EXPERIENCE APPLICATION OF THE DUPLICATING WAY "WSEM-PC" FOR THE NOTIFICATION OF PEOPLE AT FIRE IN OFFICE BUILDINGS OF JSC RUSSIAN RAILWAYS

ОПЫТ ПРИМЕНЕНИЕ ДУБЛИРУЮЩЕГО СПОСОБА «СОУЭ-ПК» ДЛЯ ОПОВЕЩЕНИЯ ЛЮДЕЙ ПРИ ПОЖАРЕ В АДМИНИСТРАТИВНЫХ ЗДАНИЯХ ОАО «РОССИЙСКИЕ ЖЕЛЕЗНЫЕ ДОРОГИ»

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Abstract. The results of the natural observation of evacuation of office buildings workers of JSC "Russian Railways" with application of various notification ways are presented in the article and the time of their response to a signal is defined. Confidential level of the possibility of use of the considered mathematical laws of distribution for the time of response description of the «Fire» signal depending on the notification way is determined. Based on the chosen law of distribution comparative assessment of efficiency of the notification at the fire depending on a notification way in comparison with standard values, and also the existing traditional ways of the notification has been conducted.

KEYWORDS: THE WARNING SYSTEM OF PEOPLE AT FIRE, THE NOTIFICATION DUPLICATING WAY, THE DISTRIBUTION LAW, NATURAL OBSERVATION, EVACUATION TIME.

1. Introduction

Nowadays the main systems promoting safety of people at fire in office buildings are the automatic fire alarm system (AFAS) and the warning system and managements of people at fire (WSEM) evacuation. The main objective of this system is the operational notification of the people who are in the building and management of process of their evacuation to a safe zone [1,2].
As it is noted in [2,3], the evacuation process of people at fire can conditionally be divided into three main stages (fig. 1): lag effect of the FPÖ systems, time of making decision on the beginning of evacuation, the real movement time on the evacuation ways. It is also fair for the office buildings included into the JSC Russian Railways (JSC "Russian Railways") control system.

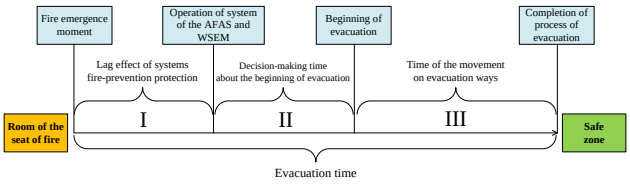

Fig. 1. *Actual time of evacuation*

The time spent for fire detection (a lag effect of systems of the AFAS) can take several tens of seconds and depends on a technical component of the AFAS system – correctness of installation, timeliness of maintenance and scheduled preventive maintenance. It is impossible to reduce this time interval to zero. However at today there are ways of decreasing the time of making decision of the evacuation beginning.

2. Prerequisites and means for a solution

Reduction of a time interval on making decision on the beginning of evacuation at the moment is an urgent task for the majority of buildings with a big congestion of people and the JSC "Russian Railways" objects are not exceptions. For the solution of this task in modern conditions it is possible to allocate two directions (fig. 2) – training of workers and personnel of the organizations in actions at receipt of a signal of the fire for the purpose of a conditioned reflex development: "alarm – immediate evacuation"; the use of special technical means aimed to persuade a person to make the right decision when his health and life are threatened due to the fire impacts.

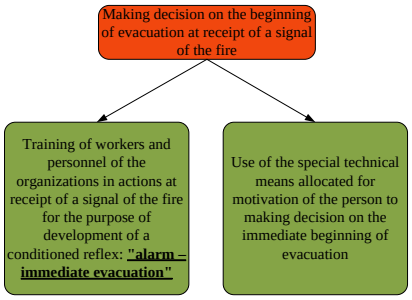

Fig. 2. *Possible ways of time reduction of the evacuation beginning*

The works on the first direction are being conducted for quite a long time – the requirements on the necessity of the evacuation plans working off and the conducting exercises for people at fire evacuation has existed for more than 10 years. However, the practice shows, when carrying out the announced doctrines in advance people act quickly and correctly, and hearing the same signal in other times people act differently – they try to establish the signal reliability, to find out what really happened, if the signal is to him personally or not, and in some cases a person just continues to perform his work.
Today great attention is paid to the creation of any technical system aimed to force a person to certain actions when receiving "Fire". It is done for the people to be able to evacuate from the building and as therefore save the people's health and life.

3. The solution of the considered problem

One of the funds allocated for the persons motivation to making decisions on the immediate beginning of evacuation is the duplication of people's warning about the fire of "WSEM-PK" [4]. It is based on the use of a technical component which allows to adjust interrelation between the WSEM system and the local computer network (LCN) which is available at the enterprise for the purpose of duplication of a fire signal on all personal computers connected to a LAN of the office building.
The essence of the applied duplicating way is that in office buildings the installation of the special software "WSEM-PC" is installed in the server computer. It allows, when receiving the fire signal from the reception and the control device of the fire alarm system on the communication line means, to carry out this fire signal duplication on all personal computers (PC) connected to a LAN. At the same time there are messages in the personal computer screen on the fire and the scheme of evacuation from the room with the definite personal computer indicating the nearest emergency exit. The personal computer blocking is conducted to avoid its further work. Except for a

visual signal to increase the efficiency of the warning in the program complex WSEM-PC the alarm voice of the displayed information is provided, on means of the previously recorded voice warning. For example: "Attention! The building's on fire! All Personnel proceed to the emergency exit immediately!".
This way is described in works in detail [5,6,7]. Its application is possible in office buildings of JSC "Russian Railways" without essential material inputs and doesn't contradict the existing normative documents as its introduction is carried out in the existing WSEM and LAN system.

4. Results and discussion

For the analysis of the efficiency of the offered duplicating notification way there are natural observations of people's behavior when receiving a "Fire" signal are conducted. Observations were made in five various office buildings of JSC "Russian Railways" (further - the Building No. 1, No. 2 … No. 5). In different days, approximately in identical time during the working day the signal of the fire was given; the notification was carried out by the 4th options:
- the standard warning system and managements of evacuation of people at fire (WSEM);
- standard WSEM + the duplicating notification way "WSEM-PC" (only sound component);
- standard WSEM + the duplicating notification way "WSEM-PC" (a sound component and the visual notification);
- standard WSEM + the duplicating notification way "WSEM-PC" (a sound component, the visual notification and blocking of the personal computer).

During the observation the response time to the fire signal, that is, the period from the signal receiving till making the decision to the evacuation beginning by each person. The received temporary indicators were included into the protocol. The generalized results of the observation are given in table 1.

Table 1

The generalized results of natural observation of people's behavior, when receiving a signal of the fire, at various notification ways

Experiment No.	Name of the building	Way notification of people	Number of people	As much as possible time of response to a signal, min.
1	Building №1	standard WSEM	153	1,94
2	Building №2		174	2,05
3	Building №3		162	1,98
4	Building №4		158	2,16
5	Building №5		147	2,05
6	Building №1	standard WSEM + "WSEM-PC" (only sound component	158	1,70
7	Building №2		171	1,72
8	Building №3		155	1,81
9	Building №4		158	2,01
10	Building №5		143	1,95
11	Building №1	standard WSEM + "WSEM-PC" (a sound component and the visual notification)	163	1,65
12	Building №2		174	1,50
13	Building №3		163	1,58
14	Building №4		136	1,91
15	Building №5		149	1,84
16	Building №1	standard WSEM + "WSEM-PC" (a sound component, the visual notification and blocking of the personal computer)	151	1,57
17	Building №2		172	1,41
18	Building №3		159	1,51
19	Building №4		147	1,83
20	Building №5		142	1,72

The data obtained as a result of natural observation have been processed by means of the statistical graphic STATGRAPHICS for Windows [8] system during which the minimum, maximum and average time of response to a signal, and also an average square deviation were defined.
According to the obtained data graphic dependence (fig. 3) of dynamics of average time of response to the «Fire» signal in the examined buildings depending on the notification way from which it is obvious (on the example of the Building No. 1) that the average time of people's reaction if only a standard way of notification is used is 18.96 sec. The average reaction time at partial use (only sound notification) of an additional notification way about the fire (WSEM-PC) is 16,33 which is 13,90% less. The average time of reaction when using the sound and visual notification (WSEM-PC) is 13.60 which is 28,29% less. And the average time of an additional notification way about the fire (WSEM-PC) is 8.97 which is 52,70% less than initial.

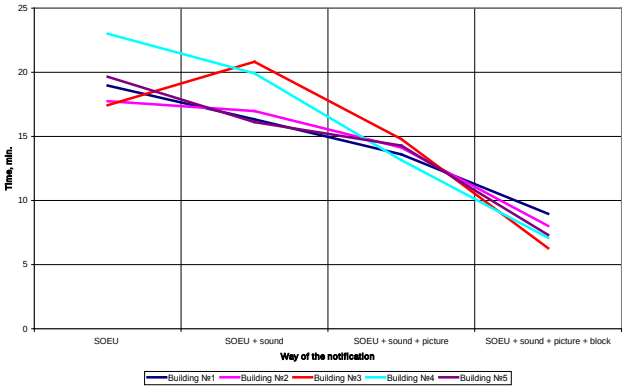

Fig. 3 *Dynamics of the average time of response to the «Fire» signal depending on the notification way*

When the obtained data research the determination of the confidential level of the possibility of the use of various mathematical laws for the description of the dynamics of the response time to the «Fire» signal was the main objective.
So for the choice of the mathematical law of distribution and the description of time of response to the fire signal, the following distribution laws have been analyzed:
- normal law;
- logarithmic normal law;
- gamma distribution;
- exponential law;
- Veybull's distribution.

5. Conclusion

From the analyzed five distributions the possibility of the normal law application has been rejected, other considered laws can be used for the modeled event description "has heard – has made the decision – has begun the movement".
The obtained data by the results of the mathematical research on the confidential level of various distribution laws use are provided in table 2.

Table 2.

Confidential level of a possibility of mathematical laws use for the obtained data research

Law of distribution	Normal law	Logarithmic normal law	Gamma distribution	Exponential law	Veybull's distribution
Confidential level of use, %	10	93	90	95	90

The data analysis and check of the possibility of the application of the considered laws of distribution to the results of the pilot study (criterion a chi-square, Kolmogorov-Smirnov's criterion, [9]) allows to make a conclusion that for the description of time to make a decision

begin evacuation it is possible to use the exponential law of distribution with the confidential level of 95% (p =0,95).
On the basis of the used mathematical model a comparative evaluation of the fire notification efficiency depending on the notification way in comparison with standard values, as well as the existing traditional notification ways was conducted. As the result the following forecasts were received: by the time of t=0,5 min. the response to the standard WSEM is 43,77%, on WSEM+ a sound – 49,93%, on WSEM+ the picture on the PC monitors + a sound in speakers – 56,44% and for WSEM+ the picture on the PC monitors + a sound in speakers + compulsory personal computer block – 63,16%. Graphically the data are submitted in figure 4.

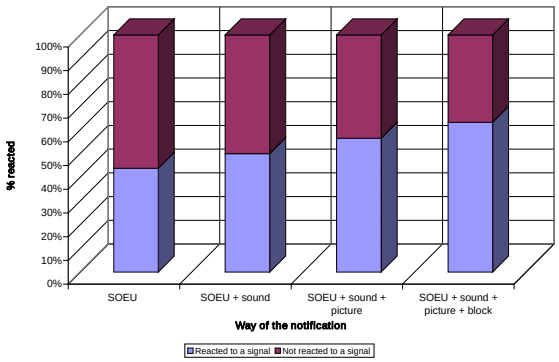

Fig. 4 *Quantity of the ones to react to the notification signal in 0,5 min. time point.*

Therefore, application of WSEM-PC will allow to increase the number of the ones to react to 0,5 min. time point for 19,39%.
By the time of t=1,0 min. the response to the standard WSEM will be 68,38%, on WSEM+ a sound – 74,93%, on WSEM+ the picture on the PC monitors + a sound in speakers – 81,09% and for WSEM+ the picture on the PC+ monitors a sound in speakers + compulsory personal computer block – 86,43%. Graphically the data are submitted in figure 5.

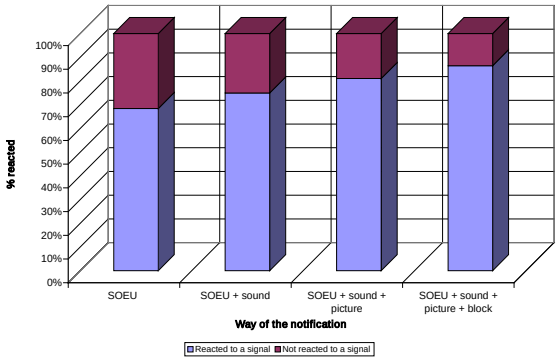

Fig. 5 *Quantity of the ones to react to the notification signal in 1.0 min. time point.*

Therefore, the number of the ones to react in 1,0 min. time point for 18,05% will allow to increase applications of WSEM-PC.
By the time of 1,5 min. the response to standard WSEM will be 82,22%, on WSEM+ a sound – 87,44%, on WSEM+ the picture on the PC monitors + a sound in speakers – 91,74% and for WSEM+ the picture on the PC monitors + a sound in speakers + compulsory personal computer block – 95,00%. Graphically the data are submitted in figure 6.

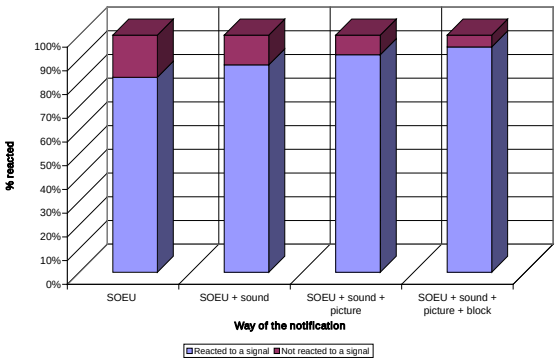

Fig. 6 *Quantity of the ones to react to the notification signal in 1.5 min. time point.*

Therefore, the number of the ones to react in 1,5 min. time point for 12,78% will allow to increase applications of WSEM-PC.
Figures 4-6 show that the suggested notification way "WSEM-PC" makes the greatest impact at the initial stages of people's notification about the fire, just in time of fire when in actual practice people do not completely understand the danger of the emergency situation and do not always take actions, necessary for the evacuation.
Thus, it is possible to make a conclusion that the application of the duplicating notification way "WSEM-PC" "Fire" has a noticeable positive impact on the average time of a signal response.

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