BUSINESS ECONOMICS

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OPTIMIZATION OF THE NUMBER OF CALL CENTER OPERATORS

Abstract*. The intensity of receiving orders from customers was determined by statistical research. The intensity of orders by month is described by a nonlinear transcendental model. Queue theory allowed us to formulate the problem of finding the optimal number of operators serving customers in the call center for a confidence level of 0.95. The economic effect is calculated.*
Keywords*: queuing theory, order statistics, optimization of the number of operators.*

According to the principle of operation of operators in the customer service mode, DD OJSC "Optima-Telecom" refers to an open queuing system with several service channels. Because the source is a myriad of applications that come to the call center with some intensity, regardless of how many applications it has accumulated.

The intensity of the flow of events in this system depends on the time of day, day of the week, and month number. Therefore, we must first find these patterns.

As a result of observations on the number and intensity of applications from customers, the data on the distribution of applications, shown in Fig.1-3.

According to the schedule of the intensity of the flow of events for the year, it is possible to clearly trace the periods of increase and decrease of the intensity of the flow of applications on a monthly basis. The period of the intensity function in this case will be equal to three months. Here the sinusoidal dependence of the intensity of the flow of events on the current number of the month is clearly traced.

From these graphs we can trace the sinusoidal dependence of the intensity of the flow of events on the time of day. Therefore, we will approximate the number of service requests using the equation of the form:

$$y = Ax^B + C(1 - e^{Dx})Sin(Ex^F + G) + H$$

where A, B, C, D, E, F, G, H – constants, flow parameters;

x – variable, equal to the number of the month, day of the week, time of day.

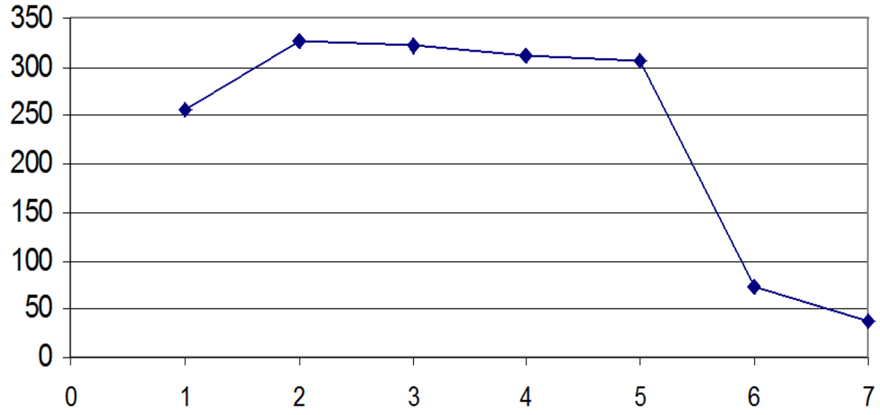

Fig. 1. **The average intensity of the flow of events for the year by days of the week**

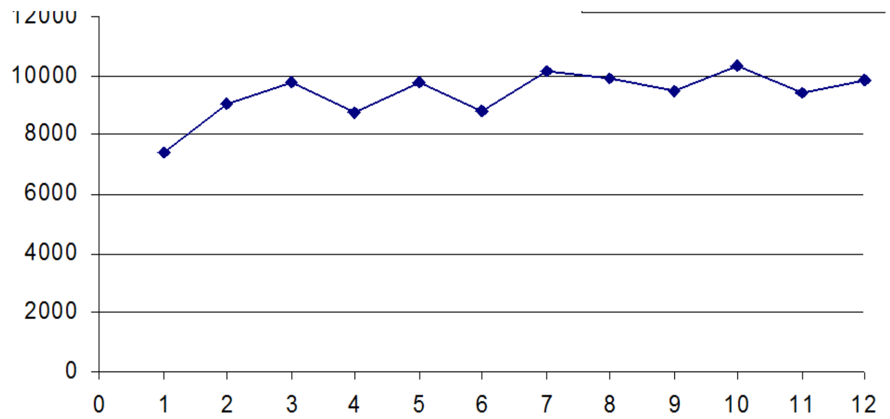

Fig. 2. **The average intensity of the flow of events for the year by months**

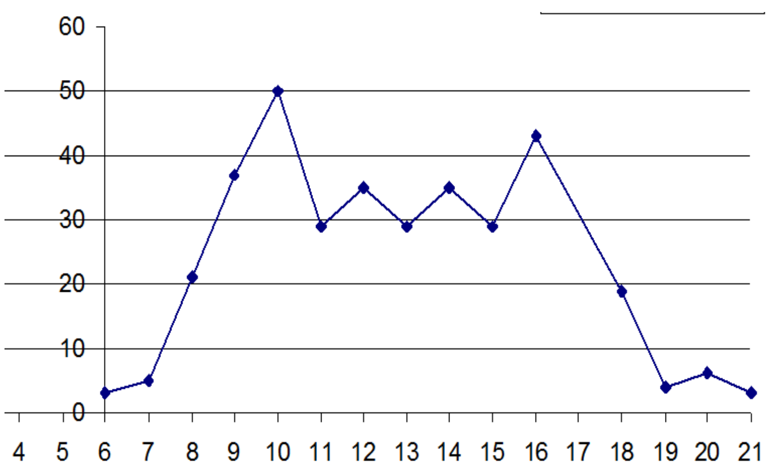

Fig. 3. **The average intensity of the flow of events per day hourly**

The method of calculating the coefficients is given in [1].

Due to the fact that planning in the DD of OJSC "Optima-Telecom" is carried out on a monthly basis, the funds for the activities of the Directorate are also allocated monthly. For this reason, the staffing schedule is one month in advance. It turns out that it makes sense to abstract from the above data on the intensity of the flow of applications hourly and by day of the week. Therefore, we will consider the data on the intensity of the flow of applications, given for the month.

After calculations, the final form of the equation describing the intensity of the flow of events by months has the form

$$F(x)=26,88x^{1,634}+521,234(1-e^{-23,6x})\sin(3,661x^{0,615}+19,926)+8818,2 \quad (1)$$

This equation describes the average intensity of the flow of events per year. According to him, we can also talk about the sinusoidal dependence of intensity on the number of the month.

Knowing the average intensity of the flow of events and its parameters, it is also necessary to know the average size of the queue that is formed to determine the optimal number of operators.

Since, according to the principle of operation of operators in the customer service mode, DD OJSC "Optima-Telecom" belongs to an open queuing system with several service channels, to determine the average long queue of applications, the following assumptions were introduced:

1) the flow of service requests is the simplest;

2) the duration of service is random and the probability that the service will take time, not less than t, is equal to $e^{-\upsilon t}$, where $\upsilon>0$ constant;

3) each application is serviced by one operator;

4) each operator serves only one application at a time when he is busy;

5) if there is a queue for service, the resigned operator, without losing working time, goes to service the next request of the queue.

Let's mark $P_\kappa(t)$ the probability that at time t in the queue is k applications. In the conditions formulated by us, these probabilities can be found under any k=0,1,2,3... [2].

Then P_k can be found by the formula

$$P_k = \frac{p^k}{n!(n-p)} * p_0 \quad (2)$$

where n is the number of service points (operators);

k is the size of the queue;

$$P_0 = \left[\sum_{k=0}^{n} \frac{P^k}{k!} + \frac{P^{n+1}}{n!(n-p)} \right]^{-1}.$$

Given the condition of normalization of probabilities, P_0 should be equal

$$P_0 = 1 - P_к \quad (3)$$

In these formulas we have accepted $p = \lambda/\upsilon$.

Given that $p^k = F(x)$, write the expanded formula, substituting instead of the function F (x) its value from formula (1)

$$P_k = \frac{((26{,}88x^{1{,}634} + 521{,}234(1\text{-} e^{-23{,}6x})\sin(3{,}661x^{0{,}615} + 19{,}926) + 8818{,}2)/\upsilon)^k}{n!(n - ((26{,}88x^{1{,}634} + 521{,}234(1\text{-} e^{-23{,}6x})\sin(3{,}661x^{0{,}615} + 19{,}926) + 8818{,}2)/\upsilon))} * p_0 \quad (4)$$

where p_k is the average bandwidth of one operator;

x is the number of the month.

The average capacity of one operator, according to the collected data, is 210 applications per day.

From the formula (4) knowing the probability from which the queue of a certain value is formed, it is possible to determine the size of this queue of applications. Knowing the average size of the queue formed by the applicants, it will be possible to determine the optimal value of the number of service operators to optimally meet the needs of consumers.

To determine the optimal number of operators, as already mentioned, you should first calculate the average daily size of the resulting queue of applicants. To find it, you can use formula (4), but in this formula you need to know the probability of forming a queue of a certain value. We will accept this probability equal 0,95 as the given size of probability is high enough and only in 5% of cases the turn of other size will be formed.

Now, knowing the probability of forming a queue of applications, you can determine the size of this queue to further determine the optimal number of operators.

To do this, introduce the necessary restrictions: k is an integer; n is an integer, 0 ≤ n, k ≤ 30.

To use formula (4) it is also necessary to know the probability P0. This probability can be found using formula (3):

$$P_0=1 - 0{,}95 = 0{,}05.$$

To find the size of the average daily queue, for each month we solve a system of equations and inequalities, changing respectively *x* (month number) using one of the MS Excel additions – "Solver".

Solving the system, as mentioned earlier, for each month separately, we obtained the average daily queue size for each month (the results of calculations are shown in table 1).

It can be seen that the optimal calculation of the queue size was performed, because each month received its own queue value, which emphasizes the number 24 in the column of rounded data.

According to the results of calculations, we can say that the number of operators per month exceeds the average daily queue size, ie we can talk about saving labor by the difference between the number of operators and the size of the queue. Considering also that the hour of work of the communication operator, according to the staff list, is equal to 360 hryvnias, it is possible to count savings of a salary fund on months and for a year as a whole. The results of the calculation of savings are presented in table 2.

Table 1

The results of system calculations

№ month	Number of applications	F(X)	p	k (calculated queue size)	k (required queue size)	Probably P_k	*n* (number of operators)
1	7433	8324,02	39,64	25,17	25	0,95	30
2	9060	9103,85	43,35	24,86	25	0,95	30

Table continuation 1

3	9802	9457,15	45,03	24,73	25	0,95	30
4	8765	8955,75	42,65	24,92	25	0,95	30
5	9774	8671,26	41,29	25,03	25	0,95	30
6	8835	9081,37	43,24	24,87	25	0,95	30
7	10140	9766,45	46,51	24,62	25	0,95	30
8	9929	10141,36	48,29	24,69	**24**	0,95	30
9	9496	10042,60	47,82	24,52	25	0,95	30
10	10325	9751,10	46,43	24,62	25	0,95	30
11	9456	9661,46	46,01	24,65	25	0,95	30
12	9882	9966,31	47,46	24,55	25	0,95	30

Table 2

Calculations of labor savings and payroll

Month	Number of operarors, pers.	Queue size, pers.	Labor savins, pers.	Savings per hour of working time, UAH.
1	30	25	5	1800
2	30	25	5	1800
3	30	25	5	1800
4	30	25	5	1800
5	30	25	5	1800
6	30	25	5	1800
7	30	25	5	1800
8	30	24	6	2160
9	30	25	5	1800
10	30	25	5	1800
11	30	25	5	1800
12	30	25	5	1800
		Saving total per year		21960

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