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ANALYSIS OF DISPATCHER'S ACTIVITY IN RAILWAY TRAFFIC CENTER

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Abstract. *The aim of this paper is to analyze the activities of dispatchers in rail traffic control centers, using the analytical-synthetic model. The biocybernetics system 'man-dispatcher', the control information system 'technics-technology', and the accompanying system 'working and living environment' form the basis of this model. By analyzing the dispatcher's work shown, the relationships between the devices in the traffic control centers and the dispatcher's abilities are determined in order to improve the ergonomic design of the traffic control centers. Model activities, described by connections between the activities, made it possible to practically form network models. A detailed analysis of the structure and the time necessary for ergonomic research has been carried out. The application of the analytical-synthetic model improves the quality and level of research, making each activity more efficient and systematically aligned with its objectives.*

Key words: *Rail traffic, Control centers, Analytical-synthetic research., Dispatcher activities, Model activities*

1. INTRODUCTION

The railway is a complex distributed system, where people, equipment, and organization exist in a changing and competitive environment. The holistic approach is proposed to analyse this complex system, which has a strong influence on the regional development and organization of a local community [1, 2, 3]. Modern analysis of the effects of the human factor and the organization of ergonomic research in complex systems is based on the systems approach, commonly referred to as "systems ergonomics" [4,5, 6] "participatory ergonomics" [7, 8], or "macroergonomics" [9, 10]. There are many control engineering challenges for regulation, governance and organization of railway transportation [11, 12]. In order to achieve efficient and safe railway transportation, adequate monitoring is needed. The

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traffic control centers and the dispatcher are two important parts of this complex socio-technical system. In railway transportation, the importance of the human factor in the control system is obvious, because even a small accident can be very dangerous, and with fatal outcomes [13]. Efficient monitoring is influenced, among other factors, by dispatcher's physical capabilities and the characteristics of display equipment, such as video terminals, display panels, and various types of monitors [14].

That is why the subject of this research involves breaking down the promoted research goal into several steps, along with an analysis of the activities required to achieve each of those goals. Through statistical analysis of the effects of these activities, the research results take their final form, which corresponds to the analytical-synthetic research model consisting of two sub-models. The first is system analysis, which analytically demonstrates the coherence of the activities carried out within the system. The second is system synthesis, which, by identifying appropriate activities, leads to decisions and solutions to the researched issue.

2. METHODOLOGY

The present study was conducted at the Rail Traffic Centre (RTC) in Niš (Fig. 1), where the WABCO Westinghouse system Flexicode 560 was installed. Within the center, there is a central transceiver system controlled by a computer. It transfers information and commands using station transceiver devices – satellites. There was also a group of functionally connected rooms, where additional functions were placed (equipment, storage, break room, kitchen and toilet). The analysis is conducted during the actual work tasks in their normal work environment.

Fig. 1 The Railway Traffic Centre in Nis

During the analysis of ergonomic research of traffic control centers, the methods of analytical-synthetic model for the analysis of activities in ergonomic research are applied. These methods enable the analysis of the structure of research and the analysis of time. The analysis of the structure involves the establishment of a logical sequence and interdependency of individual activities within ergonomic research. The analysis of time means defining the start and the end of all individual activities in the project of ergonomic research. The model

shows the sequence of activities and helps to identify the optimal sequence of the activities. The application of the model in ergonomic research significantly changes the access, quality and level of research, making them more efficient and more systematic during the implementation of project objectives.

During the organization of ergonomic research of a complex system "man-technology-environment" it is necessary to consider temporal and spatial dimensions by applying different methods in order to more logically express the quantitative and qualitative content of the research program. The methodological approach considering ergonomics research is based on an analysis of the structure of research and analysis of time. Ergonomic research starts with decomposing complex research objectives at multiple levels, with the obligatory synthesis of research results, which defines the analytic-synthetic research model (Fig. 2).

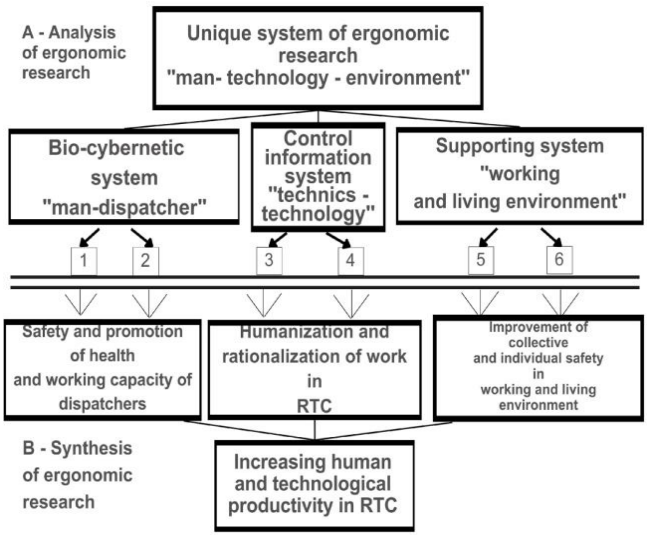

Fig. 2. Analytical-synthetic model of ergonomic research

Legend: 1) Health and psycho –physiological condition, 2) Homeostasis of dispatcher's organism during labor, 3) Ergonomic organization of control information system, 4) Ergonomic organization of work in RTC, 5) Risk factors in the working environment, 6) Risk factors in the living environment

Systems ergonomics research follows a systematic sequence of logically connected procedures within a broader research framework. It focuses ono the biocybernetics system 'human-dispatcher', the control information system 'technology and equipment' and the supporting system 'work and living environment'. These components contribute to ergonomic solutions aimed at disability prevention, promoting labor humanization, enhancing occupational safety, and improving both living and working conditions. The main goal is to increase labor productivity.

3. RESULTS

In order to construct an analytical-synthetic model, a list of activities must be developed (Table 1).

Table 1 The list of research activities.

No.	Activity description	Activity duration in weeks
1.	The definition of the task based on the hypothesis or project specification	2
2.	Determination of system objectives and limits of micro and macro level of project research	2
3.	Development of analytical - synthetic model of ergonomic research	2
4.	Determination of experimental and objective conditions of ergonomic research	1
5.	Determination of multidisciplinary team and equipment for ergonomic research	1
6.	Determination of methods and techniques for ergonomic research of the system "man - technology - environment"	2
7.	Analysis and assessment of the health status of dispatcher in RTC	4
8.	Analysis of physical and mental abilities of dispatcher in RTC	3
9.	Analysis of homeostasis of workers during labor in RTC	2
10.	Statistical analysis of results of the results of examination of dispatchers' health	1
11.	Statistical analysis of the results of tests of mental and physical working capacity of dispatcher	1
12.	Statistical analysis of the results of test of dispatchers' homeostasis	1
13.	Identification of the most important factors of ergonomic research	2
14.	Ergonomic assessment of the state of the biocybernetic system "man - dispatcher"	1
15.	Examination of internal and external determinants of the RTC	2
16.	Examination of the determinants of RTC organization	4
17.	Examination of the determinants of the labor organization in the RTC	3
18.	Statistical analysis of the results of examination of internal and external determinants of the RTC	1
19.	Statistical analysis of test results of the determinants of RTC organization	1
20.	Statistical analysis of the results of examination of the determinants of the labor organization in the RTC	1
21.	Determination of the most important factors of ergonomic research	3
22.	Ergonomic assessment of the control information system “technics-technology”	1
23.	The analysis of stress factors in the working and living environment	4
24.	The analysis of safety factors in the working and living environment	3
25.	Statistical analysis of the results of examination of stress factors in the working and living environment	1
26.	Statistical analysis of the results of examination of safety factors in the working and living environment	1
27.	Identification of the most important factors of ergonomic research	1
28.	Ergonomic evaluation of the accompanying system “working and living environment”	1
29.	Ergonomic evaluation of a unified system “man – technology – environment“ in the RTC	2
30.	Analytical-synthetic interpretation of obtained results with discussion	6
31.	Conclusions and proposals for system design	1
32.	Technical processing of the results of ergonomic research	2

Table 2. Model dispatcher's activities

Previous activities	Current activity																														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
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4. Discussion

According to the model dispatcher's activities shown in Table 2, we conclude that the following activities are very important. Activity 6, because it is preceded by activities 3, 4 and 5, and it establish the experimental and objective conditions, define multidisciplinary team and determine the equipment methods and techniques for ergonomic research of the system "man - technology - environment". Special attention should be paid to this activity during the ergonomic research of the complex dynamic system "man-technology-environment",

because it determines the methods of ergonomic research. Activity 13 follows activities 10, 11 and 12, and focuses on the statistical analysis of dispatcher health assessments, evaluations of their mental and physical work capacity, and tests of their homeostasis.

Activity 21, which is preceded by activities 18, 19 and 20, involve statistical analysis of internal and external determinants of the RTC, test results of the determinants of RTC organization and results of examination of the determinants of the labor organization within the RTC. Activity 27, preceded by activities 25 and 26, is focused on statistical analysis of the results of an examination of stress and safety factors in the working and living environment. Activity 29, which is preceded by activities 14, 22 and 28, aims at ergonomic assessment of the state of the biocybernetics system "man-dispatcher", the control information system "technics-technology" and the accompanying system "working and living environment".

The list of research activities (Table 1) and model dispatcher's activities (Table 2) made it possible to practically form network models that can be used when analyzing the activities of dispatchers in the control centers of various complex systems.

Within the development of a new integral control model based on the analysis of three complex systems in Serbia [15], a full network model is used to analyze activities and time, to Critical Path Method (CPM).

Within the analysis of dispatcher's activity in control rooms of underground coal mines [16] network models are used to analyze activities and time, to Project Evaluation and Review Technique (PERT).

Analysis of published literature showed that there are no foreign researches of dispatcher's activities in railway traffic centers, which motivated us to perform this research.

5. CONCLUSION

While designing control centers in Serbian railway traffic there were no clearly defined criteria for ergonomic solutions, leading to insufficient attention to functional and ergonomic demands. As a result, more comprehensive research on the compliance between dispatchers and information-control elements in these centers has become necessary. For this reason, research activities are defined in this paper and a model of activities described by connections between the activities is developed. They are used to realize the following: assessment of the health status, physical and mental abilities and homeostasis of dispatchers; examination of the ergonomic design of equipment and work organization and the analysis of stress and safety factors in the working and living environment.

The theoretical and practical contribution of this research lies in the fact that it provides a guarantee that, based on the applied scientific and professional methodology, the promoted issues will be addressed comprehensively within an interdisciplinary framework. This significantly enhances previous approaches to the design of railway traffic centers.

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