Safe organization of the train compiler’s work in modern conditions

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Abstract. The development of railway transport is one of the most important elements in the country’s economic development. One of JSC “Russian Railways” strategies is to automate sorting processes and reduce the share of manual labor. The analysis shows that the majority of employees at railway stations in the country perform their duties in high-risk areas, resulting in accidents and abnormal situations with employees during working hours, which cause significant damage to transport employees and transport infrastructure. The relevance of the research is the need to reduce production factors that negatively affect the work of employees of the holding, minimize manual labor and prevent economic damage to the company. The purpose of the research is to develop a set of measures to reduce the number of factors affecting the work of railway transport employees, with the possibility of applying them in international practice, where the first stage of work is to clarify the principles of combining professions and determine the priority functions of employees for automation using new technological devices or software. The main research tasks were solved using theoretical and experimental methods, such as computer modeling, expert evaluations, statistical analysis, and others. The results of the research are of theoretical and practical significance. The theoretical result - is the development of additional working conditions of employees, increasing productivity and reducing the risk of emergency situations at work; practical – development of a set of proposals to improve the quality of work of employees of the railway transport system.

1. Introduction

JSC “Russian Railways” holding occupies an important place in the transport system of the Russian Federation. Based on statistics for all types of transport, railways provide 45% of cargo turnover and 30% of passenger turnover. JSC “Russian Railways” provides jobs in the amount of 1.5% of the total number of officially employed workers in the country, as well as about 1% of the employed population of the country is provided through systematic investments and orders of the company. The strategic goals of the company’s management are to maintain its leading positions in the World in terms of efficiency and safety, improve working conditions and increase productivity, which will allow the holding to become one of the most attractive employer companies in Russia, as well as to introduce priority “green” technologies in production [1]. The difficult working conditions of the majority of railway station employees are one of the most important problems of the company, the solution of which will lead to the achievement of most strategic goals. When analyzing statistical data, it was found that most of the emergencies that occurred on the railway are the result of the influence of harmful and dangerous industrial factors. These manifestations of risk cause significant damage to the transport infrastructure, cargo, employees and passengers of transport.
The relevance of the research is expressed in the need to improve the working conditions of railway transport employees in the Russian Federation and automate the main processes on the entire railway network of the country, which will reduce economic losses, social tension and environmental damage.

The purpose of the research - is to develop a set of measures to reduce the number of factors affecting the work of railway transport employees, with the possibility of applying them in international practice, where the first stage of work is to clarify the principles of combining professions and determine the priority functions of employees for automation using new technological devices or software.

An indirect indication of the relevance and importance of the research is the output of the Order JSC “Russian Railways” from 21.01.2020 No 102/p “On approval of the policy of the holding “Russian Railways” in the field of labor safety and environment, industrial and fire safety”, where the main goals are to ensure safe working conditions for employees, protection of life and health of employees of “Russian Railways” holding and the population living in areas of activities of the holding and minimize the negative impact of the holding’s activities on the environment [2].

2. Research methods
The main research tasks were solved using theoretical and experimental methods, such as computer modeling; expert evaluations, statistical analysis and others. The results of the research are of theoretical and practical significance. The theoretical result - is the development of additional working conditions for employees that increase productivity and reduce the risk of emergencies at work; practical – development of a set of proposals to improve the quality of work of employees of the railway transport system, which will reduce the risk of accidents and minimize the cost of eliminating the consequences [3,4].

Methodological assumptions also served as:

- investments in preventive measures to ensure the safety of complex man-made systems are economically feasible, since the assessment of the prevented damage exceeds the cost, on average, in 5-10 times [5,6];
- investments in “measurements of the new technical order” that provide a synergistic effect in the interaction of all components: people → rolling stock → infrastructure → natural environment [5,6].

2.1 Relevance, practical and scientific importance of the research
The relevance of the research is expressed in the need to improve the working conditions of railway transport employees in order to reduce economic losses, social tension and environmental damage during the transportation process.

Among other things, the prerequisites for the importance of research are:

1) Emergence of the innovative development program of JSC “Russian Railways”, as well as the release of Orders and Decrees aimed at increasing attention to the field of labor safety and environmental protection, industrial and fire safety [7].
2) Accumulation of new statistical data and a more detailed study of all harmful and dangerous production factors;
3) Dynamics of increasing the productivity of employees in the company of JSC “Russian Railways” due to the combination of duties, which indirectly leads to an increase in the number of harmful and dangerous factors affecting employees [8];
4) Emergence of innovative devices aimed at applying in the work of Employees of JSC “Russian Railways”, capable of automating the most dangerous production processes at the railway station [9].
3. Research result. Theoretical prerequisites.

The study was conducted on the working profession of JSC “Russian Railways” - train compiler, since young specialists are accepted for this position after graduation from universities. The work of the train compiler consists of the following elements: control over the movement of rolling stock during shunting work, formation and disbandment of trains, ensuring safe operation during shunting movements; compliance with labor safety on railway transport. Train compilers spend most of their time performing their work duties on the street, in high-risk areas, they are affected by various factors that can contribute to a sudden, sharp deterioration of health, as well as injuries, the influence of all harmful and dangerous factors on this working profession was analyzed. [10]

3.1. Low and high temperatures

For the train compiler, the reasons for cooling and overcooling the body are many production processes performed at low temperatures. So, for example, if we do not meet the standards of workwear or the wrong mode of work, an employee during a period of high activity and humidity may be exposed to diseases associated with the respiratory tract. The main criterion for choosing the length of stay on the railway tracks is the intensity of work. Train compilers have acute or chronic damage to tissues and organs of the body due to untimely breaks during work. Prolonged local exposure to low temperatures in winter, especially in combination with humidification, causes the development of vegetative polyneuritis of the upper extremities in employee, as well as the impact of local and general cooling, can lead to the development of cold neurovasculitis. The disease is characterized by the development of functional neurovascular disorders. There is fatigue, increased sweating, swelling and pain of the extremities, muscle cramps, which disappear with the cessation of exposure to low temperatures [10,11,12].

3.2. Dust and gas pollution

One of the adverse factors that have a negative impact on the health of employees is industrial dust. However, the train compiler mainly performs shunting operations in localities that are far from large industrial enterprises. At the station, negative influences come from the exhaust system of shunting locomotives, as well as from harmful and toxic substances in the air from cargo transported in special wagons. But also, as with other factors, it is necessary to timely detect the early stages of the disease and prevent the development of diseases of the skin and respiratory tract [10,11,12].

3.3. Noise

Noise refers to a chaotic system of sound waves of different strengths and amplitudes that randomly change over time. Increased noise level affects the mental and physiological state of health of the employee, under the influence of this factor can develop: chronic insomnia, fatigue, neurosis, hearing loss, stress, decreased immunity, hearing loss, heart disease [10,11,12].

3.4. Vibration

Vibration, depending on its parameters, can have a negative impact on the train compiler during operation. In some cases, the vibration is positive, however, the vibration associated with the movement of trains directly in the area of operation of the train compiler, turns out to be a harmful factor transmitted to healthy tissues and organs. When conducting experiments with the compilers of the sorting hill at an extracurricular sorting station, the pronounced effect of vibration on the body of these employees was indicated. During the 12-hour period, directly at a distance of 2 meters from the passing train, the vibration was about 10 hours [10,11,12].

3.5. Lighting

The compiler works in shifts, both during the day and at night. If during the day the lighting allows to perform all the work duties, then at night this process can be difficult. The level of illumination brightness for an employee should be 1000-2000 Lux., however, working at night, this indicator will
be several times less. Artificial lighting is provided at railway stations, according to the standards, but in some areas the lighting is not sufficient for the employee, which leads to technical errors and additional work [10,11,12].

3.6. The severity and intensity of labor

Labor intensity is classified based on the employee’s energy expenditure in the course of working activities. Energy expenditure is determined by the degree of the coefficient of labor intensity of the muscles, as well as the nervous and emotional state of the employee during the performance of work. Another important indicator is working conditions. A train compiler in the course of performing his/her official duties has a high risk of getting an increased load on the musculoskeletal system, cardiovascular, neuromuscular and respiratory systems. In order to ensure high-quality working conditions for the employee, it is necessary to observe the norms of work and rest, as well as to have breaks in work [10,11,12].

3.7. Electromagnetic fields of industrial frequency

The train compiler is affected by low-frequency electromagnetic fields, high-frequency fields, and microwave electromagnetic fields. Constant exposure to electromagnetic fields leads to functional disorders of the nervous, endocrine and cardiovascular systems, the employee’s pulse slows down, blood pressure decreases, reflexes are inhibited and blood composition changes. Heat exposure can lead to overheating of the body and individual organs, and disruption of their functional activity. EMF of the microwave range leads to thermal cataracts. Subjectively, the manifestation of EMF exposure is expressed in increased fatigue, headache, irritability, shortness of breath, drowsiness, visual impairment and an increase in body temperature [10,11,12].

Simultaneously with the above factors, there is a tendency to decrease the number of employees of the holding. The decrease in staff is due to the fact that employees retire and dismiss at their own request. Also, to increase labor productivity, jobs that combine professions are created. The holding needs to create optimal conditions for employees to work, in order to avoid their dismissal at their own request and to attract young specialists to the company. According to the program of comprehensive improvement of technological processes of JSC “Russian Railways”, by 2025, the total number of employees will be reduced by almost 5.5%. In addition to combining professions, each year the company allocates new jobs such as: operators who can independently control rolling stock; engineers who can design high-speed lines and rolling stock; specialists associated with the operation of high-speed lines; operators of information and operating systems. It follows that in order to use new jobs, it is also necessary to create a tool that allows to comply with the safety rules for the operation of this equipment and structures.

The analysis of the number of employees of JSC “Russian Railways” and the dynamics of staff decline in the position of “train compiler” are shown in figure 1 and 2, respectively.

![Figure 1](image_url)

**Figure 1.** Number of employees of JSC “Russian Railways”. 
Based on the dynamics of the decline in the number of train compilers, it should be concluded that with a parallel increase in traffic volumes, labor productivity increases, which is reflected in the employees in the manifestation of the factor of intensity and severity of work.

At the moment, the position of “Train compiler” is combined with the following professions: car inspector (all names), cargo and baggage receiver; train receiver, assistant driver of a locomotive, electric locomotive, steam locomotive (engaged in shunting class 3-5).

Combining duties is allowed if the main work is organized so that it has technological breaks, as well as if the following mandatory conditions are met.

4. Research result. Practical results and their discussion.

The analysis of the main influencing factors on the employee in the position of “train compiler” was executed and also the number of employees in the staff for this position in various departments was analyzed. The impact of the main factors is described in Table 1.

Table 1 shows that a large number of harmful and dangerous factors affect an employee in the position of “train complier”, when combining their activities with other professions, the number of influencing factors increases, the risk of injury, psycho-emotional and physical stress increases, which negatively affects the production and quality of work. Since for the company the combination of duties brings a large profit due to increased productivity, the principles that must be applied in production to avoid emergencies and emergencies were developed.

The main principles of combining responsibilities in the company of JSC “Russian Railways”:

1) registration of the employee’s written consent to perform the added work;
2) professional training of an employee that meets the requirements for the combined profession (position);
3) mandatory medical examination of an employee to confirm the suitability of the added work for the combined profession (position), provided for by Federal laws and other regulatory legal acts of the Russian Federation for certain categories of employees;
4) organization of work on training, professional development, conducting briefings, checking the knowledge of labor safety requirements in full both for the main profession (position) of the employee and for the combined;
5) establishment by the employer of the term for performing additional works, their content and scope, confirmed by the written consent of the employee;
6) by agreement of the parties to the employment contract, setting the amount of additional payment for combining professions (positions), taking into account the content and (or) volume of additional work.

**Table 1.** Harmful and dangerous production factors affecting the train complier, and protection systems against them.

| Influencing factor | The nature of the impact | The existing system of protection |
|--------------------|--------------------------|----------------------------------|
| **Harmful production factor** | | |
| Gas contamination | exposure to the exhaust of shunting locomotives, caustic, radioactive toxic substances during the transportation of relevant goods leads to a decrease in the quality of breathing | allocation of time for a break, use of personal protective equipment (PPE) |
| dustiness | dusty air, the presence of harmful and toxic substances in it lead to a decrease in the quality of breathing | spraying of dusty surfaces with water, the use of personal protective equipment |
| noise | noise from rolling stock affects the auditory analyzer and the central nervous system | the use of sound-absorbing and sound-insulating (PPE), for example, headsets, carrying out medical and preventive measures |
| vibration | exposure to vibration from rolling stock leads to neurovascular disorders of the hands, weakness in the hands accompanied by intense pain after work and at night, a decrease in all types of skin sensitivity | lubrication of vibrating parts, use of vibration-insulating and sound-absorbing PPE, removal from the source of vibrations |
| lighting | working in the dark and twilight time of the day, and as a result, increased fatigue, reduced productivity and safety, visual acuity | use of artificial lighting, maintenance of individual lighting equipment in good condition |
| severity of labor | moving and lifting the working tool used lead to loads of musculoskeletal tissue, as a result of increased fatigue, weariness. | normalizing the work and rest regime, dosage of severity, allocation of time for a break |
| intensity of labor | increased load on the musculoskeletal system, impact on the cardiovascular, neuromuscular and respiratory systems | rationing of work and rest, providing breaks |
| **Dangerous production factor** | | |
| kinetic energy | arriving and departing trains, shunting work, securing wagons from leaving with brake shoes/cleaning them, entering the space between wagons, which can lead to injury or death | automatic warning system, compliance with the regime of being in a dangerous zone, movement through organized passages, elimination of irregularities in the roadbed, the use of reflective elements on special clothing, training, instructions |
| potential energy | collapse, fall of cargo during inspection of wagons, which can lead to injury, death | conducting training sessions, compliance with safety regulations, compliance with the rules and regulations for loading and securing cargo on the rolling stock, working at a set distance from the wagon, high-quality technical and commercial inspections |
| thermal energy | low temperature when working in the cold period, as a result of frostbite; high temperature when working in the summer period, as a result of solar, heat shock, UV burn | providing warm drinking during technological breaks, the use of protective clothing, the use of protective ointments |
| electric energy | failure or breakage of the contact network, which can lead to electro-injury or death due to contact with the contact network elements that are under voltage | isolation of current-carrying parts of the locomotive; application of protective devices: grounding, isolation; automatic disconnection of the current source |
| chemical energy | wagons with discharge and dangerous goods that can lead to chemical burns and poisoning | timely notification of wagons with such cargo, provision of complete and reliable information about them, use of protective equipment |

5. **Conclusion. Conclusions. Recommendations**

At this stage of research, it is possible to formulate the following conclusions and provisions:

1. Currently, the level of exposure to dangerous and harmful factors requires a rethinking of the complex of issues related to ensuring safety and preventing abnormal and emergency situations in railway transport.
2. Reducing the frequency of accidents and emergencies in railway transport is one of the most important tasks for the Ministry of Transport of the Russian Federation and JSC “Russian Railways”. To solve this task, new solutions are required to eliminate the influence of negative factors, including innovative technologies, the introduction of new principles and technologies that will reduce dangerous and harmful factors in the working places and improve working conditions for workers.

3. Development and application in the company of a new set of measures for automation of railway stations, new principles and technology of work of key employees, allowing combining the duties of several professions without harm to the organization of traffic and production, which will reduce the economic costs of eliminating the consequences of accidents and emergencies.

In the future, we are preparing a set of measures and proposals for automation in railway transport, evaluating their effectiveness both for JSC “Russian Railways” and for employees, with a positive result, new regulations and work technology will be developed for employees of the railway station.

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