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APPLICATION OF FUZZY LOGIC IN PROBLEMS OF RISK ASSESSMENT

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The paperdiscusses the use of fuzzy logic in the problems of risk assessment in economics and IT. Based on fuzzy logic method of occupational risk assessment considers.

The basics of fuzzy logic were formula tedby famous American mathematician Lotfi A. Zadeh attheend of 1960s. The paper "Fuzzy Sets"waspublishedin1965 inthe "Information and Control". It laid the foundations for modeling human intellectual activity and became the reference point for the development of new mathematical theory [1]. Zadeh gave the name for the new field of science – "fuzzy logic" (fuzzy – vague, uncertain). However, this theory was not put to use until the mid-1970s, when Ibrahim Mamdanidesigned of fuzzy controller for a steam engine [1]. Since then, fuzzy logic is widely use in control problems. Especially widespread fuzzy logic typical for Japan, where the world's leading companies are exploring and using fuzzy logic to design more commonsense instruments, devices and systems management.

Fuzzy logic manipulates such vague concepts as «cold», «close», «fast», etc., inherent in human thinking. The notion of fuzziness refers to classes in which there are different scales of toiletries, intermediate between full membership and belonging to this class of objects [2]. In other words, a fuzzy set is a class of objects in which there is no sharp boundary between those objects that are in this class, and those that it does not include.

On the basis of fuzzy inference were obtained solving a large number of problems of analysis and control of power systems [3], and process plants: chemical reactors, electric motors, welding processes, installations for water purification, cooling units, fans and air conditioners, heaters, rechargeable units, communication systems [4], transport.

Based on its instruments fuzzy logic has received its application in expert systems, including control problems and risk assessment. In the early 1990s a health management system applied for large firms in Japan. The fuzzy system diagnoses the health of patients and draw up personalized plans to help them prevent disease and stay fit.

The use of the theory of fuzzy sets expandsto problems of management and risk assessment, decision support. Widespread fuzzy set theory gets in the economic sphere. For example, in [5] provides a comparison of methods and models for risk analysis of bankruptcy. According to the results of the comparative analysis the most highly accurate prediction of bankruptcy of enterprises Mamdani (90%) and Tsukamoto (88%)models showed, followed by fuzzy multiple Nedosekin's method (80%) and finally, the worst performance prediction accuracy has a classic method Altman'sdiscriminant analysis (73%). In a paper [6] also conducted a comprehensive evaluation of the risk of bankruptcy corporations based on fuzzy descriptions.

Paper [7] devoted to the application of fuzzy set theory to analysis of investments in the securities market. The questions assess the risk of bankruptcy of the issuer, the project risk of direct investment, the risk of investments in stocks, bonds, options, and combinations thereof. The paper presents a technique for assessing the investment attractiveness of the shares. Suggested by the author an independent theory of risk assessment using fuzzy sets formed the basis of a number of software products developed by Russian companies. In [8] the use of fuzzy logic in assessing investment risks.

A new approach to the description of information risk based on fuzzy sets and fuzzy semantic networks presents in paper [9]. Application of this method was the basis of a software decision support system that performs some of the functions of the expert in the field of information security.

The theory of fuzzy sets is actively used to assess risks in the economy, information technology, and existing studies demonstrate the effectiveness of such methods. On the other hand, there are many different approachesin the assessment of occupational risks, which are not very flexible and are often very difficult to use. Fuzzy set theory provides convenient tools for applications in which an important role have expert knowledge. Because of these reasons, it is possible to use fuzzy set theory to evaluate occupational risks.

Currently, assessment of occupational risks is an important task, which is a quality solution with one of the key areas in order to reduce accidents and occupational diseases in the enterprise. Determining the level of occupational risk allows developing risk management measures to prevent exposure of occupational hazards to the health of employees. That is, at the moment this method is regarded as a much more effective alternative to incident response.

The level of occupational exposure is influenced by such factors as the state of injury, occupational diseases and conditions in the workplace, which are expressed in quantitative and qualitative form. Depending on the level of risk in the workplace, there are certain requirements to respond. The level of risk is expressed in a qualitative way, such as "acceptable risk". That is, input data are quantitative or qualitative data, and output data risk assessment methods should be qualitative determination of the level of risk at the workplace. These qualitative variables operates fuzzy set theory, which confirms the possibility of its application in this case.

Currently, there are several algorithms for fuzzy inference, the most famous of which are the algorithms Mamdani Tsukamoto, Sugeno and Larsen [10]. The most common is Mamdani fuzzy inference algorithm. This algorithminclude following steps: forming the base of fuzzy inference rules, fuzzification of the input parameters, aggregation, intensification sub-conditions in fuzzy production rules, defuzzification. More often than not fuzzy systems glean their rules from experts. Expert determines linguistic variables and sets the membership function for each linguistic variable term. Aggregation is a definition the degree of truth conditions for each of the fuzzy inference system rules. Next is determination degree of truth each of the conclusions of fuzzy rules. Finally, defuzzification is performed using the method of the center of gravity.

Occupational risk assessment methodology using the specified fuzzy inference was presented in [11]. This methodology has been implemented as a software application "Calculator occupational hazards". The application determines the impact of occupational risk occupational hazard, occupational hazard and occupational risk of the combined impact of harmful factors. Imprint application were compared with the results of model -based environment fuzzy TECH identical sets of input data. In general, the results were similar in values.

Obviously, the most difficult step is the formation of the rule base and the determination of membership functions for linguistic variables, as at this stage, the determining factor is the knowledge expert who performs these actions. That is the quality of the entire model is largely dependent on the professional level expert.

Based on the application of fuzzy set theory to the assessment of risks in the economy and information technology was determined the possibility of applying this theory to the evaluation of occupational hazards which are caused by health and safety hazards at work place. On the basis of methodology for assessing the level of occupational risk was developed application "Calculator occupational hazards", the realization of which is not a difficult task. Such an application can be used in the enterprise as a result of its work to assess the level of occupational risk. It can be concluded that the application of fuzzy sets theory is a promising direction to improve methodology for assessing occupational hazards.

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AN APPROXIMATE METHOD OF DETERMINING THE COEFFICIENT OF VOLTAGE HARMONIC DISTORTION

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This article is devoted to investigations of different methods of determining the coefficient of voltage harmonic distortion. The paper contains approximate expression for the calculation of the coefficient of harmonic distortion of the voltage according to the testimony of voltmeters and tasks for its further metrological studies and checking.

One of the important tasks of modern electric power is to control and maintain the quality of electricity (SCE) in accordance with GOST 13109 - 97[1], as mismatch SCE established requirements leads to a significant economic loss[2].

For an objective quality evaluation of electricity SCE should be measured instrumentally, using the appropriate measuring instruments. SCE measurement is possible in part by a general-purpose instrumentation [3] or using special measuring instruments for measuring the SCE [4].

Of course, special measuring instruments of SCE are favorable because they are universal, measured practically the entire spectrum of the SCE, are complying with the requirements of GOST metrological characteristics, able to record and store information about the measured SCE etc. Meanwhile, this equipment is complex, expensive, often intended for stationary installation and not always mobile. Therefore, if necessary, and in the absence of special instruments for measuring SCE GOST allow the measurement of certain SCE using a general-purpose instruments. [1]

Really, measuring instruments of SCE are devices that actually measure voltage, i.e. to its original purpose are voltmeters. However, not all SCE can be measured with a voltmeter. In addition, measurement of the SCE frequency counters and spectrum analyzers are necessary [4].

Such SCE as steady voltage deviation δU_s , the depth of the voltage dip δU_d , voltage asymmetry on the reverse sequence K2U and zero sequence K0U can be measured with a voltmeter [5] . Information about measuring the coefficient of harmonic distortion using a voltmeter cannot be found in the technical literature.

Harmonic distortion of the voltage according to [1] estimated coefficient voltage harmonic distortion K_{Ui} and coefficient of n-th harmonic voltage component. Of these coefficients using voltmeters can try to determine only the coefficient of voltage harmonic distortion K_{Ui} .

Harmonic distortion coefficient voltage K_{Ui} according to [1] is defined as:

$$K_{Ui} = \frac{\sqrt{\sum_{k=2}^{40} U_k^2}}{U_1} \cdot 100\% \qquad (1)$$

where U_k – active value of the higher harmonics;
U_1 – active value of the first harmonic

For simplification, we introduce a replacement:

$$U_{vg} = \sqrt{\sum_{k=2}^{40} U_k^2} \qquad (2)$$

For the ideal sinusoidal voltage the relation between the amplitude and the current value in the form is typical [6]:

$$\frac{U_{1m}}{U_1} = \sqrt{2} \qquad (3)$$