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SOME ASPECTS OF APPLYING THE THEORY OF CUSTOM SERVICE IN ECONOMIC ANALYSIS

Summary. *The article is devoted to the mathematical foundations of queuing theory, analytical and numerical methods used in it. The essence of the theory of queuing and the need to apply it in the analysis of economic entities. This is due to the increase in the objects of analytical research and management functions, which requires improved analysis of enterprises. The theory of queuing is used in cases where the requirements for service are received en masse with their subsequent satisfaction.*

The possibility of applying queuing theory models to solve applied problems is substantiated. The following factors are taken into account: the frequency of changes in the number or requirements; the likelihood of significant customer demand, a way to determine the cost of waiting and improve service. It is determined that the main task of queuing theory is to identify the dependence of system efficiency indicators on the nature of input flow, discipline and queue limitation, number, performance and operating conditions of channels in order to further optimize it. One of the characteristics of queuing theory is the time when the customer is in line. The queuing theory helps to develop balanced systems that serve customers quickly and efficiently and the results are often used in business decisions about the resources needed to provide services.

The algorithm of calculation of indicators for maintenance of work and minimization of time of processing of orders in the field of service is considered. It is proved that analytical methods of queuing theory allow to obtain the characteristics of the system in the form of functions from the parameters of its functioning. Due to this, it is possible to conduct a qualitative analysis of the impact of individual factors on the efficiency of the queuing system.

Key words: *queuing theory, task flow, time, economic analysis, modeling.*

Statement of the problem. One of the most difficult problems of the management system is to find effective solutions in conditions of uncertainty. There is a need to use modern tools of economic and mathematical modeling to accelerate economic analysis, a more complete analysis of the impact of factors on performance, increase the analytical calculations. Increasing the objects of analytical research and management functions.

Analysis of recent researches and publications. Mathematical methods are used by researchers in the construction and analysis of various systems. In [1] the basics of simulation modeling of queuing systems (QMS) using the GPSS language and its version GPSS World are presented. Methods of construction of simulation models with the help of tools of this environment are revealed. Considerable attention is paid to the issues of comparing the results of simulation and mathematical modeling of QMS. Among the publications devoted to mathematical and simulation modeling of SMO, it should be noted the work of Pidgursky O.I. [2], which presents analytical studies of the results of mathematical and simulation modeling of the superposition of uniform and Poisson transaction flows, obtained by traditional and alternative methods.

In the article [3], the results of mathematical and simulation modeling of the node of concentration (distribution) of transactions in the logistics system, formalized by the queuing system, are described. Scientists [4, 5, 6] are quite active in the development of queuing theory, which studies queuing systems or queuing systems. So in the article Maslikova S.A., Dyuzhaeva L.P. [6] proposes a mathematical model of a multi-channel queuing system based on expectations based on distributed priorities.

Critical analysis of theory and practice shows insufficient coverage of mathematical methods for quantifying queuing processes in economic analysis for the most complete and reliable reflection of the process of enterprise operation in the service sector.

Formulation purposes of article (problem). The main tasks in the work are devoted to substantiation of models of the theory of queuing and use of methods of TMO in the economic analysis for receiving the full analysis of influence of factors on results of activity, increase of analyticity of calculations.

Thema in material. The theory of queuing on the basis of the theory of probabilities investigates mathematical methods of a quantitative estimation of processes of queuing. All queues related to queuing are characterized by the random nature of the phenomena under study. This takes into account three factors [7, p.135]:

1) the frequency of changes in the number or requirements;

2) the probability of significant customer demand;

3) a way to determine the cost of waiting and improve service.

The mathematical model of the queuing system contains the following elements: the incoming flow of requirements for service; queue, which consists of requirements waiting for service; service system; outgoing flows of serviced, lost claims and requirements for re-maintenance.

The main elements of the queuing model include, first of all, the customer (service order) and service (service device, appliance, service tool, etc.). Customers come to the service system from the customer source (requirements source). In other words, the source of requirements is the customer generator. Here is the classification of queuing systems (Fig. 1).

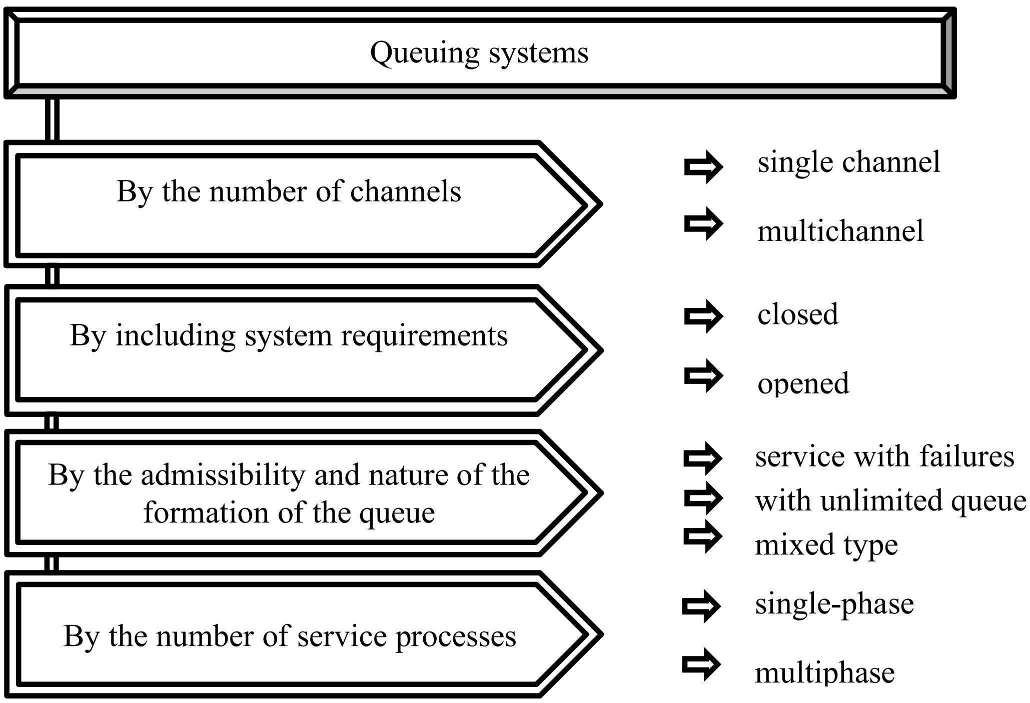

Fig. 1. Classification of queuing system

Source: [7]

The theory of queuing deals with the modeling of queuing systems (QMS) and makes it possible to determine the optimal number of outlets of this profile, the number of sellers, the frequency of delivery of goods, other parameters. Another typical example of queuing systems can be warehouses or bases of supply and marketing organizations; calculation of the area of warehouses, while the warehouse area is considered as a service device, and the arrival of vehicles for unloading - as a requirement [8].

The characteristic of the flow of requirements is the λ-intensity of orders in the system λ, ie the average number of orders coming into the system per unit time. The queue is a series of orders waiting to be serviced. There are two characteristics - length (capacity) and discipline of the queue. The queue length can be finite or infinite. The most commonly used disciplines are due to the following rules: first come - first served; came last - you are served last; random selection of orders; selection of orders according to the criterion of priority; limiting the waiting time for the moment of service (there is a queue with a limited waiting time for service, associated with the concept of "allowable queue length").

The maintenance mechanism is determined by the duration of maintenance procedures (t) and the number of requirements (μ) serviced per unit time. The type of service time can be both deterministic and random.

For example, customer service at a catering establishment is considered complete when a customer (or group of customers) leaves the facility. The duration of service time (t) depends on the requests of the customer (or group of customers) and is a random variable [4].

The output flow of requirements is characterized by the intensity (μ) of service, ie the number of requests serviced per unit time during which the device is busy servicing. There is a relationship between service time and service intensity, which is expressed by the formula:

$$t = \frac{1}{\mu} \tag{1}$$

Queuing systems (QMS) are classified according to various criteria. Depending on the conditions of waiting for the start of service requirements distinguish between QMS with failures and QMS with expectations.

An important characteristic of QMS is the service time of requirements in the system. Service time is usually a random variable and can therefore be described by a distribution law.

Consider an example. The hotel accepts telephone requests for room reservations. It is known that calls come with an intensity of 24 orders per hour. The hotel has 2 administrators (2 telephone lines), and one order is processed in an average of 6 minutes. If the customer could not call from the first call, he calls another hotel. Determine: the probability of losing a customer and the average number of orders received per unit time.

Solution. Let n-channel SMO - a hotel with two (number of service channels n = 2) administrators to service telephone requests from customers. The flow of customers has an order intensity $\lambda = 24$ per hour. The average duration of service $t_0 = 6$ min.

1) Determine the parameter of the flow of services (the intensity of order processing on one telephone line) by the formula:

$$\mu = \frac{1}{t_0} = \frac{60 \text{ min}}{6 \text{ min}} = 10 \text{ requests per hour} \qquad (2)$$

Consolidated intensity of the flow of orders (total load factor of service channels)

$$\rho = \frac{\lambda}{\mu} = \frac{24}{10} = 2{,}4. \qquad (3)$$

Because $\rho > n$, this SMO can not satisfy all customers.

To determine the probability of losing a client, we determine the limiting probabilities of states according to Erlang's formulas:

$$p_1 = \frac{\rho}{1!} \cdot P_0 = 2{,}4 \cdot P_0;$$

$$p_2 = \frac{\rho^2}{2!} \cdot P_0 = \frac{2{,}4^2}{2} \cdot P_0 = 2{,}88 \cdot P_0;$$

$$P_0 = \frac{1}{\sum_{\kappa=0}^{3} \frac{\rho^{\kappa}}{\kappa!}} = \frac{1}{1+2,4+2,88} \approx \frac{1}{6,28} \approx 0,159$$

Then:

$$p_1 \approx 2,4 \cdot 0,159 \approx 0,382;$$

$$p_2 \approx 2,88 \cdot 0,159 \approx 0,459.$$

2) The probability of losing a customer (probability of failure)

$$P_{failure} = P_2 = 0,459.$$

3) Relative capacity of hotel orders

$$\mathrm{q} = 1 - \mathrm{P_{failure}} = 1 - 0,459 = 0,541$$

4) The average number of orders received per hour or the absolute capacity of the hotel:

$$A = \lambda \cdot \mathrm{q} = 24 \cdot 0,541 = 12,984 \approx 13$$

Thus, the probability of losing a customer is 0.459; the average number of orders received per hour is 13.

The advantage of using QMS is the acceleration of economic analysis, a more complete analysis of the impact of factors on performance, increasing the analytical calculations.

Insights from this study and perspectives for further research in this direction. Thus, the need for QMS research and its use in the analysis of economic entities provides an opportunity to solve the following tasks: 1) QMS analysis tasks - determining the characteristics of service quality depending on the parameters and properties of the input flow of requirements, parameters and structure of service system and discipline service; 2) tasks of parametric synthesis - determination of parameters of service system at the set structure depending on parameters and properties of a stream of requirements, discipline and qualities of service; 3) tasks of synthesis of system structure with optimization of its parameters so that at the set streams, discipline and quality of service the cost of SMO was minimum or there were minimal losses of orders at the set streams, discipline and cost of system.

The correctness and effectiveness of the decision made is largely determined by the quality of economic, organizational, social and other types of information. The value of the information obtained depends on the accuracy of the task, since a correctly set task predetermines the need for specific information for making a decision.

Decision-making is inherent in any type of activity, and the effectiveness of the work of one person, a group of people or the entire people of a particular state may depend on it. From an economic and managerial point of view, decision making should be considered as a factor in increasing production efficiency. The efficiency of production, of course, in each case depends on the quality of the decision made by the manager.

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