UDC 338.2

USING FUZZY LOGIC ELEMENTS IN FINANCIAL CONTROL SYSTEM

K. F. Kovalchuk, Doctor of Economics, Professor, Ukraine, const1955@mail.ru
N. P. Kozenkova, Senior Lecturer, nkozenkova@gmail.com
V. D. Kozenkova, graduate student, kozenkova_vlada@rambler.ru
National Metallurgical Academy of Ukraine

Financial control at the enterprise is presented. Approaches to the organization of financial control are considered. The role of Information in the organization of financial control system is shown. The mechanism of using the elements of fuzzy logic theory in financial control is explained.

Keywords: financial control, information, fuzzy logic, management, controlling.

Statement of problem. In modern conditions the enterprises are operating with a big flow of quickly obsolescent information. Consequently there is an objective need of coordination of different division's activity. For ensuring controllability of such systems it is necessary to use new methods of management, dealing with difficulties of the external and internal environment of the enterprises. In these conditions it is necessary to use controlling which coordinates work of functional services of the enterprise and gives information and analytical support to the management at adoption of administrative decisions.

Analysis of recent papers. Many scientists devote much attention to definition and research of category of controlling. In their works, the theory and practice of controlling, the main approaches to its studying are characterized in detail. Much attention is paid to questions of construction and introduction of controlling as a structural component of management process.

In modern conditions of complication of business and development of globalization factors, the significant problem is decision-making in the conditions of uncertainty. The problem of uncertainty is inherent to all difficult systems. Such difficult systems consist of economic and social systems.

In modern theory of decision-making for describing of the uncertainties theory is widely used the fuzzy sets theory, which founded by Zadeh L. A. [1,2]. Subsequent work with fuzzy sets, optimization of fuzzy conditions, the reduction mechanism to clearness illegibility was investigated by J. Buckley [3,4], B. Kosko [5,6], E. Mamdani, T. Sugeno, G. Chen, E. Kerr [7], A. Nedosekin [8], etc.

At the same time, techniques of integration of fuzzy logic systems into models, which work with economy, in particular, in the field of financial control are represented like underserved.

Lack of the regulatory framework, which is regulating the organization of controlling and significantly complicate the creation of controlling system at the enterprise.

The insufficient attention is paid to questions of ensuring information base. It is known that necessary information for decision-making has to be available, complete and confidential, available to the persons making decisions in due time.

At the same time, in connection with the increasing complexity of the external and internal environment of business, this information is characterized by incompleteness and inaccuracy which can consist in basic impossibility of full collecting and the accounting of information on the analyzed object or process; in inauthenticity and insufficiency of initial information; in possibility of manifestation of undesirable properties of object or process. Degree of inaccuracy and uncertainty is also influenced by a number of subjective human factors.

First of all, It is connected with complexity of mathematical tools in comparison with traditional, weak understanding of the principles of the mechanism of implementation of the indistinct analysis and opportunities of its application for the solution of tasks in the field of economy and management, absence of the statistical data or data obtained in the empirical way on the basis of which systems of fuzzy logic can be approved. All this considerably reduces efficiency of use of the device of fuzzy logic in economic researches in general, and, in

financial control in particular.

Aim of the paper. Main goal of this work is representation of the mechanism of use of fuzzy logic elements in financial controlling.

Materials and methods. The analysis of national and foreign practice of introduction of controlling shows that an opportunity to start creation of controlling system is emergence of weak signals of possible risks for perspective of successful functioning of the enterprise.

The factors, which caused need of development of controlling consist of following factors [9]: fast variability of object and environment of its functioning; the uncertainty which is often connected with an incommensurability of data, which is received earlier, and new; change of techniques and standards; restriction of availability of data because of insufficient quality of information infrastructure and information support; shortcomings of the corporate reporting, not disclosure of information; decline of information quality because of the technical difficulties arising at a quantitative assessment of the existing influence factors, and also a large number of qualitative factors; decrease in accuracy and adequacy of the calculations which are connected with ignoring of the major factors and introduction of auxiliary and trend variables.

The major factors which are the basis for creation of system of controlling in the organization are [9]: essential decrease in economic indicators, low indicators in comparison with competitors; emergence of the new purposes at this conjuncture functioning; unsatisfactory coherence is more whole; the outdated methods of planning which aren't meeting modern requirements; lack of techniques of the account and analysis that leads to a lack of analytical information at adoption of administrative decisions; duplication or lack of some functions, existence of conflict situations at their performance; strengthening of competitors positions in conditions of absence of their clear advantages in providing of raw or production; unsatisfactory coordination between divisions of the enterprise.

The statement of collecting and the analysis of information characterizing a condition of a control system is one of the main operating conditions of controlling at the enterprise and is allocated as one more stage of the organization of controlling.

The system of providing information for realization of control functions has to be organized so that the controller could receive quickly the necessary information for realization of the planning functions, control and the analysis.

Process of controlling management includes a number of stages [10].

1. Formulation of management strategy. The control system is orientated to realization of anti-recessionary strategy of the enterprise and provides with a formulation of the development strategy corresponding to it. Thus, controlling has to have strategic character; it means that it reflects the main priorities of development of the enterprise. This situation defines purposeful restriction of the areas range of the increased risk, which are considered by the controlling.

2. Identification of development risks and functioning. For identification of risks is necessary to analysis of the external and internal environment of the enterprise, drawing up the reports on risks reflecting the chosen strategy of management.

3. Assessment of development risks and functioning. The problem of controlling at this stage consists in a choice of the most reasonable methods and tools of an assessment of risks, carrying out of this assessment, interpretation of the received results

4. Choice of impact methods to the risk. At this stage the choice of methods the realization of which will allow to minimize possible damage in the future is made.

5. Compilation of primary report about risks. After risks are revealed, estimated and chosen measures for their minimization, the report on risks of the enterprise is formed. In the report is given an information about description of threats of activity of the enterprise, types of risks inherent in it is given, the assessment of potential impact of all key risks on activity of the enterprise, initial probability of realization of risk events, initial impact on risk factors and initial indicators of risk is given. Also it is specified in the report responsible for risk (the owner of risk), control actions and time of their performance.

6. Decision-making about development and functioning. On the basis of the received report about risks are made the relevant decisions about management at the enterprise.

7. Impact on risk of development and functioning. At this stage was defined the direct impact on object of management by the methods chosen at the fourth stage.

8. Repeated report. Additional data on residual probability of certain events approach, their influence and residual indicators are brought in the report during the realization of the actions directed on decrease of activity risk and functioning, and control of results.

9. Control of results. At this stage actually reached and planned indicators are controlled. On the basis of the received indicator values the strategy of business management is reconsidered, or approaches, techniques and instruments of controlling has to be changed and improved, applied at analysis stages, estimates and influences.

The functions of controlling are include the collecting and the analysis of large volume of the fuzzy, non formalized and dynamic information. It provides minimization of the missed benefit, economy of constant expenses of production, facilitates search of new opportunities of development, raises possibilities of adaptation of object to the changing conditions of the uncertain environment.

Thus the gained synergetic effect consists in the high-quality and quantitative changes, which happened at the enterprise: transformation of structure, communications and methods of adjusting to the changing of environment

The modern enterprises are characterized by uncertainty of situations, risk of the decision-making, plurality of available options of capital investments, limitation of financial resources for investment, the large number of entrance indicators, and also person who makes decision has the information, which is poorly formalized and can't be considered at application of quantitative methods.

Uncertainty can't be excluded completely, especially in case of planning and forecasting. In a general the uncertainty is insufficiency of data about conditions in which will be conduct of economic activity, low degree of anticipation of these conditions will proceed as uncertainty.

Uncertainty is connected with risk of planning, decision-making, implementation of actions at all levels of economic system.

In the economic theory the uncertainty often was considered like inherent to real environment of economic system functioning.

One of the few cases of category using of uncertainty for an explanation of economic events by economists-theorists can be considered the tractability of earnings phenomenon which is created by American scientist Frank Knight as the reward earned by the businessman because of assuming risk of commercial operation failure [11].

The situation of uncertainty is characterized by the choice of the concrete plan of action can lead to any outcome from the fixed set of outcomes, but probabilities of their implementation are unknown.

Thus it is possible to allocate two cases: probabilities aren't known owing to absence of necessary statistical information; the situation not statistical and doesn't make sense to speak about objective probabilities at all. It is a situation of true uncertainty in narrow sense, inherent to innovative activity [12].

Uncertainty can be classified on: uncertainty degrees (full definiteness, probabilistic, linguistic, interval, full uncertainty); on nature of uncertainty (parametrical, structural, situational); on using of received information during directorate (removable and unrecoverable).

In general, uncertainty is the ineradicable quality of the market environment connected with market conditions which are affected by the set of factors of various nature and orientation. They make an simultaneous impact, and extent of this influence isn't determined.

In the history the first way of the uncertainty accounting was an invention of probabilities, which arose in the middle of the XVII century. The first works on probability theory belonged to the French scientists Blaise Pascal and Pierre de Fermat, and also the Dutch scientist of Christian Huygens. The outstanding success of probability theory is connected with a name of the Swiss mathematician Jakob Bernoulli, who established the law of large numbers for the scheme of independent tests with two outcomes (1713). Since 50th years of

the XX century, in science there were works calling into question total applicability of the probabilistic theory to the uncertainty accounting.

Authors of these works noted that the classical probability is defined as the characteristic general totality of statistically uniform casual events. In case statistical uniformity isn't present, application of classical probabilities in the analysis is illegal.

These remarks led to emergence of works where introduction of the nonclassical probabilities which aren't making frequency sense, and expressing informative activity of the researcher of casual processes or the person compelled to make decisions in the conditions of deficiency of information located.

Thus, there were subjective probabilities.

The concept of subjective probabilities belongs to Thomas Bayes [13]. Subjective probabilities are a rational form of representation of preferences of the subject in situations when results of the decisions are depended on «external uncertainty», and unknown «state of peace». It should be noted the important results of work belongs to L. Savage [14]. Which are allowed to generalize the principle of Thomas Bayes, also in situation when the results of making decisions are not reduced to profit.

At the same time the theory of Savage assumes that the quantity possible «conditions of the world» is incalculable: it is fair, for example, when possible values of any parameter of environment fill the whole piece.

Thus the subjective probability measure is «atomless» so any «state of peace» (scenario) has zero probability. It creates considerable difficulties in calculations. Emergence of subjective probabilities wasn't the one solution. Development was gained by interval approach in which «opportunity degree» of uncertain parameters is arranged simply and all values of parameter in the corresponding interval are considered possible («opportunity degree» is equal to unit), all others – impossible («opportunity degree» is equal to zero).

Generally it is referred to interval uncertainty the properties of which are investigated in a number of works [15].

The compromise way is to apply minimax approaches and use of a method of Hurwitz [16] when two extreme scenarios (the worst and the best) are considered in common, and as weight in a parcel of scenarios the parameter l the level of which is set by the decision-maker acts. The more l, the more optimistically is adjusted the decision-maker. The modified interval and probabilistic method of Hurwitz considers additional information on a ratio of probabilities of scenarios taking into account that exact value of scenario probabilities isn't known. It should be noted that Hurwitz's formula considers only extreme values of effect.

The selection of subjective probabilities estimates is often refer to the known principle of Gibbs-James [17]: among all probabilistic distributions coordinated with initial information on uncertainty of the corresponding indicator it is recommended to choose that one which has the greatest entropy (logarithm of density of distribution of probabilities taken with the sign «minus»).

At the same time, the principle of entropy maximum doesn't provide automatically monotony of criterion of the expected effect and has to be supplemented with boundary conditions of applicability of this criterion at a choice of probabilistic distributions.

Absolutely other approach to the accounting of uncertainty factor is fuzzy sets theory. The founder of this approach is Lotfi Zadeh, which in 1965 has brought into science the concept of 'indistinct sets' (fuzzy set) and has given the name of new theory (fuzzy logic) [1]. Use of linguistic variables (subjective categories), that is variables, which can't be described by means of mathematical language was the cornerstone of the theory, in other words it is difficult to them to give an exact (objective) quantitative assessment. For example, the concepts «small» and «average» (speaking about business), «high» or «low» (about an interest rate) have no clear boundary and can't be presented by the exact mathematical description.

According to Lotfi Zadeh, linguistic variable is a variable the value of which is a word or suggestion of natural language [1].

In literature of indistinct sets the linguistic variables also call a data-term (from English «term» – to call). By means of the corresponding mathematical apparatus becomes

possible to express linguistic estimates mathematically and subsequently to process by means of the ECM.

The following achievement of the indistinct sets theory is introduction to use of so-called fuzzy numbers – the indistinct subsets of a specialized type corresponding to statements like «value of a variable is approximately equal to a». As an example it is possible to use so-called triangular fuzzy number where three points are allocated: minimum possible, most expected and greatest possible value of a factor. Triangular numbers are the type of indistinct numbers, which is most often used in practice, and most of all they are using as expected values of parameter.

Further the set of operations over fuzzy numbers which are reduced to algebraic operations with usual numbers at a task of a certain interval of reliability (accessory level), received subsequently the name «soft calculations» was created.

Basic researches in this area are undertaken by D. Dubois and H. Prad [18].

Justification of opportunities of its use in intellectual control systems was the second stage in development by fuzzy logic [2].

In B. Kosko's works [5,6] the interrelation of fuzzy logic and the theory of neural networks was investigated and the fundamental FAT theorem (Fuzzy Approximation Theorem) is proved. This theorem is confirming the completeness of fuzzy logic.

In works of M. Zemankova and A. Kandel [19] were laid the fundamentals of the theory of fuzzy system management with inexact data, which allow to process indistinctly set inquiries, and also to use qualitative parameters along with the quantitative.

There was developed indistinct algebra - the unusual science allowing to use both of variables at calculations: exact and approximate values of variables. And at last, the widest circulation of so-called indistinct cognitive models (Fuzzy Cognitive Maps) was gained by B. Kosko on the basis of which the majority of modern systems of dynamic modeling in the field of finance, policy and business is based.

About 40 patents relating to fuzzy logic (from them 30 Japanese) appeared by 1990th year. Forty eight Japanese companies formed joint laboratory LIFE (Laboratory for International Fuzzy Engineering – the International laboratory of the development based on fuzzy logic), the Japanese government financed the five-year program for fuzzy logic including 19 various projects – from systems of an assessment of global pollution of the atmosphere and prediction of earthquakes to automated control systems for factory shops and warehouses.

Emergence of a number of the new mass microchips based on fuzzy logic was result of implementation of this program.

Since the end of the 70th years, methods of the fuzzy sets theory start being applied and in economy. It is necessary to mention the works of J. Buckley [3,4], G. Boyadzhiyev, M. Boyadzhiyev [20,21], L. Dymova, P. Sevastyanov's works [22], A. M. Lafuente [23], H. Zimmerman [24]. In these and other works were analysed economic tasks in the field of the finance, an assessment of competitiveness and appeal of business, strategic planning with application indistinct and multiple descriptions related to them.

Quickly enough economic appendices of the fuzzy sets theory formed the independent scientific direction.

The international association SIGEF (International Association for Fuzzy Set Management & Economy) was created with command centering in Barcelona which regularly approves new results in the field of indistinct and multiple economic researches, holding annual conferences and issuing the Fuzzy Economic Review magazine.

There new international school of sciences was formed on the ground of the former Soviet Union, which consist of researchers from Belarus, Ukraine and Russia.

The basis of fuzzy logic is membership function as the instrument of transfer of linguistic variables to mathematical language for further application of a method of fuzzy logic.

Membership function μA (x) is the certain mathematical function, which is setting degree or confidence. Some elements of set X belong to the indistinct set A. If the argument x is correspond to an indistinct set A, the value of μA (x) is closer to 1.

The basis for creation of membership function can be expert estimates. Its view can

be absolutely any.

The concept about so-called standard membership functions was created in modern conditions.

Triangular functions of accessory are used for a task of uncertainty type: «it is approximately equal», «average value», «it is located in an interval», «it is similar to object», «it is similar regarding», etc.

Triangular and trapezoidal functions are described as

$$f_{\Delta}(x;a,b,c)=\begin{Bmatrix}0, & x\le a\\ \frac{x-a}{b-a}, & a\le x\le b\\ \frac{c-x}{c-b}, & b\le c\le x\\ 0, & c\le x\end{Bmatrix} \quad (1)$$

$$f_{T}(x;a,b,c,d)=\begin{Bmatrix}0, & x\le a\\ \frac{x-a}{b-a}, & a\le x\le b\\ 1, & b\le x\le c\\ \frac{d-x}{d-c}, & c\le x\le d\\ 0, & d\le x\end{Bmatrix} \quad (2)$$

Z-shaped functions of accessory are used for a task of uncertainty type: «fractional amount», «small value», «insignificant size», «low level», etc.

They consist of:

– harmonious and square Z-splines

$$f_{z_1}(x;a,b)=\begin{Bmatrix}1, & x\le a\\ \frac{1}{2}+\frac{1}{2}\cos\left(\frac{x-a}{b-a}\pi\right), & a\le x\le b\\ 0, & x>b\end{Bmatrix} \quad (3)$$

$$f_{z_2}(x;a,b)=\begin{Bmatrix}1, & x\le a\\ 1-2\left(\frac{x-a}{b-a}\right)^2, & a<x\le\frac{a+b}{2}\\ 2\left(\frac{b-x}{b-a}\right)^2, & \frac{a+b}{2}<x<b\\ 0, & b\le x\end{Bmatrix} \quad (4)$$

– Z-sigmoid and Z-linear functions

$$f_{z_3}(x;a,b)=\frac{1}{1+e^{-a(x-b)}},\quad a<0 \quad (5)$$

$$f_{\downarrow}(x;a,b)=\begin{Bmatrix}1, & x\le a\\ \frac{b-x}{b-a}, & a<x<b\\ 0, & b\le x\end{Bmatrix} \quad (6)$$

S-shaped functions of accessory are used for a task of uncertainty type: «large number», «great value», «considerable size», «high level» and etc.

They consist of:

– square and harmonious S-splines

$$f_{s_1}(x;a,b)=\begin{Bmatrix}0, & x\le a\\ 2\left(\frac{x-a}{b-a}\right)^2, & a<x\le\frac{a+b}{2}\\ 1-2\left(\frac{b-x}{b-a}\right)^2, & \frac{a+b}{2}<x<b\\ 1, & b\le x\end{Bmatrix} \quad (7)$$

$$f_{s_2}(x;a,b)=\begin{Bmatrix}0, & x<a\\ \frac{1}{2}+\frac{1}{2}\cos\left(\frac{x-b}{b-a}\pi\right), & a\le x\le b\\ 1, & x>b\end{Bmatrix} \quad (8)$$

– S- sigmoid and S- linear functions

$$f_{s_3}(x;a,b)=\frac{1}{1+e^{-a(x-b)}},\quad a>0 \quad (9)$$

$$f_{\uparrow}(x;a,b)=\begin{Bmatrix}0, & x\le a\\ \frac{x-a}{b-a}, & a<x<b\\ 1, & b\ge x\end{Bmatrix} \quad (10)$$

P-shaped functions of accessory, are used for a task of uncertainty type: «approximately ranging from and to», «it is approximately equal», «near», etc.

They consist of:

– campanili form and и Gaussian function

$$f_{\Pi_1}(x;a,b,c,d)=\frac{1}{1+\left|\frac{x-c}{a}\right|^{2b}} \quad (11)$$

$$f_{\Pi_2}(x;\sigma,c)=e^{\frac{-(x-c)^2}{2\sigma^2}} \quad (12)$$

Standard functions of accessory are easily applicable to the solution of the majority of tasks. However if it is necessary to solve a specific problem, it is possible to choose also more suitable form of function.

Expert estimates can form the basis for creation of membership function. Its kind can be absolutely spontaneous. Standard membership functions are easily applicable to the solution of the tasks majority. However if its necessary to solve a specific problem, it is possible to choose the more suitable form of membership function, thus it is possible to achieve the best results of work of system, than when using functions of a standard kind.

There are two groups of construction methods of membership function of fuzzy set according to expert estimates of functions. They are straight lines and indirect methods [25].

Direct methods are characterized by the possibility of creation of rules of values determination of membership function by the

expert, which are characterizing an element x. Examples of direct methods are a direct task of membership function by the table, the schedule or a formula. A drawback of this group of methods is the big share of subjectivity.

Indirect methods of value of membership function has to get out in accordance to meet in advance formulated conditions. Expert information is only initial information for further processing.

The group of inderect methods consists of such techniques of membership function creation as creation of membership function on the basis of paired comparison with group of these methods, with using of statistical data, on a basis the ranking estimates etc.

The statement about fuzzy logic, most often the statement about system of fuzzy conclusions, which are the cornerstone of various expert and operating systems.

The main stages of fuzzy conclusion are:

1. Fuzzification (determination of values) of input parameters when values of membership function for the corresponding values of entrance variables are calculated

2. Formation of basic rules (knowledge base) of fuzzy conclusion system.

3. Aggregation (composition). At this stage all fuzzy sets appointed for each variable of a conclusion unite together to form one fuzzy set for each variable of a conclusion.

4. Defuzzification, when the fuzzy set of conclusions is transformed to accurate number, for example, with application of a centroid method when the result of x-coordinate is barycenter and received at a stage 3.

The described algorithm of fuzzy conclusion is schematically represented in figure 1.

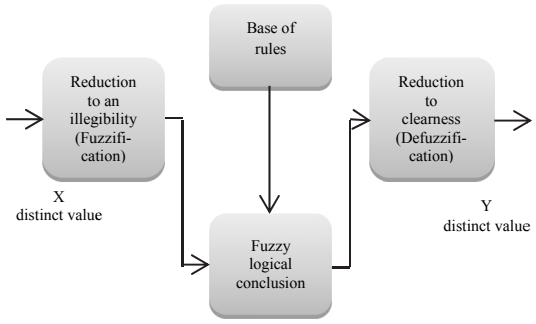

Fig. 1. Scheme of algorithm of fuzzy conclusion [26]

The most difficult is the fazzification stage. Its performance can be presented in the form of the following algorithm.

In the beginning for each term of the taken linguistic variable there are numerical values or range of the values, which are best characterizing this term.

As this value or values are «prototype» for them the single value of membership function gets out.

After determination of values with single accessory it is possible to define value of parameter with accessory «0» to this term.

This value can be chosen as value with accessory «1» to other term from among defined earlier.

After determination of extreme values it is necessary to define intermediate values.

Among standard membership functions the P – functions or L-functions (triangular) are determined for them.

S-or Z-functions of accessory are using if the values corresponding to extreme values of parameter are determined.

Further the productional rules connecting linguistic variables are defined. Set of such rules describes the strategy of management applied in this task.

The majority of fuzzy systems are using productional rules for the description of dependences between linguistic variables. The typical productional rule consists of an antecedent (part IF …) and a consequent (part THAT …).

The antecedent may contain more than one parcel. In this case they can be united by means of logical connectives And or OR.

Process of fuzzy rule calculation is called as an fuzzy logical conclusion and is subdivided into two stages: generalization and conclusion [27].

In practice of financial control a number of the indicators characterizing the separate parties of the current financial position of the enterprise are well-known.

They are indicators of liquidity, profitability, stability, turnover of the capital, profitability, etc.

On a number of indicators the certain standards characterizing their value are known: positive or negative. But in most cases the indicators estimated in the analysis unambiguously can't be normalized. It is connected with specifics of branches of

economy, with the current features of the operating enterprises, with a condition of the economic environment in which they work.

In these conditions it is possible to use the device of fuzzy logic.

The approach to an assessment of risk of enterprise bankruptcy offered by A. Nedosekin is deserving attention [8].

In its model a exhaustive set of E condition of enterprises are divided into five (generally crossed) fuzzy subsets of such kind:

– E1 – subcollection of conditions «limit trouble»;

– E2 – subcollection of conditions «trouble»;

– E3 – subcollection of conditions «middling quality»;

– E4 – subcollection of conditions «relative wellbeing»;

– E5 – subcollection of conditions «limited wellbeing».

It means the term set of the linguistic variable «Condition of the Enterprise» consists of five components.

To each value of the linguistic variable E_1… E_5 (which is fuzzy subset of values of an interval (0,1)) correspond the membership function $\mu_1(x)$ … $\mu_5(x)$.

Corresponding to a set E is full set of risk degrees of bankruptcy also of G divided into 5 subcollection:

– G1 – subcollection «limit risk of bankruptcy»,

– G2 – subcollection «degree of bankruptcy risk is high»,

– G3 – subcollection «degree of bankruptcy risk is average»,

– G4 – subcollection «low degree of bankruptcy risk»,

– G5 – subcollection «the risk of bankruptcy is insignificant». The indicator of G according to the definition accepts values from zero to unit.

For any separate financial or administrative indicator of X_i the full set of its B_i values are divided into five subcollection:

– Bi_1 – subcollection «very low level of an X_i indicator»,

– Bi_2 – subcollection «low level of an X_i indicator»,

– Bi_3 – subcollection «average level of an X_i indicator»,

– Bi_4 – subcollection «high level of an X_i indicator»,

– Bi_5 – subcollection «very high level of an X_i indicator».

Further the set of separate indicators of $X = \{X_i\}$ is built by total number of N which, according to the expert-analyst, on the one hand, influence an assessment of risk of bankruptcy of the enterprise is under construction, and, on the other hand, estimate the parties of business and financial life of the enterprise, various by the nature.

To each indicator of Xi is correlating the level of its importance for the analysis of r_i (all indicators settle down in the order of importance decrease).

The most often used indicators is:

– X_1 – equity to total assets ratio;

– X_2 – current assets coverage ratio (relation of net working capital to current assets);

– X_3 – intermediate liquidity ratio (the relation of the sum of money and receivables to short-term liabilities);

– X_4 – absolute liquidity ratio (relation of the sum of money to short-term liabilities);

– X_5 – turnover of all assets in annual calculation (the attitude of sales proceeds towards average during the cost of assets);

– X_6 – profitability of all capital (the attitude of net profit towards average during the cost of assets).

Further classification of the current value g is based on a risks exponent as a criteria of splitting this set into fuzzy subsets.

The classification of the current values x is presented by the accepted criterion and by the x_i carrier accessory level to a fuzzy subset of B_j.

Are originally estimated the weight of this or that subset from B in an assessment of a condition of the enterprise E and in an assessment of degree of risk of G.

This weight in the subsequent is participated in external summation for determination of average value of an indicator of g where g_j is not that other as an average assessment of g from the corresponding range.

Classifications of risk degree are result the linguistic description of degree of risk and (in addition) degree of confidence of the expert in correctness of his classification. And that

conclusion about degree of risk of the enterprise gets not only a linguistic form, but also the characteristic of statements quality.

The structure of the separate expert solution and analytical task includes the following main information components: conceptual model of subject domain of an expert and analytical task or system preferences of is the formalized idea of the expert about task, its elements and communications; estimates of objects from subject domain or simply objects of the real world which are analyzed at the solution of a task; the external factors of dynamics are presented in the form of statistical data (which can describe the condition of conceptual model and objects in the past) and future factors (the possible changes of which is describe the conceptual model and objects in the future); updates or internal factors of dynamics which are generated by the most conceptual model according to the established rules.

The preference scheme is the most important component of an expert and analytical task and is intended for the formalized idea of conscious knowledge of the expert about structure, communications and characteristics of elements of subject domain of the solved task.

The system of preferences is presented in the form of a set of tops and the directed communications between them.

Tops of preferences system of describe concepts, which are set by the expert and bear the concrete semantic loading are depending on a task. These concepts, in turn, are defined by other concepts and by means of communications. Communications can be considered as the relation which are set the influence of one concepts on others.

For formalization of communications of system concepts of preferences of a program complex is used the construct of fuzzy measure according to Sugeno which is set for each context on a set of his private concepts.

In other words, to each top is attributed by the some fuzzy measures for number of its contexts. Really, any concept can make various sense in various contexts.

For formalization of communications of system concepts of preferences of a program complex is used the construct of fuzzy measure according to Sugeno, which is set for each context on a set of his private concepts.

External factors of dynamics are one of the main components of a program complex, which defines variability in time as systems of preferences and estimates of objects.

Proofs or internal factors of dynamics are also one of the main component of a program complex, which defines variability in time as systems of preferences and estimates of objects.

Unlike external, the internal factors are generated by the system of preferences on the basis of an assessment of a condition of one of objects in the set timepoints. Updates together with external factors are forming a uniform field of influences.

There is an information support of fuzzy logic systems. CubiCalc is one of the most sold packages on the basis of fuzzy logic which represents expert system and in which the user sets a set of rules like «if – that», and the system tries to react adequately to change of situation on the basis of these rules. The introduced rules contain indistinct sizes, i.e. have an appearance «if X belongs to A, that Y belongs to B», where A and B are fuzzy sets.

CubiCalc 2.0 RTC — one of the most powerful commercial expert systems on the basis of fuzzy logic allowing to create own applied expert systems; CubiQuick in the cheap «university» version of a CubiCalc package.

FuziCalc of FuziWare firm is the first-ever worldwide spreadsheet allowing to work both with exact numerical values, and with approximate, «fuzzy» sizes.

AnyLogic is the instrument of imitating modeling which united methods of system dynamics, «process» discrete, event and agent-based modeling to the one language and one environment of development of models. Its use allows to reflect dynamics of difficult and diverse economic and social systems in any desirable level of abstraction. AnyLogic includes a set of primitives and objects of libraries for effective modeling of production and logistics, business processes and the personnel, finance, the consumer market, and also surrounding infrastructure in their interaction.

The object-oriented approach offered by AnyLogic is facilitate iterative stage-by-stage creation of big models. AnyLogic supports a set

of various types of experiments with models: simple run, comparison of runs, a variation of parameters, the analysis of sensitivity, optimization, calibration, and also any experiment according to the user scenario.

The software package of ITHINK is means of simulation modelling of production and financial projects and processes.

It appeared in the 90th years of the XX century and became the standard of structural modeling. It is widely used in the intellectual centers of corporations, banks, government structures and design and research establishments and is focused on performance of so-called «stream» tasks.

The package is intended for wide group of users – from the heads solving complex administrative problems to the consulting companies and individual entrepreneurs and researchers.

PolyAnalyst is intended for obtaining analytical information by automatic processing of basic data and can be used by the analysts occupied in various spheres of activity.

The technology of artificial intelligence of Data Mining is the basis for a package. During processing basic data it allows to find multiple-factor dependences to which gives then a type of any functional expressions and forms structural and classification rules.

Thus basic data of various types are exposed to the analysis: real numbers, logical and categorial sizes. The rules are assuming the view of functions, or cycles, or conditional designs.

The PolyAnalyst package consists of two parts. The first of them – the module of universal preliminary data processing of ARNAVAC. The methods realized in this module are traditional for automation of analytical data processing. ARNAVAC finds functionally coherent clusters in data files, filters noise and casual emissions. Then the automatic analyst builds multidimensional linear regression dependence as the simplest and available description of basic data, using thus the universal high-speed algorithm which is automatically choosing the most influencing parameters with correct determination of their importance.

Process of creation of hypotheses goes automatically, irrespective of their complexity.

The popular cover allowing to describe fuzzy expert systems is FuzzyCLIPS. This modification supplements possibilities of CLIPS, giving opportunities to the fuzzy argument.

CLIPS is a development tool of expert systems, which provides the full environment for designing of the rule and/or object-oriented expert systems.

CLIPS provides the uniform tool for processing of a wide range of knowledge with support of three various paradigms of programming: based on rules, object-oriented and procedural character.

Expansions for fuzzy logic are completely integrated with the facts and assumptions of a kernel of CLIPS that gives the chance to represent and manipulate the fuzzy facts and rules.

FuzzyCLIPS can deal with the accurate, fuzzy and combined arguments, that allows to mix fuzzy and normal conditions in rules and facts of expert system. The system uses two concepts of soft calculations: illegibility and uncertainty.

FuzzyCLIPS provides the useful environment for applications programming, using fuzzy logic in systems of decision-making.

The realization of FuzzyCLIPS of 6.10d version, which is existing at the moment can be used in developing of the distributed information systems of support of decision-making, such as the client-server environment of dynamic expert systems.

ExProMaster realizes intuitively obvious logic of the person decision about analytical problems of an assessment, forecasting and classification which is well coordinated with the standard principles of difficult systems research and therefore, it can be considered as construct of the solution of a wide range of system tasks.

MarketEffect is intended for development of effective marketing decisions by the enterprises of average and vast scale in the sphere of production, trade, rendering services.

It is directed on the solution of the tasks connected with advance (sale) of goods on the market with purchases of raw materials, materials, energy resources, etc.

The appendix is functioning as a part of

FinExpert system of development of the IDM company.

MarketEffect is constructed on the basis of indistinct technology (fuzzy technology).

It allows to solve the problems assigned to the appendix and to process of all possible range of initial information on the general ideological and tool basis and not to be limited thus to use only of numerical data on a condition of the market.

The appendix allows to consider in addition knowledge of experts of the market and assumptions of its development in spite of the fact that this information has descriptive character**.**

Fuzzy Estimation of Critical Messages (FECM) is intended for an assessment of integrated (cumulative) influence of a messages flow, which are arriving in a large number on the eve of and in the process of the currency auction on exchange rates. The result is forecasts of these courses.

Together with the available software products of the technical analysis, the FECM allows to connect the past and the future of forecasting exchange rates and, thereby, to raise possibility of adoption of the correct decisions by participants of the currency auction and other spheres of business**.**

Use of the program is the analyzing system and forecasting of fundamental factors during the carrying out the currency auction in the FOREX market.

Together with the available programs of the technical analysis of FECM turns into a powerful analytical complex of forecasting of exchange rates and sharply raises possibility of adoption of the correct decisions by traders.

Prospects of researches on fuzzy systems are connected with development of granular calculations. Creation of a granule of information is based on mathematical development of theories of extent of manifestation of properties.

This approach allows to consider fuzzy logic as the perspective tool for the analysis of heterogeneous information, in the form of qualitative linguistic descriptions and quantitative data.

The most perspective directions of development of fuzzy logic are: researches of indistinct databases, including indistinct temporary ranks; intellectual analysis of data and texts (Data and Text Mining); creation of intellectual information systems; formation of semantic Web space.

Conclusion. In recent years scenario and probabilistic methods of the analysis are succeeded by fuzzy and multiple approaches which, on the one hand, are free from probabilistic axiomatics and from problems with justification of a choice of probabilistic scales, and, on the other hand, include all possible scenarios of events succession.

Such approach allows generating a continuous range of scenarios of realization on each of the predicted parameters of financial model.

Use of the fuzzy sets theory has the following advantages:

1) allows to formalize unified form and to use all available non-uniform information (determined interval, statistical, linguistic) which increases the reliability and quality of decisions in financial control;

2) unlike interval method, the fuzzy and interval method is similarly to the Monte-Carlo method. It forms a full range of possible scenarios of development of the enterprise. It is forming not only the lower limit but also top borders, and the decision is made not on the basis of two estimates of efficiency, but on all set of estimates;

3) the fuzzy and interval method does not demand absolutely exact task of membership function as probabilistic methods. The result received on the basis of an indistinct and interval method is characterized by low sensitivity (high stability) to change the type of membership function of initial indistinct numbers, which in actual practice of poor quality of initial information makes the application of this method more attractive;

4) calculation of estimates of financial control indicators on the basis of fuzzy and interval method is effective in situations when probabilistic estimates cannot be received;

5) realization of fuzzy and interval method on the basis of interval arithmetic, gives ample opportunities for application of this method in financial control that is caused actually by lack of competitive approaches to the creation of reliable (that is security) and transportable (on inclusion) tool for the solution

of numerical tasks;

6) it is characterized by simplicity of expert knowledge identification.

Thus, the unique method of accounting uncertainty at the financial control organization and assessment of innovations (at this stage of development of science) are expert estimates, and the best option of representation of opinions of experts is fuzzy intervals.

Literature

1. Zadeh L. A. Fuzzy Sets as a Basis for a Theory of Possibility // Fuzzy Sets and Systems. 1978. Vol. 1.

2. Zadeh L. A. Outline of a New Approach to the Analysis of Complex Systems and Decision Processes / IEEE Transactions on Systems, Man, and Cybernetics, SMC-3(1), January 1973. – P. 28–44.

3. Buckley, J. Solving fuzzy equations in economics and finance // Fuzzy Sets & Systems, 1992, № 48.

4. Buckley, J. The Fuzzy Mathematics of Finance // Fuzzy Sets & Systems, 1987, № 21.

5. Kosko B. Fuzzy thinking / Hyperion, 1993.

6. Kosko B. Neural Networks and Fuzzy Systems / Englewood Cliffs, NJ : Prentice-Hall, 1991.

7. Fuzzy Logic Toolbox. Manual. 1994–2006 The MathWorks, Inc. [Electronic resource] //Mode to access: http://www.mathworks.com/access/helpdesk/help/toolbox/ fuzzy/index.html

8. Недосекин А. О. Оценка риска бизнеса на основе нечетких данных/ А. О. Недосекин / [Электронный ресурс] / Код доступа : http://sedok.narod.ru /sc_group.html

9. Головина Т. А. Теория и методология контроллингового управления промышленными предприятиями в условиях нелинейного развития экономических систем : монография / Т. А. Головина – Орел : ФГБОУ ВПО «Госуниверситет – УНПК», 2011. – 330 с

10. Кутанин Ю. В. Алгоритм организации контроллинга на предприятии // Ю. В. Кутанин / Российский экономический интернет-журнал: Электронный журнал. – М. : АТиСО, 2009. № гос. регистрации 0420600008. [Электронный ресурс] / Код доступа: http://www.e-rej.ru/Articles/2009/Kutanin.pdf.

11. Иванов М. М. США: управление наукой и нововведениями / М. М. Иванов, С. Р. Колупаева, Г. Б. Кочетков; ред.: Л. И. Евенко, Г. Б. Кочетков; АН СССР, Ин-т США и Канады. – М. : Наука, 1990. – 216 с.

12. Тычинский А. В. Управление инновационной деятельностью компаний: современные подходы, алгоритмы, опыт / А. В. Тычинский. – Таганрог : ТРТУ, 2006. – 108 с.

13. Bayes T. Facsimilies of two papers by Bayes: An essay toward solving a problem in the doctrine of chances. With Richard Price's foreword and discussion. With commentary by Edward C. Molina. // Phil. Trans. Royal Soc., 1963.

14. Savage L. J. The foundation of Statistics. N.Y. : Wiley, 1954.

15. Смоляк С. А. Оценка эффективности инвестиционных проектов в условиях риска и неопределенности (теория ожидаемого эффекта) / С. А. Смоляк. – М. : ЦЭМИ РАН, 2001. – 143 с.

16. Hurwicz L. Optimality Criteria for Decision Making under Ignorance // Cowles commission papers, 1951, №370.

17. Лившиц В. Н. Оптимизация при перспективном планировании и проектировании / В. Н. Лившиц. – М. : Экономика, 1984. – 224 с.

18. Dubois D., Prade H. Fuzzy Sets and Systems. N.-Y., Academic Press, 1980

19. Zemankova-Leech, Maria, and Abraham Kandel. Fuzzy Relational Data Bases: A Key to Expert Systems / Cologne : Verlag TUV Rheinland, 1984.

20. Bojadziev G. Fuzzy Logic for Business, Finance and Management // Advances in Fuzzy Systems, 1997. Vol. 12.

21. Bojadziev G., Bojadziev M. Fuzzy Sets, Fuzzy Logic, Applications. World Scientific Pub Co, 1996.

22. Dimova L, Sevastjanov P., Sevastianov D. Fuzzy Capital Budgeting: Investment Project Valuation and Optimization // Chenstohova Tech. Univercity Proceedings, 2001

23. Хил Лафуенте А. М. Финансовый анализ в условиях неопределенности: Пер. с исп. Под редакцией Е. И. Велесько, В. В. Краснопрошина, Н. А. Лепешинского / А. М. Хил Лафуенте. – Мн. : Тэхналопя, 1998. – 150 с.

24. Zimmerman H. Fuzzy Sets Theory – and Its Applications. Kluwer Academic Publishers, 2001.

25. Алтунин А. Е. Модели и алгоритмы принятия решений в нечетких условиях: Монография/ А. Е. Алтунин, М. В. Семухин. – Тюмень : Издательство Тюменского государственного университета, 2000. – 352 с

26. Борисов А. Н. Принятие решений на основе нечетких моделей. Примеры использования/ А. Н. Борисов, О. А. Крумберг, И. П. Федоров. – Рига : Зинатне, 1990. – 184 с.

27. Гриняев С. Нечеткая логика в системах управления/С.Гриняев. [Электронный ресурс] / Код доступа: http://www.computerra.ru/offline/ 2001/ 415/ 13052/ print.html

28. Штовба С. Д. Введение в теорию нечетких множеств и нечеткую логику проекта / С. Д. Штовба. [Электронный ресурс] / Код доступа: http://matlab.exponenta.ru/fuzzylogic/book1

ВИКОРИСТАННЯ ЕЛЕМЕНТІВ НЕЧІТКОЇ ЛОГІКИ В СИСТЕМІ ФІНАНСОВОГО КОНТРОЛЮ

К. Ф. Ковальчук, д. е. н., професор, Н. П. Козенкова, старший викладач, В. Д. Козенкова, аспірант, Національна металургійна академія України

У статті розглянуто питання функціонування фінансового контролю на підприємстві. Проаналізовано підходи до організації фінансового контролю. Показано роль інформації в організації системи фінансового контролю. Представлено механізм використання елементів теорії нечіткої логіки у фінансовому контролі.

Ключові слова: фінансовий контроль, інформація, нечітка логіка, управління, контроль.

ИСПОЛЬЗОВАНИЕ ЭЛЕМЕНТОВ НЕЧЕТКОЙ ЛОГИКИ В СИСТЕМЕ ФИНАНСОВОГО КОНТРОЛЯ

К. Ф. Ковальчук, д. э. н., профессор, Н. П. Козенкова, старший преподаватель, В. Д. Козенкова, аспирант, Национальная металлургическая академия Украины

В статье рассмотрены вопросы функционирования финансового контроля на предприятии. Проанализированы подходы к организации финансового контроля. Показана роль информации в организации системы финансового контроля. Представлен механизм использования элементов теории нечеткой логики в финансовом контроле.

Ключевые слова: финансовый контроль, информация, нечеткая логика, управление, контроль.

Рекомендовано до друку д. е. н., проф. Пилипенко Ю. І. *Надійшла до редакції 25.09.15.*