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ALGORITHM OF ESTIMATION OF SENSITIVITY OF SYSTEMS OF SERVICE OF OBJECTS OF NETWORK RETAIL TO MEASURES OF OPTIMIZATION

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АЛГОРИТМ ОЦІНКИ ЧУТЛИВОСТІ СИСТЕМ ОБСЛУГОВУВАННЯ ОБ'ЄКТІВ МЕРЕЖЕВОГО РИТЕЙЛУ ДО ЗАХОДІВ ОПТИЗАЦІЇ

The maneuvering basis between soft load and soft unload of mass servicing systems of the network retail object is their sensitivity to changes in indicators of integrated content of applied measures of its optimization (or the ability of the effective indicator to react to the aggregate actions or means caused by the measure x), which is an element of the network retail object management system at the local level. Sensitivity is based on reactivity in y to x. In particular, the operating parameters of each service channel must respond to the integrated actions of the influence of changes in their initial parameters. The general picture of such sensitivity can be formed by the analysis of sensitivity. Thus, the research is aimed at the identification and system characterization of algorithms of estimation of the sensitivity of service systems of

network retail objects to measures of optimization. Within the framework of the study, it's noted that the development and realization of measures of optimization of mass service systems to which the most sensitive effective indicators are necessary since it is influence on such parameters can provide maintenance between soft load and soft unload systems of mass service of the network retail object. According to the results of the research, it is concluded that the basis of the maintenance between the loading of mass service systems of the network retail object is their sensitivity to changes in indicators of integrated by the content of the applied measures of its optimization, which in fact should be an element of the control system of network retail objects at the local level. It's proved that the maintenance between soft load and soft unload of mass servicing system will help to refuse an application at the rigid overload of the modes with unlimited queues (the use of such modes as a forced measure, stops the client from buying, leads to the refusals of a considerable number of clients from buying at the cash register, as a result of which objects of the network retail suffer direct losses and (or) lose profit). The basis of loading maintenance is the sensitivity of the system of mass service of the network retail object to changes of indicators of integrated content of the applied measures of its optimization, which in fact should be an element of the system of control of objects of network retail at the local level.

Основою лавірування між м'якою завантаженістю та м'якою недовантаженістю систем масового обслуговування об'єкта мережевого ритейлу є їх чутливість до змін показників інтегрованих змістом застосовуваних заходів її оптимізації, яка є елементом системи керування об'єктами мережевого ритейлу на локальному рівні. Фактично чутливість ґрунтується на реактивності у до х. Зокрема, важливо, щоб параметри роботи кожного каналу обслуговування реагували на інтегровані заходами впливу зміни їх вихідних параметрів. Загальну картину такої чутливості можна сформувати через аналіз чутливості. Відтак, дослідження спрямоване на ідентифікацію та системну характеристика алгоритмів оцінки чутливості систем обслуговування об'єктів мережевого ритейлу до заходів оптимізації. У межах дослідження звернено увагу, що потрібна розробка та проведення заходів оптимізації систем масового обслуговування до яких найбільш чутливі результативні показники, оскільки саме вплив на такі параметри може забезпечити лавірування між м'якою завантаженістю та м'якою недовантаженістю система масового обслуговування об'єкта мережевого ритейлу. За результатами дослідження

зроблено висновок, що основою лавірування між завантаженістю систем масового обслуговування об'єкту мережевого ритейлу є їх чутливість до змін показників інтегрованих за змістом застосовуваних заходів її оптимізації, які фактично мають бути елементом системи керування об'єктами мережевого ритейлу на локальному рівні. Доведено, що лавірування між м'якою завантаженістю та м'якою недовантаженістю системи масового обслуговування допоможе відмовитися від застосування при жорсткому перевантаженні режимів з необмеженими чергами (застосування таких режимів, як вимушеної міри, зупиняє клієнта від купівлі, призводять до відмов значної кількості клієнтів від купівлі на касі, в результаті якої об'єкти мережевого ритейлу зазнають прямі збитки та (або) втрачають прибуток). Основою лавірування завантаженістю є чутливість системи масового обслуговування об'єкта мережевого ритейлу до змін показників інтегрованих змістом застосовуваних заходів її оптимізації, яка фактично має бути елементом системи керування об'єктами мережевого ритейлу на локальному рівні. Перспективи подальших розробок пов'язані з використанням алгоритмів чутливості систем масового обслуговування до заходів оптимізації для розробки алгоритмів гнучкого регулювання завантаження систем обслуговування об'єктів мережевої роздрібності.

Keywords: *system of mass servicing; channels of service; sources of applications; applications; queues.*

Ключові слова*: система масового обслуговування; канали обслуговування; джерела заявок; заявки; черги.*

Problem setting (description of the problem being analyzed in general and its connection with important academic or practical tasks). The maneuvering basis between soft load and soft unload of mass servicing systems of the network retail object is their sensitivity to changes in indicators of integrated content of applied measures of its optimization (or the ability of the effective indicator to react to the aggregate actions or means caused by the measure x), which is an element of the network retail object management system at the local level. Sensitivity is based on reactivity in y to x. In particular, the operation parameters of each service channel must respond to the

integrated actions of the influence of changes in their initial parameters. The general picture of such sensitivity can be formed by the analysis of sensitivity. At present, several approaches to mass servicing systems' sensitivity estimation are distinguished by the objects of the network retail to optimization measures, in particular: the iteration approach based on the iteration transformations, data simulation, and average; the correlation-regression approach based on the studies of the dependence of the effective indicator on key variables. The definition and specificity of the given approaches to mass servicing systems sensitivity estimation allow us to conclude that a sufficient number of observations, changes in the effective indicators, and a set of key variables, which are involved in optimization measures, the best is the correlation-regression approach.

The analysis of the last research and publications in which the solution to this problem is begun. The proposed research is a continuation of the theoretical and applied work of scientists, whose interests touched upon various aspects of the management of network retail objects. The questions concerning the management of mass servicing systems of network retail objects are devoted to works of famous domestic scientists, in particular: Nesmiyanova M. [4], Kravets', V. [2], Pavlova M. [5]. At the same time, most of the existing works are devoted to the management of only certain processes, which are characterized by such systems, in particular, as regards the sources of applications (range of goods) in retail networks of large-scale trade enterprises, improvement of retail technologies in modern conditions, etc. At the same time, the peculiarities of the optimization of a mass service system are considered rather limited and ambiguous.

The wording of the purposes of the article (problem). The purpose of the article is identification and system characterization of estimation algorithms of sensitivity of mass service systems of network retail objects to measures of optimization.

The paper's main body with full reasoning of academic results. The best basis for the correlation-regression approach to the assessment of mass service systems' sensitivity to optimization measures is a comprehensive sensitivity assessment (equivalent to the classical equalization of multiple regression), which determines the

strength of the reaction time of service or waiting time for the change of key variables. This is possible with the following algorithm groups [1]:

1. The algorithms of identification of the form of the reaction of mass service systems on the impact of optimization activity

2. Algorithms of identification of probable (significant) values for key variables;

3. Algorithms of identification of the influence of key variable actions optimization and effective indicators

4. Algorithms of identification of the possible scope of changes of result and key variables.

Let us consider in detail each of the structural groups of algorithms allocated by us, having revealed their properties (characteristic features), and the form of submission (as the final aggregate of precisely defined rules [1]).

Algorithms of identification of the form of the reaction of mass service systems to the influence of the optimization event solve several questions:

- selection of key variables (x) included in the equalization;

- formalization of the level of sensitivity (MLR) according to the content of key variables and the effective indicator;

- a general assessment of the adequacy of the equal sensitivity of the result to the key variables.

Selection of key variables (x) included in the equation (for which the reactive, effective measures mass service or "y" should be applied). The key variables that form the sensitivity response xy have the following properties:

- quantitative measurement (for x units of measurement can be different);
- linear reactivity with the result (i.e. a pair coefficient that measures the linear reaction between y and x (ry,xj) should strive to 1);
- the absence of a significant linear reaction to each other (i.e., a pair coefficient measuring the linear reaction between m and xx (rxj, xk) should strive to 0).

- According to the content of the components that form the xy sensitivity response, the selection of key variables includes:

- identification of variables that change the actions or means caused by the optimization event, provided that the number of service devices n (number of mass servicing systems workers, operators' cashiers, self-service terminals, online service channels), the intensity of the application flow λ, the intensity of service flow (productivity) of the μ service channel, the length of m, qz – number of selected sources of applications [1, p. 10-13]. The set of key variables is the basis of the f(x1,x2,…,xc) function, which in linear form synthesizes the sensitivity "B" or the response "y" that appears as a response (reaction) to the following algorithm:

$$f(x1,x2,\ldots,xc)+E=y, \quad (1);$$

where: key variables that are the basis of the function that synthesizes the reaction effect and explains the sensitivity of "y"; b is the effective sign that is reactive to key variables (x); ϵ – the stochastic variable that takes into account the reaction effect of "y" on other variables that are not taken into account in equalizing sensitivity;

- quantitative assessment of the reaction relationship between the key variables and the effective indicator "y", described by the contents of the correlation matrix, formed according to the algorithm:

$$\begin{matrix} r_{y,y} & r_{y,x1} & r_{y,xm} \\ r_{x1,y} & r_{x1,x2} & r_{x2,xm} \\ \ldots. & \ldots\ldots. & \ldots.. \\ r_{xm,y} & r_{xm,x1} & r_{xm,xm} \end{matrix} \quad (2);$$

where: $r_{y,xj}$ - the pair coefficient, which measures the linear response between y and xj, if j = 1; m, m – the number of key variables; $r_{xj,\ xk}$ - the pair coefficient, which measures the linear response between key variables xj and xkj, if k = 1;

At the same time, we believe that the level for estimation of xy sensitivity should be chosen only those key variables x, according to which in the correlation matrix the obtained $r_{y,xj}$, which are in the interval from 0,6 to 0,and $r_{xj,\ xk}$, which are in the interval from 0,4 to 1. The other variables are such that they do not measure the linear reaction of results and measures of optimization of mass service systems.

Formalization of the level of sensitivity (MLR) according to the content of the key variables and the effective indicator (in particular, matrix method or through Kramer's algorithm the construction of a regression model with explanatory variables is carried

out). We offer two-factor functions f(x1, x2), to perform formalization of equitation (MLR) according to Kramer's algorithm. It's simple because carried out by finding the Di (which is identified with the replacement of the i-th column by the free member's column) and its separation into the main determinant D [1; 2]. Kramer's algorithm allows the formalization of equal sensitivity of the form of y=b0+b1x1+b2x2. For functions with more than two key variables, refer to the matrix equalization formalization method, through operations with the initial matrix of values x, to which the conditional single column is added (in particular, we transport matrix X (we get XT) and C. At that the main actions are the multiplication of matrices XT X, XT Y, finding the backup matrix (XTX)-1, and finding vectors of coefficient estimates or b, that reflect the sensitivity response of each x formed within the framework of optimization measures, to y by uses the matrix multiplication (XTX)-1XTY). The defined vectors of estimation of coefficients reflecting the response of sensitivity allow, in general, form formalization of equalization of sensitivity MLR (y=b0+b1x1+b2x2+…+ bnxn).

A general assessment of the adequacy of the level of sensitivity of the result (y) to the key variables (x) is required if the x is different, and characterized by different units of measure. For this assessment, the level of sensitivity is supplemented by the combined indices of the close relationship xy, allowing to rank x by the force of influence on (the stronger the influence of x, the greater the reaction y up to x). The indices of the estimation of the adequacy of the level of sensitivity to the x are given by private elasticity coefficients y up to x (Ej) or b- coefficients (b*j*). Note that to assess the adequacy of equalization of the sensitivity of the result to the key variables (x) you can choose any of the following indicators, due to their high informality, regarding reactivity y up to x. If the level of sensitivity in terms of the key variable and the effective indicator contains zero or low reactivity, it is not adequate and needs to be transformed (elimination of variable x, forming low reactivity). At that all algorithms of identification of the form of the reaction of mass service systems to the influence, which come from the event of optimization are repeated, but with excluded x, which form a low reaction.

Algorithms of identification of probable (significant) values for the key variables (which lead to sensitivity of the effective indexes mass service systems of the network retail objects) solve the following questions:

1. determine the importance of the equalization of sensitivity based on calculation and analysis of the values of the determinate coefficient (or R2) according to the general totality data. This indicator determines the average percentage of cases where changes x cause reactive changes y (hence, the higher the R2 value, the greater the formed sensitivity level in x is, and the more accurate the selection of reactive components is).

To the value of the determinate coefficient (R2), we suggest entering the following scale of values: 0-0,1% (α- level) – zero or critically low level of sensitivity equalization y up to x; 0,11-0,4 - low level of sensitivity equalization y up to x; 0,41-0,6 – the average level of importance sensitivity equalization y up to x; 0,61-1 – high level of importance sensitivity equalization y up to x. At the same time, at the zero and low levels of importance, implementation of the measure of optimization of mass service systems of the network retail objects makes no sense;

2. definition of key variables according to the content of the optimization event, using the verification of hypotheses relative to the significance of individual coefficients of sensitivity equalization, according to t-statistics for each b up to x. The main focus is the probability of an accidental (false) reaction (or that can happen or not because it is the result of a large number of random factors, which is not directly related to the very start of optimization). If the coefficient bi to x important - this suggests that an accidental (false) reaction was probable, so this is the most likely value for the key variables that characterize the sensitivity of the chosen effective indicator to the specific activity of optimization of mass service systems of the network retail object.

Algorithms of identification of parameters of key variable actions optimization and effective indicators mass service systems in standard scale. These algorithms are entered into effect if the key variable sensitivity levels are different or by units of measure. Under such conditions, algorithms solve the question of:

1. obtaining a detailed assessment of the influence of key variables on the algorithms of multiple sensitivity equalization in the standard scale. For this purpose,

both every key variable x and the effective sign-in are expressed in standard deviations (ty, tx1,…,txn), which gives the possibility to standardize them and to form the standardized appearance of equitation of sensitivity. For this purpose, we recommend focusing exclusively on classical standardization algorithms, as they allow us to work with all types of sensitivity levels. The differentiated standardization of the components of the sensitivity equalization x and V is also carried out on the standardized variable sensitivity (ty or txji);

2. formalization of the final level of sensitivity mass service systems of network retail objects according to the results of its standardization. This direction is based on the assessment of the impact of b-factors based on the formation of a standardized system of equations. After conversion, the formalization of the remaining sensitivity equalization will look like this:

$$\begin{cases} rx1y = b\ 1 + rx1x2 \cdot b2 + \cdots + rx1xm \cdot bm \\ \quad\ldots \qquad\qquad \ldots \qquad\qquad \ldots \\ rxmy = rxmx1 \cdot b1 + rxmx2 \cdot b2 + \cdots + bm \end{cases}, \qquad (3);$$

Formalization of the final level of sensitivity allows for overestimation of the value of vectors of estimates of the bj commitment coefficients, which reflect the sensitivity response of each x formed within the framework of optimization measures (which, previously, found by multiplication (XTX)-1XTY)).

Algorithms of identification of the possible extent of changes in the result and key variables in equal sensitivity mass service systems solve questions and determination of the trust intervals of changes of key variables (or approximate limits in which key variables can vary) and result. At the same time, if the wide trust intervals have been defined, the number of observations regarding x and V should be extended, in equal sensitivity and repeat each of the above algorithms of the mass service systems sensitivity estimation according to the classes of tasks.

Summary research summary and prospects for further tasks in this area. Within the framework of the study, it is noted that the development and implementation of measures of optimization of mass service systems to which the most sensitive effective indicators are since it is the influence on such parameters can provide the maneuvering between soft load and soft distrust system of mass service of the network

retail object. According to the results of the study, the following conclusions were made:

1. The basis of the maintenance between the loading mass service systems of the network retail object is their sensitivity to changes in the indicators integrated by the content of the applied measures of its optimization, which in fact should be an element of the control system of the network retail objects at the local level.

2. The maintenance between soft load and soft unload of the mass servicing system will help to avoid the application of unlimited modes at rigid reloading (application of such modes as forced measures, stops the client from buying, leads to the refusal of a large number of clients from purchasing at the cash office, as a result of which the network retail objects suffer direct losses and/or loss of profit).

3. The maneuvering basis of loading is the sensitivity of the system of mass service of the network retail object to changes in the indicators of integrated content of the applied measures of its optimization, which in fact should be an element of the system of control of the network retail objects at the local level.

The prospects for further developments related to using the algorithms of sensitivity of mass service systems to measures of optimization for the development of algorithms of flexible adjustment of loading of service systems of network retail objects.

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