Article

Good practices to counteract epidemic emergency in mining companies in Poland

Patrycja Bąk [1]

[1] AGH University of Science and Technology, Faculty of Mining and Geoengineering, pbak@agh.edu.pl

Abstract: The state of epidemic emergency in force in our country since March and the related requirement to implement various sanitary procedures constitute problems for the operation of all companies. However, the unique operation of underground mining companies increases their scale considerably. However, despite initial turbulent moments related to the occurrence of an unknown threat, it was possible to stabilise the situation in all such companies as a result of implementing various anti-threat actions. Following the initial introduction to basic properties of the SARS-CoV-2 coronavirus, the paper presents the results of the study (a case study) on actions taken in individual mining companies. There was an attempt to formulate the so-called good work practices recommended to be applied.

Keywords: COVID 19, pandemic, mining company, epidemic emergency, prevention, good practices.

1. Introduction

In March 2020, an epidemic emergency appeared in Poland due to the spread of the coronavirus SARS-CoV-2, causing acute respiratory disease COVID-19, which in some cases may even lead to the death of the infected person. It was acknowledged that the virus is very easily transmitted from one person to another. The virus is mainly transmitted by the droplets created, when a person infected coughs, sneezes or speaks. These droplets are too heavy to float in the air, so they fall quickly on surfaces. Then a person may become infected after touching the contaminated surface followed by touching their eyes, nose or mouth. The risk of a severe course of the coronavirus disease appeared to be serious and led to making high-level decisions concerning the announcement of the state of epidemic emergency in the Republic of Poland commencing 14 March 2020 and the state of epidemic commencing 20 March 2020 [1, 2, 3]. On that basis, a number of radical actions were implemented in the field of isolation and distancing of people. The isolation involved mainly the large scale, temporary suspension of their activities, especially closures of many businesses, offices, schools and retail outlets. Whenever it was possible, the so-called remote working system was implemented. This created a dilemma - what decisions to make and what will be the consequences for mines? These decisions were left to be made by the mining companies and mines managements. These had to be made having insufficient information concerning a threat of this kind, which actually "only just" emerged. Therefore, what decisions need to be made (as soon as possible) with regard to the functioning of mines, without having any reliable knowledge about the sources of the spread of the threat itself and methods of preventing it? And the knowledge of the risks involved is essential at each mining company management level. Although it would be more favourable to implement decisions that would involve "no risk", the basis of the security concept involves "acceptable risk". If it is adopted in relation to a mining company, it is necessary to anticipate and predict the possibility of occurrence of a risk. This term should be understood as a risk included between the desired upper and lower levels of safety taking into account a set of necessary criteria. In the analysed case, the criteria should concern epidemic emergency in relation to the employees. It should be clearly emphasised that the lack of knowledge on the virus concerns not only mining industry. The COVID-19 pandemic has spread worldwide and has had economic, environmental and social impacts [4, 5, 6, 7, 8]. All countries where the virus causing the previously unknown disease appeared, have undertaken basic actions primarily aimed at limiting the possibility of its spread by forcing the so-called "social distancing". This has often involved the introduction of a *lockdown* of all social activities ("stay at home- closure of educational, commercial and cultural facilities) and economic (forced production stops of many industrial plants). However, due to the specific nature of mining production, such recommendations could not completely be implemented in mining companies - neither the vast majority of mine workers can "stay at home", nor, due to the deformation of underground excavations, can the mine's operation be stopped for a long time. In such a situation, their managers had to make quick decisions concerning both reducing the spread of infections and preventing adverse effects on the operation of individual mines and plants. This study is consists of an overview of the various solutions used in various mining companies to counteract the emerging epidemic emergency.

1.1. SARS-CoV-2 coronavirus, possible routes of infection, influence of environmental factors on its persistence, ways of spreading

SARS-CoV-2 virus (Severe acute respiratory syndrome coronavirus 2) is a coronavirus of animal origin, causing acute respiratory infectious disease in humans that can even lead to death, called COVID-19 (Coronavirus Disease 19) [9]. According to the World Health Organization, SARS-CoV-2 is mainly spread via respiratory droplets [10]. Infection can occur through direct or close contact with the virus carrier or indirectly through contact with an object or surface contaminated with the pathogen. When speaking, coughing or sneezing, the carrier of the virus (a person with COVID-19 disease or asymptomatic infection) produces respiratory secretions or saliva that carry the pathogen. Such molecules contain the virus, and through another person's mouth, nose or eyes lead to a viral infection [11, 12, 13]. According to the literature, coronaviruses can survive from 2 hours to 9 days on the surfaces of various materials, such as plastic, metal or glass. A synthesis of the results of the studies included in the papers [14, 15], containing detailed data on the survival of different types of coronaviruses depending on the type of surface, in relation to human coronaviruses being an equivalent to SARS-CoV-2 virus in the study, is presented in the publication [16] (Table 1).
Based, among other things, on the analyses carried out by Carraturo and co-workers, the following coronavirus life span is assumed for each type of surface: aluminum 2-8 hours, metal 5 days, wood 4 days, paper and glass 5 days, plastic 2-5 days.
Another team of researchers assessed the amount of virus retaining its infectious properties for different surface types. The experiment to determine the duration of virus persistence in the air spray was carried out for three hours from the moment of spraying. During the whole time it was conducted, the following environmental conditions were maintained: temperature 21-23°C and air humidity ≥ 40%.

Table 1. Survival of the two main SARS-CoV-2 virus surrogates (HCoV 229E and SARS-CoV) on different types of inanimate surfaces

Surface type	Strain	Temperature	Life span
Aluminium	hCoV 229E and OC43	21°C	2-8 hours
Metal	SARS-CoV P9	room	5 d
Wood	SARS-CoV P9	room	4 d
Paper	SARS-CoV GVU6109 and P9	room	3 hours - 5 d
Glass	SARS-CoV P9	room	2-5 d
Plastic	SARS-CoV FFM1, HKU39849 and P9	20-25°C	2-5 d
PVC	hCoV 229E	21°C	5 d
Silicone	hCoV 229E	21°C	5 d
Latex	hCoV 229E and OC43	21°C	≤ 8 h
Disposable apron	SARS-CoV GVU6109	room	1 hour - 2 d
Ceramics	hCoV 229E	21°C	5 d
Teflon	hCoV 229E	21°C	5 d

Source: [16].

The amount of the virus in the sample was expressed as TCID50. On the basis of the conducted tests, it was found that the SARS-CoV-2 coronavirus had the shortest life span on the copper (4 hours) and cardboard (24 hours) surfaces, while the longest was on plastic and stainless steel surfaces (up to 72 hours). As mentioned, the concentration of viruses in the aerosol was measured within three hours. A decrease in the concentration of infectious virus particles in the air was found - the virus half-life span of the analysed strains reached a similar value and was approximately 1.1-1.2 hours. It was noted, however, that at the end of the experiment, the value of TCID50 remained above the set detection threshold. The half-life span of SARS-CoV-2 on particular types of surfaces was: 6.8 hours for plastic, 5.6 hours for stainless steel, 3.8 hours for cardboard and about 1 hour for copper [17]. The results of the study on the influence of temperature on the coronavirus activity were presented, among others, in the paper [18]. Its authors evaluated in the laboratory tests the stability of SARS-CoV-2 on steel plates incubated at: room temperature and 4°C and 30°C, at constant ambient humidity of 30-40%. The activity of pathogens was evaluated in 4th, 8th i 24th hour of the test, in the 1st - 9th day of incubation. The research proved that while there was a significant decrease in the viral load within 1 hour after spraying at room temperature, its value remained stable within the next 4-8 hours of incubation. A minimum decrease in values was recorded for 30°C and for samples incubated at 4°C temperature a large discrepancy in results was observed in individual series of measurements. After eight hours of incubation, a stable, slow decrease of the viral load was

observed in all analysed temperatures during the following days of the experiment. However, the authors pointed out that it was possible to recover (reactivate) the amount of infectious SARS-CoV-2 even after 180-hour incubation on a metal surface. The humidity of the environment in relation to coronavirus molecules was considered in the study in two ways - in terms of the influence of environmental humidity on its life span and the influence on the size of respiratory droplets being the direct carrier of the pathogen. The paper [19, 20] presents the results of the research which shows that:
◎ very high humidity (99.5%) induces a hygroscopic increase in liquid droplets, while humidity of 40% causes water to evaporate, reducing droplet size,
◎ ambient humidity has a significant impact on the size of medium sized respiratory droplets (50-100 μm) - high humidity is conducive to slowing down the evaporation of the droplets, so that the droplets will settle on the substrate more quickly and evaporate more quickly in dry air, which will cause them to stay longer in the air spray.

2. The essence of the problem

The mining production process consists primarily of a selection of the applicable technology for mining the deposit while maintaining occupational safety. Concerning the management of a mining company and its individual mines, particularly vital are decisions involving [21]:

- ensuring high standards of occupational safety,
- implementation of modern technical and technological solutions for deposit mining,
- ensuring the required quality of commercial coal produced,
- protection of the mining area where the effects of the carried out mining and the natural environment may be visible.

Additionally, from an economic point of view, the mining production process should be efficient, or at least not generate financial losses. Such requirements for mining production are shown in Figure 1.

Figure 1. Features of standard for carrying out mining production process
Source: Own study based on [21].

In underground mining, the basis for decisions, especially those related to industrial safety and natural hazards, are the laws, regulations, guidelines and various rules and procedures developed. In many cases, those are established based on the past experience and are often supported by scientific research. These regulations are, or at least should be, well known to individual decision-makers. This allows for proper management of a mine and a mining company - proper, i.e. in a way that ensures the highest possible level of safety and avoids unjustified risks concerning mining production.

Hazards present in underground mining have been either technological or natural. The method of conducting works in the conditions of their occurrence and the scope of necessary anti-hazard measures have been developed over many years based on operational experience and scientific research conducted on a large scale. On the other hand, in the case of an epidemic emergency caused by the virus, we are only dealing with a wide range of ignorance concerning the decision-making process in relation to the operation of a mining plant.

As opposed to other hazards, in the case of an epidemic emergency caused by the SARS-CoV-2 there are no specific procedures that could be strictly followed in the operation of a mining company. For example, the Website of the Republic of Poland provides only five general guidelines [22]:

1. Regularly wash your hands with soap and water.
2. Cover your mouth and nose with your bent elbow or tissue when you cough.
3. Avoid touching your eyes, nose and mouth.
4. Stay at least 2 meters from other people.
5. Stay home.

This means that the primary mean of protection against becoming infected is to keep a distance from other people or even to avoid any contact at all. Implementation of such rules is absolutely not feasible in mines where the limited space of shaft hoist cages, underground means of transport and excavations, where a large number of people work, make it impossible to maintain two-meter space between people.

Various measures have been taken by various mining companies to counteract the epidemic emergency related to SARS-CoV-2 coronavirus. Today we can say that they brought good results - after the initial perturbations resulting from a large number of infections among employees, the situation has been managed and stabilised. With the continuous enforcement of the newly developed and implemented procedures, mining companies now operate without the major turmoil that might have been brought by the spreading pandemic. As they have fulfilled their role, they can be described as "good practices used to counteract the epidemic emergency". The research problem undertaken is an attempt to develop a set of such practices which could be recommended for use in conditions of epidemic emergency.

3. Research method adopted

In order to conduct research on the activities undertaken in mining companies and their effects, it was decided to use one of the qualitative research methods, which is a case study. As the name itself indicates, the primary purpose of this method is to illustrate and analyse the "selected case" in detail. The reasons for its use are most often atypical character of the case and a desire to learn about the analysed phenomenon in detail. As American scientist Wilbur Schramm, the pioneer of social communication research, stated: "*The essence of a case study (...) is to explain the decisions: why it was made, how it was made and what was the effect*". [23]. It indicates that in the case study the main focus is on the decisions made. This is the preferred method in situations where [24]:

- the main questions are "how?" or "why?",
- the researcher has little influence on behavioural factors,
- the study concerns a contemporary phenomenon.

With regard to the issues related to actions to combat the epidemic emergency caused by the previously unknown coronavirus, all the above conditions are undoubtedly met.

A research project using a case study should have [24]:

1. formulated question(s),
2. assumptions (if necessary),
3. analysis units,
4. logic of combining data with assumptions,
5. specific criteria for interpretation of results.

In this case, all the above requirements have been fulfilled. In order to obtain information on how to counteract the epidemic emergency, nine mining companies (seven from the hard coal mining industry and two from the metal ore mining industry) were sent a question about all undertakings - organisational, operational, informational - related to the preventive actions (ad. 1).

As mentioned, in mining companies, actions concerning combating the threats occurring so far are undertaken based on the applicable legal regulations. On the other hand, the study assumed (re. 2) that due to the lack of regulations imposing a specific course of action, independent solutions were introduced in each company.

The assumed unit of enquiry (re. 3), i.e. a specific case, was each separate company and solutions implemented in it.

Surveyed companies sent back various answers consisting of descriptions, drawings, diagrams and tables concerning the scope of undertaken actions. Some solutions were used in all of the companies, other in individual cases. For the sake of comparability, all of the solutions have been summed up together, regardless of frequency of their implementation. The only condition for inclusion in the list was usefulness in combating the threat (re. 4).

The list of solutions used in various mining companies was analysed in terms of the frequency of their implementation and the results (effects) obtained. Next, on this basis, a set of the so-called good practices, recommended to use in the area concerned, was developed (re. 5).

At the first stage of the case study, an assumption (theory) was made, which should be proved by the result of the study (a negative result was also considered). The assumption was as follows:

So far, no methods of combating the epidemic threat in underground mines caused by an unknown virus have been formulated clearly. However, if various actions were taken in different mining plans and were successful in all such plants, it is possible to prepare a list of standardised recommendations to be used in practice in the future.

Figure 2 shows the procedure and assumptions adopted in the conducted study.

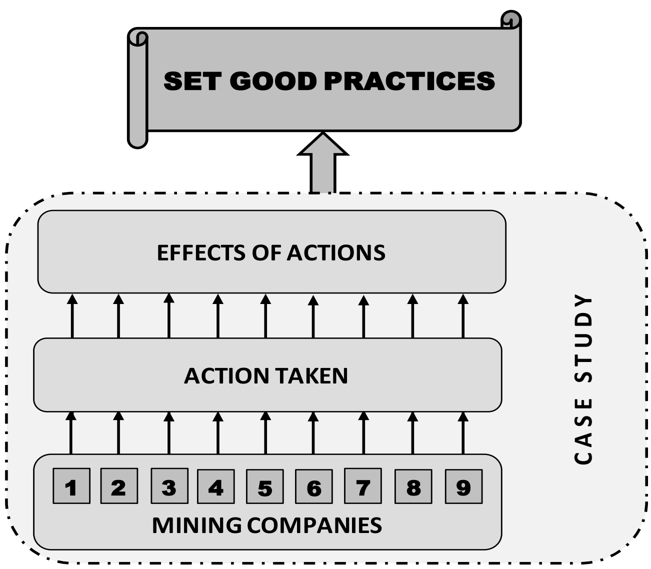

Figure 2. Object and expected result of the case study
Source: Author's own elaboration

4. Result

The first step consisted of asking managements of the nine mining companies to draw up a brief description of all action taken to combat the epidemic threat that has been spreading since March and to assess the effects of their implementation. From descriptions received, 33 various, specific projects were isolated and tabulated. Assuming that in some cases the descriptions focused only on the vital counteractions concerning a given company, the compiled summary table was sent to all companies, asking them to analyse the list and mark all the actions that were taken in individual companies. In addition, acknowledging that some of them may not have been included in the submitted descriptions, companies were asked to add others, not included in the table in order to include all the implemented project.
As a result, the total number of actions amounted to 40. They are presented in Table 2. Before analysing the list, one should note that the descriptions showed that in all companies the first actions were taken even before the official announcement of epidemic threat (14 March). Most frequently, those actions included the obligation to use any available protective masks, introducing an option to (or obligation to) measure the temperature of all people entering the premises and making urgent purchases of disinfectants and protective masks and gloves (in order to speed up their acquisition, purchase procedures were significantly simplified in all companies). This clearly shows that there is an awareness of the need to counteract a widespread and unknown threat as soon as possible.
Seventeen of all 40 actions were introduced in all mining companies. The majority of the actions concerned the possibility of maintaining the so-called social distance by:

- limiting all company-wide meetings to a minimum, including business-related meetings with customers/applicants, while maintaining special care when dealing with coworkers,
- implementing changes to the schedule and working hours of underground workers in order to divide them into smaller groups, which led to smaller concentrations of people in places where they had gathered in larger groups, with such places being mainly pitbottoms, pitheads, means of vertical and horizontal transport, baths,
- introducing remote work for workstations that can be operated remotely.

Other actions were related to:

- taking continuous actions related to providing information about the threat with the use of all available means,
- measuring the temperature of all people entering the workplace and in means of public transport for workers,
- making it mandatory to wear and use protective masks in the workplace,
- disinfecting rooms, equipment, devices, and workstations on a regular basis, including the provision of wide access to disinfectants for workers.

In addition, special rooms for people suspected of contracting the virus and showing symptoms at work were established in all mining companies.

Another common action was establishing crisis management teams (for the entire company and individual mines) that coordinated the implementation of anti-threat procedures and monitored the effects of their implementation. Other actions listed in Table 2 were taken depending on the epidemic situation in a company. This particularly concerns conducting screening tests among workers and temporarily suspending or limiting works.

Table 2. List of actions taken in mining companies to combat the epidemic threat

No	Actions taken	LW Bogdanka SA	PGG SA	Węglokoks Kraj Sp. z o.o.	TAURON Wydobycie SA	JSW SA	SRK SA	ZG Bolesław SA	KGHM Polska Miedź SA	PG Silesia
1.	Before 14 March – making a decision to wear dust masks available in the mine obligatorily.	◆	◆	◆	◆	◆	◆	◆	◆	◆
2.	Before 14 March – introducing the possibility of measuring the body temperature of people entering the workplace.	◆	◆		◆	◆	◆		◆	
3.	Establishing a crisis management team – ongoing monitoring of the situation, developing appropriate recommendations and guidelines if necessary.	◆	◆	◆	◆	◆	◆	◆	◆	◆
4.	Specifying the so-called critical areas in which workers may contract the virus the fastest due to large concentrations of people.	◆	◆	◆	◆	◆	◆	◆	◆	◆
5.	Introducing mandatory quarantine for people who **may have had** contact with the virus.	◆	◆	◆	◆	◆	◆	◆	◆	◆

6.	Obliging workers to provide information when they, their household members, or people with whom they have close contact return from abroad where there were COVID-19 cases.	◆	◆	◆	◆	◆	◆	◆	◆	◆
7.	Suspending all business trips and trips/events organised by the Social Department.	◆		◆	◆	◆	◆	◆	◆	◆
8.	Suspending the distribution of tickets for sporting and cultural events by the Social Department.	◆	◆	◆	◆	◆		◆	◆	◆
9.	Limiting all company-wide meetings to a minimum, including business-related meetings with customers/applicants.	◆	◆	◆	◆	◆	◆	◆	◆	◆
10.	Recommending that special care must be taken during contact with colleagues, limiting direct contact (e.g. handshakes), and paying special attention to hand hygiene.	◆	◆	◆	◆	◆	◆	◆	◆	◆

11.	Organising information and training sessions with a representative of the sanitary and epidemiological station.	◆		◆			◆			◆
12.	Taking continuous actions related to providing information about the threat with the use of all available means – OHS training boards, radio system, the Internet, posters, leaflets.	◆	◆	◆	◆	◆	◆	◆	◆	◆
13.	Providing workers with cotton masks for compulsory use when moving around passageways.	◆	◆	◆	◆	◆	◆	◆	◆	◆
14.	Modifying the terms and conditions of cooperation with external companies.	◆	◆	◆	◆	◆	◆	◆	◆	◆
15.	Implementing simplified procedures for purchasing dust masks, surgical masks, protective gloves, and disinfectants.	◆	◆	◆	◆	◆	◆	◆	◆	◆
16.	Measuring the temperature of all people entering the workplace and in	◆	◆	◆		◆	◆	◆	◆	◆

	means of public transport for workers with the use of remote thermometers and thermal cameras.									
17.	Implementing changes to the working hours of underground workers in order to divide them into smaller groups.	◆	◆	◆	◆	◆	◆	◆	◆	◆
18.	Thinning groups of workers in lamp rooms, pitbottoms, and pitheads, in work division areas etc. by implementing one-way traffic, changing work schedules, specifying areas to wait in queues – keeping a safe distance.	◆	◆	◆	◆	◆	◆	◆	◆	◆
19.	Thinning groups of workers in cages of mining lifts by reducing the number of transported workers.	◆	◆	◆	◆	◆	◆	◆	◆	
20.	Installing additional protections in the form of a system of special partitions and provisional tunnels as well as making it mandatory to wear	◆		◆		◆	◆		◆	◆

	a mask while being transported.									
21.	Making it mandatory to wear and use (cotton, surgical, dust) masks in the workplace and recommending that they are worn when commuting to and from the workplace as specified in general regulations.	◆	◆	◆	◆	◆	◆	◆	◆	◆
22.	Disinfecting equipment, devices, and workstations on a regular basis – unlimited access to disinfectants for every worker; disinfecting shaft cages and underground cars after every use by people; disinfecting handrails, handles etc. on a regular basis.	◆	◆	◆	◆	◆	◆	◆	◆	◆
23.	Installing additional underground hand washing stations.	◆	◆							
24.	Implementing a ban on taking snuff, eating seeds etc., which generate an additional risk of spreading	◆	◆	◆		◆	◆			◆

	the virus by droplet transmission.									
25.	Shutting down touch-controlled equipment/devices if not necessary for mine operation (kiosks, vending machines).	◆		◆	◆	◆			◆	
26.	Reorganising the canteen – only takeaway meals.	◆	—	◆	◆		—		◆	
27.	Introducing remote work for workstations that can be operated remotely.	◆	◆	◆	◆	◆	◆	◆	◆	◆
28.	Providing special rooms for people who have shown symptoms during work and waiting for the decision of the State Sanitary Inspection on a further course of action.	◆	◆	◆	◆	◆	◆	◆	◆	◆
29.	Conducting screening tests among workers.		◆	◆		◆			◆	◆
30.	Launching a 24/7 psychological support service for employees.		◆	◆	◆	◆			◆	
31.	Suspending or limiting heading works.		◆	◆	◆		—			◆
32.	Suspending or limiting excavation.		◆	◆	◆		—			◆

33.	Installing decontamination chambers.			◆		◆				
34.	Revising the occupational hazard evaluation at workstations					◆	◆			
35.	Suspending the bonus for no absences due to sickness.	◆	—	—	—	—	—	—	◆	—
36.	Preparing and implementing Business Continuity Plans (BCPs).					◆				
37.	Implementing periodic OHS training in the form of e-learning.	◆								
38.	Suspending the obligation to conduct periodic check-ups of workers as specified in Article 12a of the Act of 31 March 2020.	◆								
39.	Introducing quarantine for incoming mail. Reorganising its reception so that direct contact between a mail department employee and external persons is limited.						◆			
40.	Implementing the possibility of conducting fast tests (at the cost of the company) for						◆			

	workers who may have had contact with people who contracted the vi-rus.									

Table 1. List of actions taken in mining companies to combat the epidemic threat
Source: Author's own elaboration

Figure 3 shows a diagram of classifying actions into groups concerning particular action areas in the studied companies.

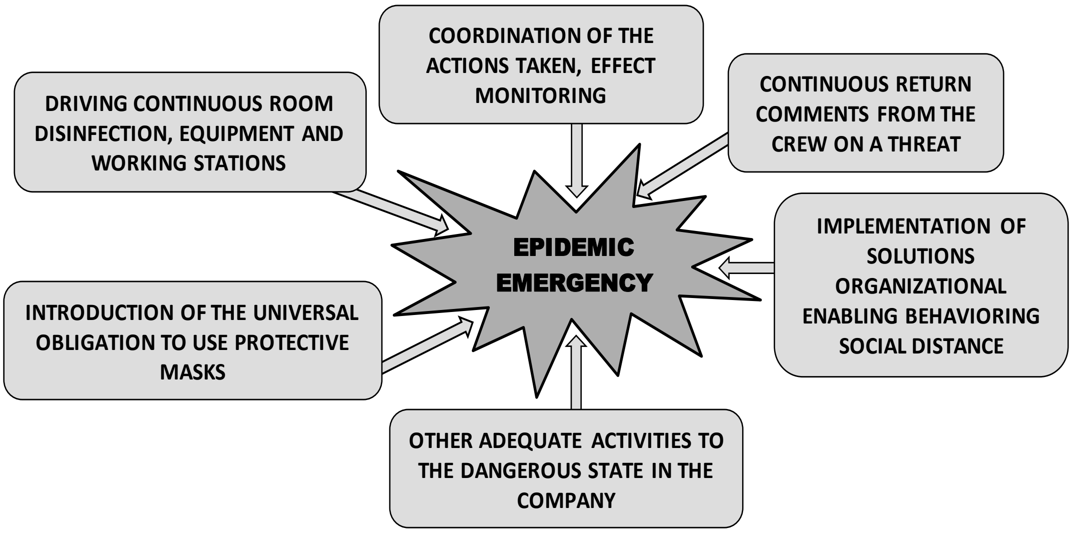

Fig. 3. Actions taken to combat the epidemic threat in mines
Source: Author's own elaboration

In all descriptions of actions prepared before, it was emphasised that the implemented anti-threat procedures had a positive effect and despite initial considerable disruptions in the operation of individual mines, they helped to control crisis situations. In many cases, actions were taken "by intuition" in a manner that would, to the largest extent possible, satisfy the recommendations of epidemiological services for the society as a whole and manufacturing companies operating in sectors other than the mining industry. Their effectiveness makes it possible to formulate a thesis that in the absence of means that would combat the ongoing pandemic effectively, the six groups of various actions shown in Figure 3 may be considered a list of good practices used to fight the epidemic threat affecting the operation of companies. However, it is also important for the new procedures to be reflected in documents prepared in mines and plants belonging to the mining company. In particular, this applies to the "*Safety Document*" prepared according to the template included in the appendix to the Regulation of the Minister of Energy of 23 November 2016 [25]. This document should mainly include the descriptions of:

- threats in a mining plant, how to identify and monitor them, and how to protect against them,
- how to evaluate and document risks in workplaces and workstations,
- how to inform workers of risks and prevent threats,
- provision of workplaces with collective protection measures and of employees with personal protective equipment as well as safety signs in use.

All of these points should include appropriate provisions on the epidemic threat and the established countermeasures. In addition, if the implemented procedures are in any way related to the applicable regulations or workstation instructions, these documents should also be modified accordingly.

5. Discussion

According to numerous studies conducted all over the world on the fight against the threats posed by SARS-CoV-2, there is no chance of its natural extinction. Until an effective vaccine is developed, there will be no other way to slow down the spread of the pandemic than to limit contact between individuals. Therefore, the management of mining companies must adopt such an assumption when making decisions related to their operation.

First of all, it is necessary to take all measures to reduce the number of people in underground excavations. One of them includes a change to the organisation of work, which is commonly introduced and mainly involves an increase in the number of shifts combined with varying work starting hours. Still, in-depth technical and economical analyses may also be conducted in every mine concerning the possibility of:

1. limiting the number of people working at the face of a mine,
2. limiting the number of faces in terms of works related to driving both headings and excavations,
3. shutting down certain excavations and basic facilities (e.g. shafts and foreshafts).

The principles and technologies for carrying out certain works often, among others, provide for employing the minimum number of people necessary for their safe operation. Therefore, the procedure aiming at the reduction of the number of people working at faces of a mine cannot involve reducing this number below the required minimum. However, in many cases, it is possible to apply modern technical solutions that allow for the number of workers to be reduced significantly. They include, for example:

- the use of electro-hydraulic controllers for sections of powered roof supports carried out by only one operator located at the main gate,
- the use of full visualisation and automation for controlling conveyors that transport the output,
- the use of a container system for transporting materials - containers loaded on the surface can be transported directly to the face of a mine without the need of reloading them on main transport roads.

It is also very important to wear personal protective equipment such as gloves and masks as well as to disinfect rooms with such equipment, workstations, and tools on a regular basis.

If there are other ways to prevent the epidemic threat in a given mining company and/or its mines, it is, of course, always necessary to use them. However, it is important for all activities to be taken in a coordinated manner, which should ensure their increased effectiveness.

There is one more observation based on the analysis of actions taken to combat the threat. Compared to other companies, the situation at LW Bogdanka SA is particularly interesting because it did not have a single case of COVID-19 for a long time. It seems that this is due to two main reasons. The first reason is the location of the mine – the Lubelskie Voivodeship – which has a considerably smaller population (approx. 2.1 million) compared to the Śląskie Voivodeship (approx. 4.5 million). In addition, the number of infections in this voivodeship was considerably lower, which was less than 4,200 as at the end of the first decade of October, with this number being almost 25,200 in the Śląskie Voivodeship. This is an advantage of some sort, fully utilised by the management of the mining company because the other reason is that actions were taken the earliest in this mine, while their scope was the most extensive and detailed.

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References

1. Regulation of the Minister of Health of 13 March 2020 on declaring the state of epidemic emergency in the Republic of Poland, Dz. U. /Journal of Laws/ of 2020, item 433.
2. Regulation of the Minister of Health of 20 March 2020 on declaring the state of the epidemic in the Republic of Poland, Dz. U. /Journal of Laws/ of 2020, item 491.
3. Regulation of the Minister of Health of 24 March 2020 amending the regulation on declaring the state of the epidemic in the Republic of Poland, Dz. U. /Journal of Laws/ of 2020, item 522.
4. Dar, M.A.; Gladysz, B.;Buczacki, A. *Impact of COVID19 on Operational Activities of Manufacturing Organizations — A Case Study and Industry 4.0*-BasedSurvive-Stabilise-Sustainability (3S) Framework. Energies 2021,14, 1900.https://doi.org/10.3390/en14071900.
5. Rapaccini, M.; Saccani, N.; Kowalkowski, C.; Paiola, M.; Adrodegari, F. Navigating Disruptive Crises through Service-LedGrowth: The Impact of COVID-19 on Italian Manufacturing Firms.Ind. Mark. Manag.2020.
6. Liu, F.; Wang, M.; Zheng, M. Effects of COVID-19 Lockdown on Global Air Quality and Health.Sci. Total Environ.2021,755,142533.
7. Ino, E.; Watanabe, K. The Impact of COVID-19 on the Global Supply Chain: A Discussion on Decentralization of the Supply-Chain and Ensuring Interoperability.J. Disaster Res.2021,16.
8. Hauser, P.; Schönheit, D.; Scharf, H.; Anke, C.-P.; Möst, D. Covid-19's Impact on European Power Sectors: An EconometricAnalysis.Energies2021,14, 1639.
9. Wang Q., Zhang Y., Wu L., Zhou H., Yan J., Qi J., 2020, Structural and Functional basis of SARS-CoV-2 Entry by Using Human ACE3. Cell, vol. 181. DOI: 10.1016/j.cell.2020.03.045.
10. WHO 2020, Transmission of SARS-CoV-2: implications for infection prevention precautions. Scientific Brief https://www.who.int/news-room/commentaries/detail/transmissionof-sars-cov-2-implications-for-infection-prevention-precautions.
11. Chan J.F.-W., Yuan S., Kok K.-H., To K.K.-W., Chu H., Yang J., 2020, A familial cluster of pneumonia associated with the 2019 novel coronavirus indicating person-to-person transmission: a study of a family cluster. Lancet, vol. 395.
12. Liu J., Liao X., Qian S., Yuan J., Wang F., Liu Y., 2020, Community Transmission of Severe Acute Respiratory Syndrome Coronavirus 2, Shenzhen, China. Emerging Infectious Diseases Journal, vol. 26.
13. WHO 2020 Modes of transmission of virus causing COVID-19: implications for IPC precaution recommendations. Scientific brief, 29 March 2020. https://www.who.int/newsroom/commentaries/detail/modes-of-transmission-of-virus-causing-covid-19-implicationsfor-ipc-precaution-recommendations; retrieved: 16 July 2020.
14. Kampf. G., 2020, Potential role of inanimate surfaces for the spread of coronaviruses and their inactivation with disinfectant agents. Infection Prevention in Practice, vol. 2(2). DOI: 10.1016/j.infpip.2020.100044.
15. Kampf G., Todt S., Pfaender E., Steinmann P., 2020, Persistence of coronaviruses on inanimate surfaces and their inactivation with biocidal agents. Journal of Hospital Infection, vol. 104(3). DOI: 10.1016/j.jhin.2020.01.022.
16. Carraturo F., Del Giudice C., Morelli M., Cerullo V., Libralato G., Galdiero E., Guida M., 2020, Persistence of SARS-CoV-2 in the environment and COVID-19 transmission risk from environmental matrices and surfaces. Environmental Pollutants. DOI: 10.1016/j.envpol.2020.115010.
17. Van Doremalen N., Bushmaker T., Morris D.H., Holbrook M., Gamble A., Wiliamson B.N., Tamin A., Harcout J., Thornburg N.J., Gerber S.I., Lloyd-Smith J., de Wit E., Minster V.J., 2020, Aerosol and surface stability of SARS-CoV-2 as compared with SARS-CoV-1. New England Journal of Medicine, vol. 328(16). DOI: 10.1056/NEJMc2004973.
18. Kratzel A., Steiner S., 2020, *Temperature-dependent surface stability of SARS-CoV-2*. Journal of Infection, vol. 81. DOI: 10.1016/j.jinf.2020.05.074.
19. Feng Y., Marchal T., Sperry T., Yi H., 2020, Influence of wind and relative humidity on the social distancing effectiveness to prevent COVID-19 airborne transmission: a numerical study. Journal of Aerosol Science, vol. 147, 105585. DOI: 10.1016/j.jaerosci.2020.105585.
20. Buxton G., 2020, Spreadsheet Model of COVID-19 transmission: Evaporation and Dispersion of Respiratory Droplet. SSRN Electronic Journal, DOI:10.2139/ssrn.3582665.
21. Dubiński J., Turek M., Prusek S., 2017, Key tasks of science in improving effectiveness of hard coal production in Poland. Archives of Mining Sciences, No. 62., iss. 3.
22. https://www.gov.pl/web/coronawirus
23. Schramm W., 1971, *Notes on case studies of instructional media projects*. Working paper for the Stanford University, Californian Institute for Communication, California, USA.
24. Yin R.K., 2015, A case study in scientific research. Design and methods. Publishing House of the Jagiellonian University, Krakow.
25. Regulation of the Minister of Energy of 23 November 2016 on detailed requirements for operation of underground mining plants (Dz.U. /Journal of Laws/, of 2017, item 1118).