UDC 338.2(476)+316.42(476)
JEL Classification: H10, J58, P35, Z13

DEVELOPMENT OF A MODEL FOR THE ANALYSIS OF SOCIO-ECONOMIC SECURITY OF A COMPLEX SYSTEM

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РАЗРАБОТКА МОДЕЛИ АНАЛИЗА СОЦИАЛЬНО-ЭКОНОМИЧЕСКОЙ БЕЗОПАСНОСТИ СЛОЖНОЙ СИСТЕМЫ

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Abstract. The effectiveness of the use of mathematical methods of data analysis to the results of experimental studies is justified by a formalized representation of the quality of the objects of the studied array in numerical format. At the same time, depending on the individuality of the field of study there is an opportunity to meet a number of problems. As a rule, the socio-economic area of the probabilities of formalization of the quality of the objects is located at the stage between difficult and easy) formalization. The difficulty of formalization, first of all, is that it is impossible not to take into account the social component in the formal description of social and economic systems. But if earlier the formalization of the social element in principle was not likely due to the undeveloped apparatus, then it was not remembered. All modelling was limited to the analogy with technical systems or statistical data processing. However, at the moment on the basis of interdisciplinary approaches there is a real probability to address the formalization of society - a difficult field of study.

Аннотация. Результативность использования математических способов анализа данных к итогам опытных исследований обоснована формализованным представлением качеств объектов исследуемого массива в числовом формате. При этом в зависимости от индивидуальностей области изучений тут имеет возможность встретится ряд проблем. Как правило, социально-экономическая область по вероятностям формализации качеств исследуемых объектов располагается на этапе между трудной и легкой) формализацией. Трудность формализации, в первую очередь, состоит в том, что невозможно не учитывать социальный компонент в формализованном описании социально-экономических систем. Но в случае если раньше формализация общественного элемента впринципе не представлялась вероятной в силу неразработанности аппарата, то о ней и не вспоминали. Все моделирование ограничивалось приведением аналогий с техническими системами или же статистической обработкой данных. Впрочем в данный момент на базе междисциплинарных подходов присутствует действительная вероятность адресоваться к формализации социума - трудноформалнзуемой области изучения.

Keywords: socio-economic security; the government; society; enterprise; employee; threat; security; interests; Economics, analysis, system.

Ключевые слова: социально-экономическая защищенность; государство; общество; предприятие; работник; угроза; защищенность; интересы; экономика, анализ, система.

Resolution of issues provide protection, including socio-economic, with attraction of mathematical apparatus of enlightened work of V. M. Matrosov, V. A. Koptyug, S. N. Vasiliev, A. D. Gvishiani [1; 2] etc. worthy of interest to explore how the predictive assessment of socio-economic characteristics of the protection of state A. V. Rezchikova, A. D. Tvircun, V. A. Kushnikova, N. In. Endibaeva, V. A. Ivaschenko [3; 4].

All these scientists agree on one thing. The effectiveness of the use of mathematical methods of data analysis to the results of experimental studies is justified by a formalized representation of the properties of the objects of the studied array in numerical format. At the same time, depending on the individuality of the field of study here has the opportunity to meet a number of problems. As a rule, the socio-economic area of the probabilities of formalization of the quality of the studied objects is located at the stage between difficult and easy) formalization. The difficulty of formalizing in the first place, is that it is impossible not to take into account the social component in a formalized description of socio-economic systems [5, p. 102]. But if earlier the formalization of the social element in principle was not likely due to the undeveloped apparatus, then it was not remembered. All the modelling was limited to the reduction of analogies to technical systems or the statistical treatment of the data. However, at the moment on the basis of interdisciplinary approaches there is a real probability to address the formalization of society - a difficult to formalize field of study. For hard-formalized areas [6, p. 140] such features are peculiar:

- the task will not be defined only in numeric form (character representation required);
- algorithmic conclusion of the problem is unknown or impossible to apply due to limited resources (computer memory, performance);
- the objectives of the problem cannot be expressed in the definitions of a specific objective function or there is no clear mathematical model of the problem.

Knowledge of the real world is inherent in the so-called non-factors. They characterize the array of forms of knowledge that are not amenable to formalization by classical methods and all kinds of shortcomings of knowledge, as well as probable forms of ignorance, which are an obligatory and leading part of any knowledge.

A feature of non-factors is considered negative in the value of the description of the representation in formal systems. As a rule, this includes incompleteness, incorrectness, underdeterminacy, etc. [7, p. 65].

According to the systematization of statistical methods [8], in applied statistics there are 4 areas: statistics of (numerical) random variables; multivariate statistical analysis; statistics of time series and random processes; statistics of objects of non-numerical nature.

The starting point in mathematical statistics is sampling. In statistical probability theory, sampling is an array of independent identically distributed random components. In traditional mathematical statistics, the components of the sample are numbers. In multivariate statistical analysis - vectors. In statistics non-numeric components of the sample is non - numeric objects of nature, which cannot multiply and stack with numbers. In other words, objects of non-numeric nature lie in a space that does not have a vector structure.

Modern researchers in the field of applied statistics focus on the study of objects of non-numerical nature:

- values of qualitative symptoms, that is, the results of encoding objects using this list of categories (gradations);
- ordering (ranking) of objects by specialists according to different criteria;

- classification, that is, the division of objects similar to each other into groups (clusters);
- tolerance, that is, binary relations describing the monotony of objects among themselves, evaluated by experts for various purposes;
- the results of paired comparisons or quality control for another symptom (fit - marriage), that is, the order of 0 and 1;
- sets (ordinary or fuzzy), for example, zones affected by corrosion, or lists of probable causes of the accident, compiled by experts independently from each other;
- words, sentences, texts;
- vectors, coordinates of which - the array of values of different types of symptoms, for example, the summary of the statistical report on the scientific and technical work completed or a computerized diagnosis of the disease, in which the proportion of symptoms is of a qualitative nature, and the proportion of quantitative;
- answers to the questions of expert, sociological or psychological questionnaire, the share of which is quantitative (perhaps, interval), the share is in the choice of one of several tips, and the share is represented in the texts, etc.
- interval data can also be considered as an example of objects of non-numeric nature, but just as an exceptional case of fuzzy sets.

At the same time, the emphasis in applied statistical analysis only on objects of non-numerical nature is considered incomplete. When the subject field contains a difficult system organization, the first question arises about what symptoms (attributes, characteristics, variables) should be included in the statistical experiment project. There can be quite a large number of symptoms available for measurement (fixation). Often in advanced research their number is measured in tens, hundreds and thousands, and in advance it is impossible to foresee their likely usefulness. So, here is another powerful non-factor-high dimension and uncertainty of the initial description of objects.

In addition, it is often difficult to formulate statistical analysis criteria when preparing experimental data. This non-factor can be qualified as the fuzziness of external criteria.

As an Autonomous non-factor, the presence in the descriptions of difficult objects of a significant number of noisy, valueless variables that can obscure the desired patterns in the structures of experimental data is singled out. In addition, the presence of an array of duplicate variables in the descriptions of the objects of study can play an unfavourable role.

Apart from the previously noted diversity of symptoms, which have to work within the description of objects with a difficult system organization, an important feature is the heterogeneity of classes of objects, which are formed on the basis of those or other external criteria, which can be defined in another non-factor. The designated objects often belong to the equifinal systems, for which the monotonous external manifestations are due to different internal mechanisms.

Obtaining data related to labour-intensive and time-consuming experiments is often accompanied by burdens in the form of another non-factor - an array of missing values. At the same time, the duration of the process of obtaining initial data has the ability to lead to a different, no less unfavourable history - the formation of rapidly deviating values (emissions) from one or another measured indicator (almost independently of its nature).

Another non-factor appears when the number of columns in the data sets (the number of analyzed variables) is able to exceed the number of rows by 10 or more times. There is an unusual situation for conventional multivariate analysis-a large amount of data, but the situation should be interpreted as a small sample.

The main models used in the analysis of sequences of numbers and signs are not compatible with each other on the basis of basic assumptions. Methods for finding patterns in sequences of characters are based on brute force, which can be implemented in a rather limited options, or rely on significant heuristic assumptions. Here there is a discrepancy in the reconstruction of attractors, because the important qualities of the processes occurring in systems with difficult internal organization are often expressed in the form of patterns with changing periods. These patterns can represent not a clear never-ending sequence of numbers or characters, and have an internal region wild. The pattern of patterns with jokers and the intervals between them at the beginning of the real experience are unidentified - this is another non-factor.

Another non-factor related to the area of character sequencing in a number of timely tasks with support for statistical methods is the task of presenting the initial data in the form of a feature table. Partly this dilemma is currently trying to solve with the help of special sequence alignment algorithms. However, these methods, being heuristic, in fact, are not ready to take into account the fact that the images of sequences can be inserted (and unexplained nature) in a variety of places and different volumes.

In theory, the security of the individual questions analysis of the system, not related to the person, could relates to the fields of good formalization. As a result, they are deprived of a number of the problems listed above. However, some non-factors related to the features of classical methods of study (applied statistics) for the theory of security remain. So, for example, for the formation of the security cube and its subsequent analysis it is necessary to represent the initial data in the form of tables object-feature. In order to form conclusions about the behaviour of the analyzed system by the numerical values of symptoms, it is obvious to request a one-to-one ratio of the empirical relations of objects and the resulting numerical relations between the values of symptoms in these objects. In connection with the above, we have to talk about the need to find an isomorphism between the structure of formalized data and the structure of empirical non-formalized knowledge. As of this isomorphism in the theory of measurements [8; 9, p 133; 10, p. 148; 11, p. 83] is the notion of the measurement scale of the symptom. At the current stage, a fairly extensive and universal view of the dilemma typing scales of symptoms and the meaningfulness of the comparison of their values is developed, based on the presentation of the symptom by the family of mappings of a large number of objects in a large number of real numbers. In this theory, without limiting the generality, it is assumed that all the indicators of symptoms are numerical, due to the fact that the components of the array having a power not greater than the continuum can be coded with numbers. There is no doubt that in this proportion between the values of symptoms pass into the proper proportions between the numbers. The symptom itself as a reflection is set together with the mass of allowed transformations, which means fixing a large number of numerical transformations of the symptom that do not change it. A large number of allowed transformations of the symptom characterizes the type of the scale of its measurement.

A certain attention for solving the problem of this type forms a class of features, a large number of values of which consists of only 2 components. These symptoms are called dichotomous (Boolean). According to the scientific literature [12, p. 119], a large number of all one-to-one transformations for dichotomous symptoms coincides with an abundance of linear transformations.Relation $y = Ax + B$ specifies a one-to-one correspondence between 2 specific distinct values x_1 and x_2 2-mind specific values y_1 and y_2, because when $A \neq 0$ and $x_1 \neq x_2$ it follows that $y_1 \neq y_2$. There is no doubt that qualitative dichotomous symptoms have all chances to be represented in arithmetic Euclidean space in quantitative form by means of dichotomization procedure, the essence of which is as follows.

Let x be a qualitative sign having n values on N objects: $\{x_{ij}, i = \overline{1,N}, j = \overline{1,n}\}$. We will consider its representation by dichotomous features $\{x_s, s = \overline{1,n}\}$. We can assume that

$$x_{ij} = \{^{1 \text{ при } x_{ij}=x_{s,}}_{0 \text{ при } x_{ij}\neq x_{s,}} \quad (1)$$

Simply put, this means that if the j-th sign appears on the i-th object, then this fact is fixed by 1, if not — then 0.

Found n dichotomous features $\{x_s, s = \overline{1,n}\}$ form columns of matrix X of dimension N×n. The matrix X is Boolean and provides an adequate representation of the trait x, which represents the possibility to transform each object by a string as a point of p-dimensional space and characterizes the trait x by a set of n columns.

Following the described procedure, the dichotomous trait X is given by 2 Boolean columns corresponding to any of the 2 values of this trait. But at the same time, it is possible to represent a dichotomous sign as a single Boolean column, in which units correspond to the 1st, and zeros-to another value of the function.

Learn the transformation Ax, where $A\neq 0$, x — Boolean column. This transformation converts a unit in a, And the zeros of leaves with zeros. It is clear that the array of Ah vectors characterizes different scale changes at a fixed reference point. These arrays of transformations pay attention to one, non-zero, value of the trait, which is quite important for the analysis of the situations. In the presented cases, the 2nd value of conditional dichotomous features expresses not the presence of any property alternative to the first, but only the inaccessibility of the first. The relative dichotomous trait practically distinguishes a subset of objects that possess a suitable quality, only in this value contrasting them with the remaining objects. These symptoms are not considered nominal, due to the fact that they do not separate the entire set into classes of objects in relation to the values of symptoms on these objects.

In the approach to the solution of problems associated with the transformation of symptoms, have all chances to be put forward separate a priori assumptions about the existence of relations between empirical objects, not reflected by the initial non-quantitative scales. Taking into account the available a priori array of information is due to the need for the introduction of non-quantitative symptoms taking place or the alleged relationship. Generally speaking, the study of paired interdependencies of symptoms is considered to be one of the first and leading stages of the analysis of empirical data.

Let X be a table object-a sign of dimension N×M, which generally includes a sub-table X_i dimensions $N \times n_i$ ($i = \overline{1,k}$), where $\sum_{i=1}^{k} n_i = M$. The study of the interdependence of features is to find and interpret the matrix R of dimension M×M, the elements of which are the selective evaluation of the characteristics of the pair relationship of features of a certain type.

For symptoms of any type, there are a large number of various characteristics of communication, differing both in the size of the necessary calculations, and the aspects of communication that they display. Thus, in the scientific literature [13, p. 112] when considering the total natural and mathematical bases of formation and application of measures when it is concluded that the bulk of the measurement relations based either on the principle of covariance, or the principle of mutual complementarity. Based on the first principle, the conclusion about the connection between symptoms is made in the case when the increase in the numerical values of the 1st symptom is coupled with a persistent increase or decrease in the numerical values of the other. In mathematical terms, the problem leads to the calculation of the magnitude of the covariance of symptoms. On the principle of mutual conjugacy are based when in the process of analysis of empirical studies on 2-um symptoms want to know the patterns of occurrence of individual values of the 1st symptom depending on the individual values of another symptom. In the provided case, only the precedent of the presence or unavailability of the values of the symptom of interest independently from their quantitative expression is strengthened.

Due to the fact that dichotomous symptoms are relevant for us, we will dwell on the analysis of their communication measures. Let us analyze the system of 2-dichotomous symptoms (X, Z) and their conjugation table (Figure).

	Z	Z	
X	a	b	a+b
X	c	d	c+d
	a+c	b+d	

Figure. Contingency table of (X, Z) (Source: elaboration of author)

In the generalized case, we speak of a positive feature relation if the share of Z among X is more than in the whole array:

$$\frac{a}{a+c} > \frac{a+b}{N}, \qquad (2)$$

As a result of modifications, an equivalent ratio can be formed:

$$\text{ad} < \text{bc}, \qquad (3)$$

In the opposite case, the relationship can be considered negative.

From the theory [14, p. 18] the presented requirement to the degree of connection of dichotomous signs is known: it should monotonically and stably depend on the share of the positive indicator of the sign X in classes Z and part of the positive indicator of the sign Z in classes x [15; 16]. So, the measure of communication must meet the condition:

$$\oint\left(\frac{a}{a+b}, \frac{c}{c+d}\right) = \oint\left(\frac{a}{a+c}, \frac{c}{b+d}\right), \qquad (4)$$

Also quite well known is such an indicator of the relationship as the Yule coefficient

$$Q = \frac{ab-bc}{ab+bc}, \qquad (5)$$

And the colligation ratio

$$Y = \frac{\sqrt{ad} - \sqrt{bc}}{\sqrt{ad} + \sqrt{bc}} \qquad (6)$$

These measures acquire zero value if the signs are statistically Autonomous, and their sign corresponds to the sign of connection of signs. A super-positive (+1) or super-negative (-1) value can be achieved if one of the values a, b,C,d is 0. This means that the measures Q and Y can give an extreme value in the event that a single forecast of the indicators of one feature for the values of the other cannot occur.

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Работа поступила в редакцию 11.10.2018 г.

Принята к публикации 16.10.2018 г.

Ссылка для цитирования:

Shvaiba D. Development of a model for the analysis of the socio-economic security of a complex system // Бюллетень науки и практики. 2018. Т. 4. №11. С. 281-288. Режим доступа: http://www.bulletennauki.com/schw (дата обращения 15.11.2018).

Cite as (APA):

Shvaiba, D. (2018). Development of a model for the analysis of the socio-economic security of a complex system. *Bulletin of Science and Practice, 4*(11), 281-288. (in Russian).