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THE APPLICATION OF MASS SERVICE THEORY MARKOV PROCESS MODEL ASSESSING THE IRRECEPTION OPPORTUNITY OF EMERGENCY PHONE CALL 122

1. Introduction. Having diceled general emergency center (further GEC) telephone number 112, a subscriber contacts with a center dispatcher. The connection between the dispatchers and subscribers is hold through subscriber's lines.

The number of subscriber's lines usually is greater than the number of dispatchers, maintaining received calls. That is why is fire security there is widely used parallel GEC 112 connection of lines to dispatcher's stands, and it allows each dispatcher to accept a call, received by any of the general emergency center 112 lines.

If a call is received at the moment, when all the dispatchers maintain other calls, it occupies free line and wait for the beginning of its maintenance. For this reason the whale system through the calls' reception may be defined as the mass service system whit limited number of waiting places, and the whole process (the reception of calls through the special lines 112) may be defined as the opportunity of call loss and the waiting for the maintenance beginning.

Not only calls of fires are receiving but also many other calls, disturbing the work of dispatchers and loading them additionally.

They are usually the telephone calls of subscribers, which astray dialed the number , or the calls to get some necessary information and so on. So, in the care of the flow of certain phone calls, the system is laden.

This load is calculated according to the formula:

$$\gamma = \lambda \cdot T_{maint.1} \ , \tag{1}$$

where γ – system load; λ – total phone calls' intensity: $\lambda = N / t$; N – total number of phone calls; t - time; $T_{maint.1}$ – time during which the subscriber will vacate line.

The time $T_{maint.1}$ do not define the load of dispatchers, maintaining phone calls completely. In spite of time to maintain a phone call, which is recorded from call receiving moment to the total vacation of line, dispatcher needs some time to process the received message, to take a proper decision and report the direction to fire–subdivision.

It is obvious, that at the point while data collecting and processing is in progress, dispatcher practically won't be able to maintain newly received call. Call maintenance time:

$$T_{maint.2} = T_{maint.1} + T_{maint.0}, \tag{2}$$

where $T_{maint.0}$ – dispatchers occupation time for received call's data–processing.

Being aware of call's flow and call's maintenance time, having transacted certain mathematical calculations we are able to determine, optimal maintenance's system's structure.

The maintenance quality rates of maintenance system calls have to be good. That's why it is very important to secure high system's permeability power. The maintenance system's permeability power depends on the number of specific lines (GEC lines) and the number of dispatchers.

To improve maintenance system permeability power it is necessary to increase the number of lines, used in the system, and the number of dispatchers, maintaining received calls, and it requires extra expenditure. So selecting the call's reception system it is necessary to determine the number of lines and dispatchers, during which the call's maintenance would be most effective.

Firstly we will establish the necessary number of lines, then the number of dispatchers, assessing the time of hold. We may calculate the number of necessary lines (assessing the reliability of the equipment) according to the formula:

$$n = n_1 / h_g \ , \tag{3}$$

where n_1 – the number of lines, not having evaluated the reliability of equipment; h_g - equipment preparation coefficient ($h_g \leq 1$).

2. GEC 112 as mass service system. As we mentioned before (automatic) service system may be analyzed as mass service system, which reception stand receives certain flow of messages about fires, other incidents and other telephone calls.

The calls which are received by GEC 112 system are random accidents and may happen independently of each other periodically and with the same intensity λ.

For this reason the flow may be analyzed as a natural Poisson flow.

Thus, analyzing automatic service system as the mass service system, it is easy to determine parameters, defining the permeability power of the system, it means, to determine a number of necessary lines and dispatchers.

The call's flow, coming to n–line system is the Poisson flow with intensity λ. The intensity of call flow – it means the number of received calls over a period of time.

Time, necessary to receive a call is under the exponential law with the parameter μ:

$$F(t) = 1 - e^{-\mu t} \ , \tag{4}$$

where $\mu = 1 / T_{maint.1}$ - the intensity of time.

Having done a number of mathematical actions, we get a probability that,

in care of complete occupation of lines, the call cannot be maintained:

$$P_{ref} = \sum P_{in}. \tag{5}$$

And the probability, that a call will be in the queue:

$$P_{queue} = \sum \sum P_{ij}. \tag{6}$$

Being aware of the probability to lose a call, we may find a probability stat newly received call will be maintained:

$$P_{ma\,\mathrm{int.}} = 1 - P_{ref}. \tag{7}$$

The probability, that one line will be occupied is equal to the proportion of the occupied lines and the number of total lines.

3. Summary and future perspectives. Having done all the calculations and determined the exact number of lines and dispatchers to maintain calls there is assesses the reliability of the system – it means the probability that the system may functionate avoiding refusals is determined.

Thus to estimate the reliability of the system we use the formula:

$$R\ (t)\ =\ e^{-\lambda t}\ , \tag{8}$$

where $R\ (t)$ – the probability of the system's work without refusals over a period of time t; λ – the intensity of maintained calls.

The probability that the system will not be able to maintain newly received call over a period of time t is calculated according to the formula

$$F\ (t)\ =\ 1\ -\ e^{-\lambda t}\ . \tag{9}$$

Having assessed the reliability of the system $R(t)$, it is possible to determine whether our calculations, using Erlanger formulas, may be applied to determine the necessary number of lines and dispatchers.

If the system's reliability $R(t)$ (it means the probability, that system may functionate without the refusals and all the calls are maintained) approximately will be equal to the probability $P_k(t)$:

$$R(t) = P_k(t). \tag{10}$$

If $R(t) = P_n(t)$, where n – the total number of lines, the reliability of system do not suffice there is not enough reliability of system to maintain calls.