

STUDY OF THE ERGONOMIC - ORGANIZATIONAL RESPONSE OF LARGE COMPANIES TO THE SAFETY THREATS CAUSED BY COVID-19 VIRUS - CASE STUDY

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Abstract The subject of this study is the functioning of companies with a large number of employees in the conditions of a pandemic, on whose work the life and work of the majority of the population of a country largely depend. Such are, for example, companies from the energy sector. If the infection caused by the SARS-CoV-2 virus were to spread in such companies, the consequences for the life and work of citizens would be incalculable. Through the control of human - object interaction, ergonomics contributes to preventing the transmission of infection. In order to assess the application of ergonomic, organizational and safety measures to prevent the spread of infection, a questionnaire was formed in this paper. It was used in a case study that included a company of national importance with a large number of employees, which operates within the Electric Power Industry of Serbia. The research included 158 employees in this company. Observation, interviewing and insight into relevant company documentation were used as control methods. The results of the research showed a high agreement of the results collected by the mentioned methods. The study showed that most ergonomic measures are applied to suppress the transmission of the infection, as well as that they give satisfactory results. However, one of the biggest problems is group work, when it is often not possible to maintain the prescribed distance between employees. In this regard, the new role of ergonomics and its experts was emphasized, which consists in redesigning work tasks and the workplaces in a way that will not endanger work efficiency, and which will contribute to preventing the spread of infection among employees.

Keywords: SARS-CoV-2 virus; COVID-19 pandemic; ergonomic prevention; organizational measures; large companies.

1. INTRODUCTION

Harmonizing the human - machine - environment system is extremely important for any company. However, this alignment has been disrupted by the emergence of the global Covid-19 virus pandemic. Complex systems with a large number of employees are especially endangered, on whose work not only the employees of these companies and their families depend, but also a large part of the population of one country.

Maintaining such a complex system in a functional state in a pandemic is a special challenge. There is a very large number of possible human interactions with machines and other devices used in the work process, with the object of work, as well as the environment, so the possibility of spreading the infection in such companies is very pronounced. In order for such a complex system to be able to continue to function in the newly created conditions, ergonomic and hygienic-sanitary control is necessary. Due to the absence of workers from work as a consequence of going on sick leave due to

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infection with the virus, certain formal or informal organizational changes are often necessary in complex systems.

The main goal of this paper is to investigate the measures taken in the ergonomic and organizational sense, in order to prevent the spread of infection among employees and maintain the production process, on the example of a case study of a large system with a great number of employees and with high social responsibility. After reviewing the factual situation, it will be possible to propose ergonomic - organizational measures in order to improve the safety of such complex systems in pandemic conditions.



Figure 1. KMB surface mine.

One such complex system is the Kolubara Mining Basin (KMB). This system started working in 1896. Mass surface exploitation of coal began in 1952. KMB covers an area of 600 km². It is engaged in the production, processing and transport of coal. It is part of the parent company Elektroprivreda Srbije (EPS) and is owned by the state. KMB, the largest branch of EPS, employs 11.880 workers. The largest number of employees, 6.625, work in the organizational unit "Surface mines" and they are the pillar of the company's production. "Processing" employs 1.528 workers, "Metal" 2.001 workers, "Project" 87, while "Directorate" has 1.639 employees.

2. METHOD

In order to collect data, two approaches were used. The first approach was based on the application of the method of interviewing RBC employees, observation of preparatory and work activities, as well as analysis of relevant company documents (for the subject of research). The second approach was based on collecting data from employees based on a survey. In order to conduct the survey, a questionnaire was formed. This questionnaire contains questions aimed at detecting certain segments, ergonomic, organizational and safety, which are estimated to be of particular importance from the aspect of preventing the spread of infection within a company with a large number of employees. The aim of the questionnaire is to determine the changes that have occurred in the organization of work tasks, register the initiated measures taken to limit and prevent the interaction of workers with

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potentially infected facilities and surfaces, as well as to detect whether human-human interactions are in safe frameworks. In addition, the aim of this questionnaire is also to determine how the previously prescribed measures are actually implemented in practice, ie to identify potential problems that hinder the implementation of the prescribed measures. Based on the results of this research, it will be possible to report appropriate conclusions and create conditions for the formation of recommendations that could reduce the risk of disease of workers, which would further improve the company's business in a pandemic. This questionnaire is given below.

QUESTIONNAIRE ON THE TRACKING OF CHANGES IN THE ORGANISATION OF PERFORMING OF WORK TASKS AND APPLICATION OF ADDITIONAL ERGONOMIC MEASURES INITIATED TO PREVENT THE EXPANSION OF THE CORONAVIRUS INFECTION IN A COMPANY WITH A LARGE NUMBER OF EMPLOYEES

1. Is there a disinfection treatment for your hands on the occasion of entering the company?

YES NO

2. Is there a disinfection treatment for your shoes on the occasion of entering the company?

YES NO

3. Are there any warning signs of the Coronavirus at the entrance to each company facility?

YES NO

4. Are there any warning signs of the Coronavirus at certain locations within the facility (facilities) themselves?

YES NO

5. Has there been a reorganization of the schedule of employees in the workplace in any way due to the appearance of the Corona virus (eg has your sitting location changed, the distance to the next workplace increased, etc.)?

YES NO

6. Are you able to maintain the recommended distance of 1.5-2 m at any time during the performance of the work task?

YES NO

7. If the phone is used at a certain workplace by workers from different shifts, is it disinfected after use?

YES NO I DO NOT KNOW

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8. If the same workstation with a computer is used by two workers, is the keyboard and mouse disinfected daily after use and/or before use?

YES NO I DO NOT KNOW

9. Are tools shared by workers from different shifts disinfected after use?

YES NO I DO NOT KNOW

10. In case the same tools are used by employees from different shifts, do the workers use protective gloves?

YES NO I DO NOT KNOW

11. Do you know that two or more workers have used the same protective equipment during their shifts (helmets, gloves, goggles, noise protection equipment, etc.) since the onset of the Coronavirus?

YES NO I DO NOT KNOW

12. Is your workspace equipped with a vacuum cleaning carpet?

YES NO

12b. If the answer to the previous question is YES, does the air conditioner turn off during carpet cleaning?

YES NO I DO NOT KNOW

13. In cases of workers' need for work at a short distance (such as, for example, designing), in your opinion, to what extent are you able to adhere to all prescribed protection measures?

0 10 20 30 40 50 60 70 80 90 100

14. Do you know that rooms are used in which there is no natural or artificial ventilation?

YES NO I DO NOT KNOW

15. Were meetings held indoors, where a greater number of people were present?

YES NO I DO NOT KNOW

16. Were meetings held electronically?

YES NO I DO NOT KNOW

17. Have appropriate protective measures been taken at locations where a large number of employees gather, such as canteens, resting rooms, etc.?

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YES NO

18. Have extraordinary cleaning and control measures for ventilation and air-conditioning devices been introduced in addition to the regular ones?

YES NO I DO NOT KNOW

19. Are surfaces that are touched by a large number of people regularly cleaned during the day (such as handrails, locks, faucets, trays, etc.)?

YES NO I DO NOT KNOW

20. Are the control panels in the elevators and the locks on the elevators periodically disinfected during the working day?

YES NO I DO NOT KNOW

21. Is it mandatory to wear protective masks in elevators?

YES NO

22. Are the cabins of construction and other devices (used successively by two or more employees) disinfected and ventilated after each use?

YES NO I DO NOT KNOW

23. Is it obligatory to use protective masks in the means of local transport of workers (buses) that are owned by the company?

YES NO

24. According to your estimation, which percentage of employees adhere to the recommendations of wearing a protective mask in the company's local transport vehicles (circle or enter the number)?

0 10 20 30 40 50 60 70 80 90 100

25. Due to the presence of the Coronavirus, have you been directed to conduct business for the company from home?

YES NO

26. Given the type of work you do, is it possible to do your usual work from home?

YES NO

26b. If the answer to the previous question is NO, please write on the line below the reason why it is not possible to do your working tasks from home

27. In general, is it more difficult for you to perform work activities in the conditions of the existence of the Coronavirus than in regular circumstances?

YES NO

27b. If the answer to the previous question is yes, circle on the scale (or write-in), in your opinion, how much is heavier for you to perform work tasks in the conditions of the existence of the Coronavirus compared to the previous period?

0 10 20 30 40 50 60 70 80 90 100

28. In your estimation, to what extent (percentage) do workers generally adhere to all prescribed measures of protection against coronavirus at work?

0 10 20 30 40 50 60 70 80 90 100

The survey involved 158 KMB employees, 121 males and 37 females. The pandemic caused by the COVID-19 virus showed, at first glance, considerable selectivity with regard to the age categories of people who become ill or fall victim to the virus. Table 1 shows the number of persons (frequency) depending on the age of the respondents. At the time the survey was conducted (between March and June 2020), people over the age of 60 were the most vulnerable category of the population. At that time, according to official data, the number of infected people under the age of 30 was minimal. For that reason, it was estimated that people over the age of 30 would be more interested in participating in the survey, which turned out to be true. The survey covered 32 different jobs.

Table 1. Distribution of age structure of respondents.

Years of age	30 – 40	40 – 50	50 – 60	Over 60
Frequency	21	80	32	25

3. RESULTS

First, the collected data will be presented, which were obtained on the basis of interviewing employees, observation of preparatory and work activities, as well as analysis of relevant company documents. After that, the results obtained by applying the questionnaire will be presented.

3.1. Data Collected Through Interviews, Observations and Access to Documentation

Here, the subject of consideration is primarily focused on the organizational unit of KMB called "Tamnava Surface Mine" (TSM). The main activity performed within the TSM is coal mining. This organizational unit has 1.082 employees, 943 men and 139 women.

It is interesting to consider what organizational changes have occurred in the company KMB after the introduction of the state of emergency in Serbia due to the Coronavirus epidemic (March 15, 2020). Immediately after the declaration of the state of emergency, a number of workers were sent on paid leave - all workers over the age of 60, mothers with children under the age of 12, as well as workers with certain chronic diseases such as diabetes, asthma, etc. This type of preventive isolation included 123 workers, 93 men and 30 women. Thirteen workers were sent to home isolation due to suspicion of Coronavirus and a previous stay abroad. There were 5 additional workers in the house isolation, because their Coronavirus infection was confirmed. All workers who referred to isolation on suspicion of SARS-CoV-2 virus infection or if they had confirmed infection were under 50 years of age. There were no fatal cases in the TSM during that period.

The formal organizational structure of the company has not changed. KMB's organizational chart remained unchanged. However, the informal organizational structure has changed to some extent, as it has been necessary to ensure a continuous production process due to the sending of workers to isolation. This was achieved through the redistribution of responsibilities and the introduction of overtime work among workers. The working unit where these changes were most common is "coal preparation".

In the state of emergency caused by the pandemic, the employer acted in accordance with the requirements prescribed by the General Directive of the European Union and the Law on Safety and Health at Work of the Republic of Serbia [1], primarily with regard to risk reduction, adjustment of work and workplace to employees and implementation of preventive measures. In addition, the company's management and employees adhered to the guidelines published at the time by the Ministry of Labor, Employment, Veterans' Affairs and Social Affairs on their website. These guidelines primarily referred to vulnerable categories of residents, people over the age of 60, employed parents with children under the age of 12, as well as work from home. All this was in accordance with the Regulation on the organization of work of employers during the state of emergency [2].

The responsible sectors and the service for safety and health at work took care of the implementation of the measures. In order to minimize the risk of infection, before each field trip, mass transport vehicles and trailers on which means for fieldwork and clothes are transported were thoroughly disinfected. The production department worked in all three shifts, production capacities were engaged as before the epidemic, 24 hours a day. Employees were informed about the measures they need to take to protect themselves, about where and to whom they can turn if they notice symptoms. A crisis headquarters was formed at the level of EPS, as well as teams in production and distribution that monitored the situation on the ground, reacted and organized work in accordance with the prescribed measures of the Government of Serbia.

Since the beginning of the virus pandemic, work has been done on disinfecting workplaces and production facilities within the Tamnava branch, with special emphasis on locations where there was a higher frequency of employees. The biggest problem was the need to work in groups of 3-4 workers. Representatives of the KMB Workers' Union have always participated in activities to prevent the spread of the virus. Together with the representatives of the employer, they often stayed in the field, at all points and parts of the company. Protective equipment, such as masks and gloves, was

procured. All employees were ordered to adhere to distances of 2 m. The movement of workers within the company, going to other jobs or offices are kept to a minimum.

The Electric Power Industry of Serbia, whose branch is KMB, has issued special recommendations on the organization of work during the implementation of activities to combat the spread of infectious diseases. In addition to the general ones, these recommendations contain strict instructions for employees, special protection measures, rules for actions in case of detection of Coronavirus, as well as instructions for controlling the prescribed measures. EPS also passed a special decision on performing work outside the employer's premises during the pandemic.

3.1. Results Obtained on the Basis of the Formed Questionnaire

As previously mentioned, the main purpose of the questionnaire was to determine, based on its application, whether the interaction of workers with potentially infected facilities in the workplace and in the immediate environment is adequately prevented, whether preventive measures that relate to man - man type of interaction have been implemented, as well as to check how the prescribed measures are implemented in practice. The results of the respondents' answers to the questions from the questionnaire are given in Tables 2 and 3.

Table 2. Results that are obtained on the basis of the questionnaire, to the questions with yes, no and I don't know options.

Ordinal number of questions	Respondents' answers		
	Yes	No	I don't know
1.	158		
2.	158		
3.	158		
4.	158		
5.	158		
6.	99	59	
7.	158		
8.	158		
9.	122	36	
10.	158		
11.		158	
12.	42	116	
12b.	42		
14.		158	
15.	12		146
16.		62	96
17.	158		

Ordinal number of questions	Respondents' answers		
	Yes	No	I don't know
18.	112		46
19.	102		56
20.	44		114
21.	158		
22.	110		48
23.	158		
24.	47	111	
25.	58	100	
26.	92	66	
27.	158		

Table 3. Results that were obtained on the basis of the questionnaire, to the questions for which the answers were given on a scale from 0 to 100.

Ordinal number of questions	Frequencies of respondents' answers										
	0	10	20	30	40	50	60	70	80	90	100
13.	0	0	0	0	0	10	13	17	30	88	0
24.	0	0	0	0	0	0	0	21	45	92	0
27b.	0	0	0	0	0	0	45	13	22	12	0
28.	0	0	0	0	0	0	28	31	47	52	0

Regarding question 26b, 100 respondents answered that their work is related to direct production and that their existing employment contracts do not allow them to work from home in the pandemic.

4. DISCUSSION OF RESULTS

To the first 5 questions from the questionnaire, 100% of respondents answered in the affirmative. This means that hands and shoes must be disinfected before entering the company, that there are warning signs related to Coronavirus at the entrance to the company's facilities and at appropriate locations within the company, and that the distance between neighboring workplaces has been increased. The answers to other questions show the following:

- 37.3% of workers are not able to be at a distance of 2 m from a neighboring person at each time during the performance of the work task
- VDT workplaces and telephones are disinfected in 100% of cases

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- 22.7% of respondents stated that they know that there are cases when tools used by a large number of people are not successively disinfected, but that workers in these cases are equipped with protective gloves
- in 100% of cases, workers do not exchange individual protective equipment (each worker has his own protective equipment)
- 26.6% of workers in their offices have a vacuum cleaning carpet, while the air conditioner turned off during carpet cleaning
- in case the work activity requires work at a shorter distance (for example design), workers believe that in the range of 50% to 90% are able to adhere to the prescribed protection measures
- in 100% of cases, the rooms have natural or artificial ventilation that allows ventilation
- 7.6% of workers stated that it is known to them that meetings were held indoors during the pandemic where a large number of workers were present (other workers stated that they were not aware of this information)
- 0% of workers stated that they know that the meetings were held electronically in the past period
- 100% of surveyed workers believe that all prescribed protection measures are applied at locations where a large number of workers gather
- 70.8% of workers state that air conditioning and ventilation devices are additionally (extraordinarily) cleaned (others do not know for this information)
- 64.5% of respondents stated that surfaces that are touched by a large number of people (such as handrails, locks, faucets, trays, etc.) are regularly cleaned (other respondents were not aware of this information)
- 27.8% of workers stated that they know that control panels and elevator locks are regularly cleaned (other respondents did not know anything about that)
- 100% of respondents believe that wearing a mask in elevators is mandatory
- 69.6% of workers are aware of the fact that the cabins of construction machinery and equipment are cleaned and ventilated after use (other respondents do not know this information)
- 100% of workers stated that wearing protective masks in local transport is mandatory
- respondents estimate that between 70% and 90% of workers comply with the regulations for wearing masks in the company's local transport
- 29.7% of surveyed workers stated that at some point during the pandemic they were instructed to perform work activities for the company from home
- 36.7% of surveyed workers believe that the nature of the work they do allows them to do work from home
- 58.2% of workers believe that it is now more difficult for them to perform normal work tasks than before the pandemic and the state of emergency
- respondents believe that it is between 60% and 90% harder for them to perform usual work tasks now than before the pandemic (refers to the previously mentioned 58.2% of respondents who stated that their work is harder at this time than before)
- respondents believe that employees in the company adhere to all prescribed measures to prevent the spread of infection in the interval between 60% and 90% of cases.

5. CONCLUSION

The aim of this paper was to investigate through a case study the possibilities and effectiveness of ergonomic and organizational measures to combat the spread of Covid-19 virus infection in

companies with a large number of employees, whose social responsibility is high. The company Kolubara Mining Basin, which is one of the pillars of the Serbian power industry, was chosen as a representative example of such a company. If the pandemic were allowed to endanger the business of this company, the operation of thermal power plants would be endangered, which would mean that a significant part of Serbia would be left without electricity. The consequences of such a situation would be incalculable. Ergonomics can make a significant contribution to preventing the spread of pandemic infection through the control of human - object interactions [3], because Coronavirus can be transmitted from almost all objects to humans (and vice versa). In addition, ergonomic control of human-human interaction can also prevent the spread of infection.

For the realization of this study, several methods were used. In addition to the methods of interviewing employees, observations and insight into the relevant documentation of the company, a survey of employees was conducted, based on a questionnaire that was created for this purpose. The data collected on the basis of all the previously mentioned methods showed a high degree of agreement. This means that KMB has prepared very well for the challenges posed by the pandemic. This is evidenced by the small number of infected people, which at the company level at that time was 21 (without fatal outcomes).

However, the results of the survey indicate certain weak points, which can be improved. One of the biggest problems is group work on the realization of a common task. In such situations, the distance between employees is reduced, so it is practically difficult to maintain the prescribed distance. In addition, the possibility of holding meetings electronically was not sufficiently used. Of course, in companies with such a large number of employees, this is not simply feasible. For this reason, in the IT sector of the company is part of the responsibility for finding additional solutions in order to use this possibility to realize meetings. Given that the survey showed that the prescribed measures to prevent the spread of the infection are not fully implemented, the application of strict controls and the introduction of penalties for violators could have a positive effect on preventing the spread of the infection.

A large number of ergonomic measures have been applied in the KMB to prevent the spread of infection. However, there is considerable room for the application of ergonomic knowledge and the work of ergonomic experts in large companies to combat the spread of viruses. Their work should be focused on reorganizing group work, ie redesigning work tasks in a way that will prevent the spread of infection in these situations. As already mentioned, workers are often unable to maintain a safe distance from each other in group work conditions. The task of the ergonomist, in this case, would be to find new solutions for working in such workplaces, as well as redesigning the execution of work tasks in a way that will prevent the spread of infection, while the work efficiency would not be compromised.

References

- [1] Law on Safety and Health at Work (in Serbian), Sl. glasnik RS, br. 101/2005, 91/2015 i 113/2017.
- [2] Decree on organizing the work of employers during the state of emergency (in Serbian), 2020, Službeni glasnik RS, No. 31, March 16.
- [3] Zunjic A., 2020, The role of ergonomics in preventing the spread of the COVID-19 virus, *IETI Transactions on Ergonomics and Safety*, Vo. 4 Iss.1, pp. 1-4.