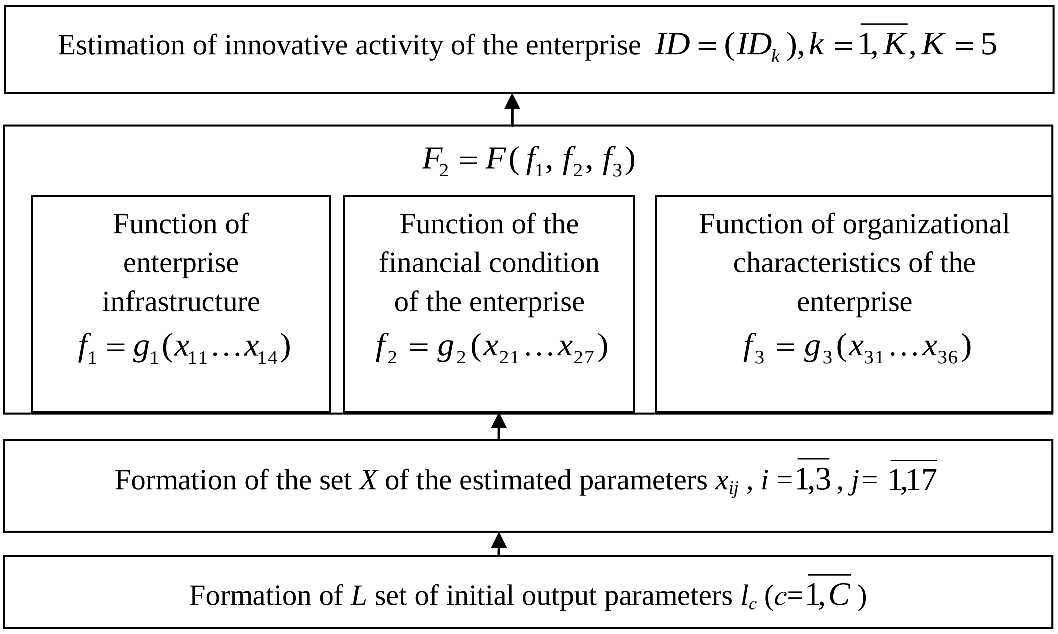

Figure 1 - Structural model for assessing the innovation attractiveness of an enterprise

To evaluate the parameters $x_{11}, \dots, x_{14}$, $x_{21}, \dots, x_{27}$, $x_{31}, \dots, x_{36}$ it is expedient to use three fuzzy terms $t = \overline{1, T}$, T=3, since they take into account the sufficient level of accuracy of the specifics of the parameters studied. Imagine the value of these indicators on a scale of "0-1".

Using the article agreed by the authors of the article, the information provided by experts compiled knowledge matrices for the evaluation of parameters describing the enterprise infrastructure, financial status and its organizational characteristics. Let's illustrate the example of the infrastructure of the enterprise (table 1) [3].

Table 1

The matrix of knowledge for evaluating the functional f1 is the infrastructure of the enterprise

x_{11}	x_{12}	x_{13}	x_{14}	f_1
B	*B*	*B*	*B*	*B*
B	*B*	*C*	*B*	
C	*B*	*B*	*C*	*BC*
C	*C*	*B*	*B*	
C	*B*	*C*	*C*	*C*
C	*C*	*H*	*C*	
C	*C*	*C*	*C*	*HC*
H	*C*	*C*	*C*	
H	*C*	*H*	*H*	*H*
H	*H*	*H*	*H*	

Based on the knowledge matrix, logical equations for all aggregation functionals are compiled. In particular, for f1 such equations acquire the form [4]:

$$\mu^{B}(f_1)=\mu^{B}(x_{11})*\mu^{B}(x_{12})*\mu^{B}(x_{13})*\mu^{B}(x_{14})\vee\mu^{B}(x_{11})*\mu^{B}(x_{12})*\mu^{C}(x_{13})*\mu^{B}(x_{14})$$

$$\mu^{BC}(f_1)=\mu^{C}(x_{11})*\mu^{B}(x_{12})*\mu^{B}(x_{13})*\mu^{C}(x_{14})\vee\mu^{C}(x_{11})*\mu^{C}(x_{12})*\mu^{B}(x_{13})*\mu^{B}(x_{14})$$

$$\mu^{C}(f_1)=\mu^{C}(x_{11})*\mu^{B}(x_{12})*\mu^{C}(x_{13})*\mu^{C}(x_{14})\vee\mu^{C}(x_{11})*\mu^{C}(x_{12})*\mu^{H}(x_{13})*\mu^{C}(x_{14})$$

$$\mu^{HC}(f_1)=\mu^{C}(x_{11})*\mu^{C}(x_{12})*\mu^{C}(x_{13})*\mu^{C}(x_{14})\vee\mu^{H}(x_{11})*\mu^{C}(x_{12})*\mu^{C}(x_{13})*\mu^{C}(x_{14})$$

$$\mu^{H}(f_1)=\mu^{H}(x_{11})*\mu^{C}(x_{12})*\mu^{H}(x_{13})*\mu^{H}(x_{14})\vee\mu^{H}(x_{11})*\mu^{H}(x_{12})*\mu^{H}(x_{13})*\mu^{H}(x_{14})$$

As a result of the research, a mathematical model for estimating the level of PPI was developed, based on the mathematical apparatus of the theory of fuzzy logic. The advantage of the developed fuzzy model is that the connection between the input parameters and the output parameter is described with the help of natural language concepts that are objectively much more "closer" to expert analysts than abstract mathematical concepts. This ensures a high level of adequacy of expert formalization. Also, the developed model has a high ability to adapt to expert data due to the presence of a large number of parameters that can be optimized.

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