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# Impact of the COVID-19 crisis on the mining sector in Croatia

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**Abstract**

Mining as a human activity shares the fate of humanity in all global situations that affect the planet. These are, to a lesser extent, positive effects such as the opening of the world market, the industrial revolution, etc., and, to a greater extent, negative effects such as various conflicts or pandemics that have a global character. The COVID-19 pandemic has had an unprecedented impact on all sectors of human society, justifying a scientific interest in assessing its impact at global and local levels. Recently, the World Health Organization declared the end of the pandemic, after which the Croatian government did the same. This also marks the end of the research period for the preparation of this paper. The paper is about the study of the impact of the pandemic on the Croatian mining sector in Croatia. In addition to statistical data on production and the number of employees in the mining sector, the results of a survey of economic entities and conclusions about the management of companies in crisis situations were processed.

**Keywords:**

crisis management; production; positive experiences, Croatian economy, mining companies

## 1. Introduction

The COVID-19 pandemic outbreak and quarantines around the world have affected humanity on an unprecedented scale, but they have also had a tremendous negative impact on the global economy. The official start of the COVID-19 world pandemic was on January 30th, 2020, when the WHO urgently declared the outbreak of the new coronavirus a public health problem of international concern (Cucinotta and Vanelli, 2020). In 2020, many countries adopted lockdown measures, and closed their borders to contain COVID-19. However, these measures disrupted global production and supply chains; no industry remained fully intact (Giese, 2022).

Following the spread of the coronavirus in Europe, the European Union upgraded the risk of an epidemic from moderate to high on March 2nd, 2020. On March 4th, 2020, the Ministry of Health (**URL1, 2020**) issued the decision on the declaration of the risk of epidemic of the infectious disease COVID-19 for the entire territory of the Republic of Croatia, and on March 11th, 2020, the decision on the declaration of the epidemic of the disease COVID-19.

To limit the spread of the virus, the Government of the Republic of Croatia imposed a lockdown on March 16th, 2020, affecting all sectors and industries of the Croatian economy. In order to mitigate the negative consequences of the epidemic COVID-19, immediately after the imposition of the restrictive measures, the government presented aid measures to support the economy (**Sataic, 2021**). It is also worth mentioning the paper (**Kunji and Stojanović, 2021**), which does not mention mining specifically, but gives an overview of the economic measures which were undertaken by the Government of the Republic of Croatia to mitigate the negative economic consequences of the COVID-19 pandemic for the Croatian economy.

As early as July 2020, after the first wave of the pandemic had passed, a more detailed analysis (**Jovitt, 2020**) of how the COVID-19 pandemic affected mining worldwide was published. The analysis included studies of mining activity, prices, demand, and the supply of metal. Even then, it was pointed out that most governments believed that the impact of the pandemic on the mining industry and metal production had been minimal thus far. However, rising metal inventories and falling metal prices suggest that the COVID-19 crisis would have a negative impact on the mining industry, at least in the short term. These predictions were confirmed in studies by other researchers who published their papers later. At the same time, publications on the impact of COVID-19 on the Polish mining sector (**Krzysztofik et al., 2020; Stala-Szlugajet and Grudzińsk, 2021**) highlighted the main problem, namely the negative impact

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on the coal mining sector, as the Polish coal market reacted strongly to the COVID-19 pandemic. This sector is considered by the Polish government as one of the most important from the economic and political point of view.

Galas and others (**Gałaš et al., 2021**) conducted research in Austria, Poland, Serbia, and Sweden and concluded that the greatest influence of COVID-19 was observed in feasibility study projects and in new mine development projects. The medium influence was confirmed in the exploration and discovery phases. The authors also conclude that the impact on ongoing mining production is smaller and the impact in this case is short-term. The interruption of exploration and development of new mines, on the other hand, will have long-term impacts, including an increased likelihood of disruptions to future raw material supplies.

Research by Turkish scientists (**Kekeç et al., 2022**) shows that the main impact of the COVID-19 pandemic on the global mining industry has been a drastic drop in demand and production, which has led to a drop in the prices of various commodities such as aluminum, copper, zinc, nickel, iron ore, and coal. Starting in mid-2020, prices of most minerals and metals slowly began to return to pre-pandemic levels. The price of gold, on the other hand, increased significantly during the pandemic. The Turkish mining industry was somewhat affected by the COVID-19 crisis. Natural stone production declined slightly in 2020, but recovered quickly, and natural stone production increased again in 2021. The researchers emphasized (**Kekeç et al., 2022**) the need to plan and implement effective measures to contain the spread of COVID-19 in mining. These measures include the use of posters with safety information at assembly sites, vaccination, health screening, hand disinfection, and other hygienic measures to control the pandemic. They also recommended holding online meetings and training sessions, as well as organizing shift work.

According to the research conducted (**Mitev and Galabova, 2022**) on the Bulgarian mining industry in 2020, it can be concluded that the prospects of mining companies for 2020 are favorable, despite the weak growth in production, due to the rapid increase in prices. Such a trend is also predicted for the coming years, as the consumption of products for the chemical and food industries in Europe is increasing.

A recent paper by Chinese researchers (**Wang et al., 2023**) shows that the pandemic significantly disrupted global metal mining and related supply chains and caused cascading impacts on the economy, climate change, and human health. The pandemic caused the global metal mining industry to decline by 10-20% in 2020. This decline subsequently led to losses in global economic output of about $117 billion. However, the researchers also point to positive impacts in the form of a reduction in $CO_2$ emissions of about 33 million metric tons and estimate that this reduces harm to human health by 78,192 life-years. Such impacts are mainly associated with copper and iron mining, and China and American countries are the most affected. The Chinese researchers emphasize that in order to plan for sustainable mining in the future, it is necessary to analyze both the negative and positive impacts of the COVID-19 pandemic.

Due to the COVID-19 pandemic, national governments took measures to cope with the pandemic that affected not only the economy but also fundamental rights and democracy (**Grogan, 2022**), and also to reduce pollution (**Mandal and Pal, 2020**). The strength of government action changed with pandemic waves, years, and varied from country to country. The Oxford COVID-19 Government Response Tracker (**Hale, 2021**) is the database that collected the most data on pandemic policy. Some researchers (**Boin and Rhinard, 2023**) assess the success of the EU in managing the pandemic crisis as not very bad, as the Union acted quickly after a somewhat slow start and was very effective in mobilizing various resources. At the same time, key policy decisions were made without much public discussion. Initially, all member states responded independently, leading to enormous efforts at the supranational level. Similarly, crisis management began during the pandemic in Croatia. Early research (**Mikac, 2020**) revealed numerous open contradictions, controversies, and paradoxes resulting from the lack of a crisis management system in which the responsibilities and powers of all actors, from government to citizens, were clearly defined.

In general, it can be stated that the reviewed literature contains information on how the COVID-19 pandemic affected the mining sector around the world, as well as the impact in neighboring countries. To date, there is not a single scientific paper in Croatia that specifically addresses this issue from the perspective of scientific research, and in general, there are few published studies that mention the mining sector in the context of the COVID-19 pandemic in just a few sentences (**Rogić Dumančić et al., 2020; Bašić, 2021; Lovrinčević et al., 2021; URL2, 2021**).

After the end of COVID-19 pandemic was declared, the consequences for the mining industry can be realistically assessed based on the analysis of the past years. The aim of this paper is to examine the impact of the COVID-19 crisis on the Croatian mining sector. Finally, indications of the economic impact of this type of crisis are given, focusing on the positive effects. This is the best way to prepare for crisis situations that may occur in the future.

## 2. Research methodology

The research methodology is adapted to the structure of the mining sector in Croatia. In the past, many mineral resources were mined on Croatian territory (**Briševac et al., 2021**), but currently the Croatian mining sector is oriented towards the production of con-

struction materials, which causes a close connection between these two professions and the transfer of challenges from one to the other. In the Republic of Croatia today (**URL3, 2023**), solid energy raw materials of coal and metal ores are no longer exploited, except for bauxite in negligible quantities of several thousand tons, through shallow surface excavations. Mainly non-metallic mineral raw materials are exploited by surface mining. Underground exploitation of architectural-building stone is carried out only in the exploitation field Kanfanar. A total of 14 types of mineral raw materials are exploited in the Republic of Croatia: architectural-building stone (block and slab), technical-building stone, carbonate raw material for industrial processing, silicate raw material for industrial processing, raw material to produce cement, gypsum, bauxite, brick, ceramic and refractory clay, building and flint sand, sea salt and tuff.

There are 805 exploitation fields of mineral raw materials in the register of exploitation fields maintained by the Croatian Ministry of Economy (see **Figure 1**). On 335 fields, exploitation has been completed and the execution of mining works has been permanently suspended so fields are deleted, 141 fields have the status of inactive, and 329 fields are active (**URL4, 2023**).

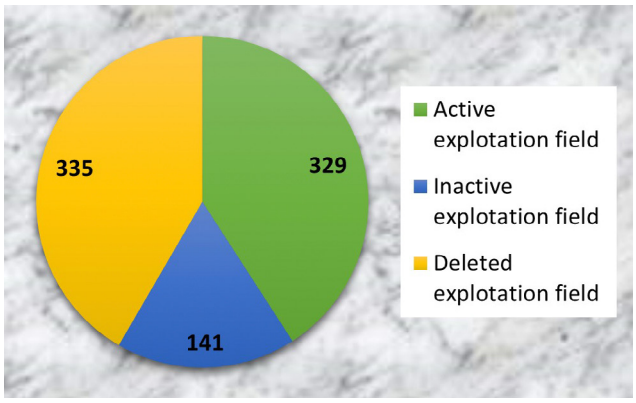


**Figure 1:** Exploitation field in Republic of Croatia (**URL4, 2023**).

The Ministry of Economy and Sustainable Development took over and entered in its Registers of exploitation fields of mineral raw materials 259 exploitation fields of technical-building stone, 84 exploitation fields of construction sand and gravel and 32 exploitation fields of brick clay, i.e. a total of 375 exploitation fields of mineral raw materials for the production of building materials (**URL4, 2023**).

For this research, it was important to determine how many economic entities (companies) are actively engaged in mining. According to the Croatian Bureau of Statistics (**URL5, 2022**), as of March 31st, 2022, there were 189 active legal entities engaged in mining and extraction. However, 38 of them do not have employees, so it was impossible to do research there, so in fact the relevant number is 151 companies.

The aim of the survey was to determine how the management and effects of the pandemic on companies whose activities are based in or closely related to the mining industry in Croatia. In developing the research methodology, the authors were aware of the limitations that exist in this type of research. The logical choice was to conduct a survey in companies, even though there is a kind of inflation of all types of surveys and consequently an insufficient willingness to participate (**Oosterveld et al., 2019**). To avoid this, it was decided to conduct a survey using non-probability sampling (**Vehovar et al., 2016; Adeoye, 2023**) because in this process, sample participants are purposively selected based on knowledge and understanding of the relevant research topic. It is a quick and relatively easy method to obtain results, and it allows researchers to achieve a lower margin of error by using a purposive sampling approach because the collected information comes directly from the source. Based on this methodology, the researchers developed a questionnaire with a smaller number of concise questions, which are essential for determining the behavior of companies in times of crisis.

The authors wanted to collect relevant responses from professionals who deal with business management on a daily basis and objectively do not have time for additional tasks such as filling out a questionnaire. It was necessary to invest a lot of effort and time in data collection. However, most of the problems related to the questionnaire can be best solved if the questions are formulated from the respondent's point of view. In formulating the questions, care was taken to ensure that they were unambiguous and clear.

Therefore, the questionnaire contained 25 questions (see **Appendix A**), most of which were of the "closed" type, offering answers in several categories to choose from. Two questions were open-ended, allowing respondents to formulate their own answers to the questions: What general crisis experiences have they had for the future and what other obstacles do they face that are not covered in the questionnaire. Five questions were related to the specific activity of the company, the length of its existence, the number of employees and the number of mining engineers employed.

It is important to emphasize that the authors have divided the period of the pandemic into three research periods (see **Figure 2**). The first two are foundational, and the third is a control period that examined how much positive experience in crisis management was retained in mining companies.

Companies indicated whether they had any interruption in production and whether they had used state subsidies as part of the crisis management measures in the Republic of Croatia (**Kunji and Stojanović, 2021**). The decrease in demand was expressed as a percentage. They could also choose one of the following answers to the question about the biggest obstacle: Disruption of the movement of goods and people, inability of the authori-

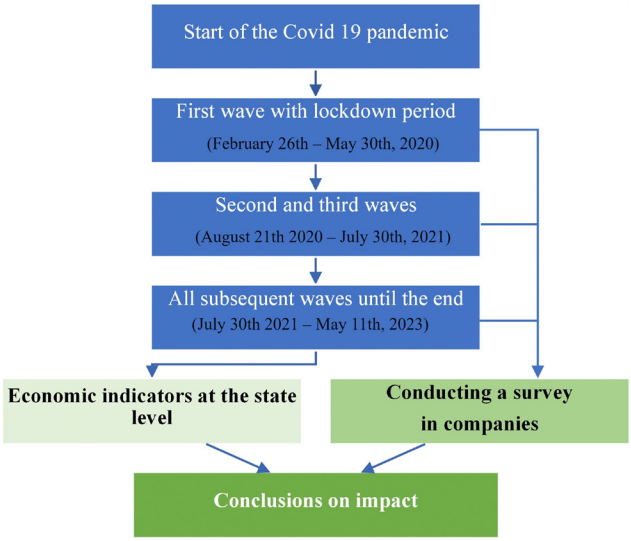


**Figure 2:** A brief overview of the research process

ties, increase in bureaucracy, and preventive COVID-19 measures.

Since Croatia was hit by two big earthquakes during the pandemic, in Zagreb on March 22nd, 2020 (**Dasović et al., 2020**) and Petrinja on December 29th, 2020 (**Dasović et al., 2021**), the questionnaire also included two questions whether these natural disasters had an effect of interrupting production or increasing production.

After the creation of the questionnaire, a web form was created and sent to the companies concerned, but the response to the surveys was very low. For this reason, the survey was launched through personal contacts, telephone, and online conversations, which managed to interview enough experts in the field of mining management. Although this meant more work for the researcher, it has positive effects because you can be sure that the questions are answered by real persons from the mining sector, and you also get additional information about the state of the Croatian mining sector during the interviews.

Due to the practicality and dynamics of the pandemic, but more importantly due to the way the Government of the Republic of Croatia took restrictive measures to deal with the pandemic, the research periods were set. According to the Oxford COVID-19 Government Response Tracker (**Hale, 2021**), Croatian authorities implemented the most restrictive measures in the first wave, while measures in the other waves were among the least restrictive. The authors of this study conducted the surveys in three waves. In this subdivision, each wave of the pandemic was not considered strictly separately, but they were combined in terms of the severity of the measures implemented. The first studied period is the first wave of the pandemic in Croatia, which lasted from February 26th to May 30th, 2020. During this period, a lockdown, and a restriction on movement between municipalities were imposed, and educational institutions and all types of activities were conducted from home. The second studied period included the second and third waves of the pandemic from August 21st, 2020, to July 11th, 2021, during which there were no stricter movement prohibitions, although the pandemic peaked in that period, and the authors believe that that period should be analyzed separately. Several more waves followed in the third research period, but they had no significant impact on the work of the mining sector, as no further restrictive measures were introduced.

Following the survey, the results were evaluated and compared with the economic indicators (quantity of exploited mineral raw material, number of employees and financial results) for the period of the pandemic, everything was analysed and conclusions were drawn about the impact of the crisis on the mining sector in Croatia.

## 3. Results

The results are divided in two parts according to the research process shown in **Figure 2**. In this way, the results are presented more clearly at the state level and at the company survey level.

### *3.1. Economic indicator on the State level*

Economic indicators were collected from three relevant sources. Data about exploitation were collected from the Ministry of Economy and Sustainable Development, data about the number of employees from the Croatian Bureau of Statistics and data about the financial results of mining companies from FINA reports.

**Table 1** and **Table 2** show the quantity of exploited mineral raw material for the period from 2019 to 2022. The data is written separately because the quantities for individual raw materials are shown in cubic meters, and some in 1000 tons.

Data from the Croatian Bureau of Statistics clearly show that the number of employees in mining and exploitation was reduced in the period 2020 to 2022 (see **Figure 3**). It is important to note that the number of employees at the end of 2022 was higher than the number

**Table 1:** Quantity of exploited mineral raw material for the period 2019 to 2022 in 1000 m³ (**URL6, 2023**)

| Year | Dimension stone | Brick clay | Construction gravel and sand | Construction stone |
|---|---|---|---|---|
| 2019 | 83.03 | 361.96 | 2974.09 | 9978.63 |
| 2020 | 77.33 | 459.43 | 3182.42 | 10480.69 |
| 2021 | 85.60 | 413.81 | 3663.69 | 11414.72 |
| 2022 | 82.36 | 576.70 | 3295.89 | 11318.00 |

**Table 2:** Quantity of exploited mineral raw material for the period 2019 to 2022 in 1000 t (**URL6, 2023**)

| Year | Gypsum | Carbonate for industrial processing | Construction gravel and sand | Flint sand | Raw material for cement production | Tuff | Sea salt |
|---|---|---|---|---|---|---|---|
| 2019 | 199.25 | 792.28 | 2974.09 | 28.97 | 3440.41 | 21.98 | 93.87 |
| 2020 | 221.63 | 1233.67 | 3182.42 | 50.81 | 3507.81 | 13.58 | 111.90 |
| 2021 | 285.97 | 992.10 | 3663.69 | 39.57 | 3540.87 | 19.18 | 111.32 |
| 2022 | 278.58 | 1077.79 | 3295.89 | 0.00 | 3007.04 | 31.55 | 102.67 |

of employees in the sector at the end of 2021. The highest number of employees was recorded in the last quarter of 2019, between 4137 and 4146 employees. Despite the decrease in the number of employees in the mining sector in 2020, the concessions collected from the exploitation of mineral resources increased from €4.784.675 in 2019 to €4.996.489 in 2020 (**URL7**). Data for years 2021 and 2022 are not yet publicly available. **Table 1** shows the business results of entrepreneurs in the mining and exploitation sector for the period from 2020 to 2022 according to FINA yearly reports.

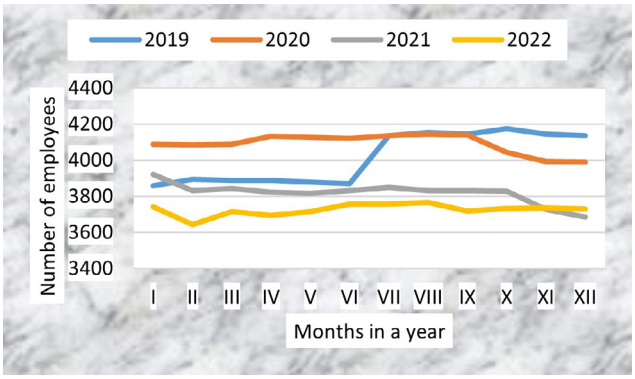


**Figure 3:** Number of people working in the area of mining and exploitation (made according to data from **URL5, 2023**)

**Table 3:** Business results of entrepreneurs in the area of mining and exploitation for the period 2020 to 2022 (**URL8 to URL10**)

| Year | Number of employees | Total revenues (M€) | Profit or loss for the period (M€) |
|---|---|---|---|
| 2020 | 3359 | 401.059 | -18.434 |
| 2021 | 3468 | 438.795 | 6.403 |
| 2022 | 3379 | 463.755 | 11.992 |

In the first COVID-19 year, the sector generated a loss of about €18.4 million. The number of employees decreased from 2021 to 2022 and the profit per employee increased from €1846/employee to €3549/employee or about 92%.

### *3.2. Results of Survey*

The survey was conducted during the pandemic period. A total of 20 mining companies completed the questionnaire. According to financial reports for the year 2020, 2 of the 5 largest companies in Croatia by production of raw materials for the construction sector participated in the survey. Most of them (see **Figure 4**), 14 (70%), list the production of construction materials as their main activity, while the other companies list mining services: blasting services, design services and project documentation, geotechnical works, demolition of buildings, recovery and recycling, hazardous waste collection and traffic infrastructure.

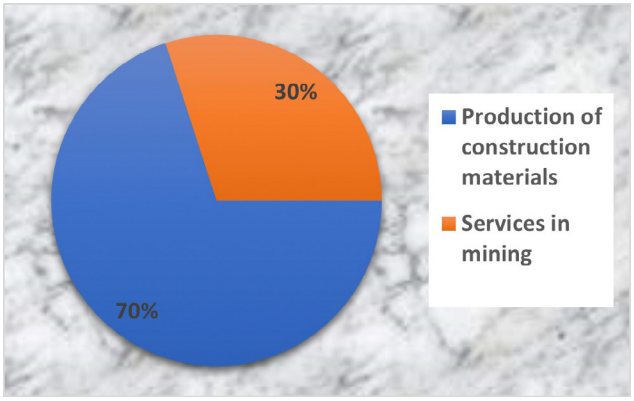


**Figure 4:** Surveyed companies according to their economic activities

According to the number of employees (see **Figure 5**), 10% of the surveyed enterprises belong to micro enterprises with less than 10 employees, 35% to small enterprises with less than 50 employees, 30% to medium enterprises with less than 250 employees and 25% to large enterprises with more than 250 employees. Two of them were ranked among the 5 most successful companies, according to the number of employees and realized

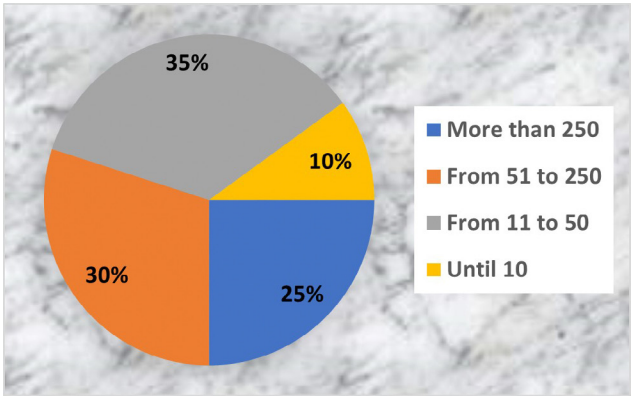


**Figure 5:** Surveyed companies according to the number of employees

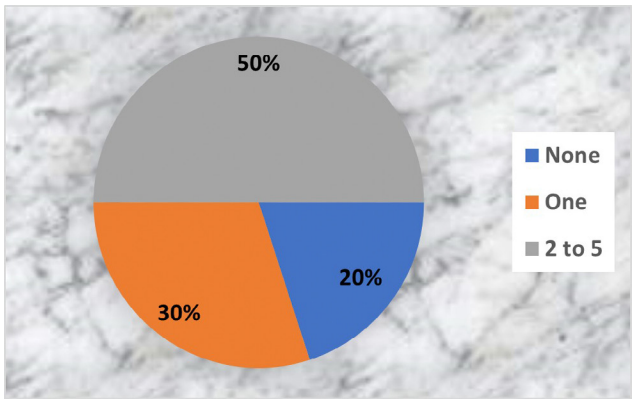


**Figure 6:** Surveyed companies according to the number of employed mining engineers

revenues, in the production of building materials, aggregates and glassworks in 2020. Most of the companies (19 out of 20) have a tradition of more than 10 years, while one of the companies was founded 5-10 years before the response to the questionnaire.

According to the number of mining engineers employed (see **Figure 6**), 20% of the companies studied had no such employees, 30% had one, and 50% had up to 5 mining engineers. In most cases, the number of employed mining engineers is related to the number of exploitation fields under the company's concessions and gives us information about the size of the mining companies.

According to the results of the questionnaire, during the first COVID-19 wave from February 26th to May 30th, 2020, 15% of the companies, or 3 out of 20, had to stop production for a period of 1 to 3 months and more than half of them took advantage of government support for the companies affected by the COVID-19 pandemic. More than half of the companies (see **Figure 7a**), or 55%, said they did not experience a drop in demand, 20% said the drop in demand was 5-10%, 20% said the drop in demand was between 11% and 50%, and one company had a drop in demand of more than 51%.

Most companies surveyed pointed out the disruption to freedom of travel introduced by the state to stop the pandemic as the biggest obstacle to business, with the increase in bureaucratic obligations felt by entrepreneurs coming in second place. Examples of bureaucratic constraints are phenomena such as excessively long waiting times for the granting and renewal of concessions for the exploitation of mineral resources, a sluggish, slow and inefficient local bureaucracy that does not listen to mining problems, and spatial planning prohibitions that lead to a lack of sites potentially suitable for exploitation.

All companies have had experience with remote working during the first research period (see **Figure 8a**),

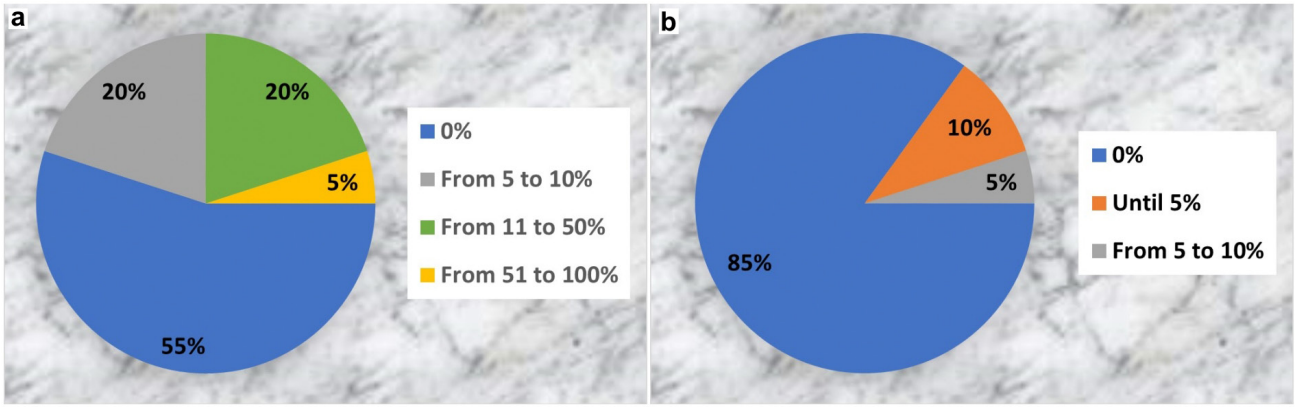


**Figure 7:** Observed drop in demand for (**a**) the first investigated period and (**b**) for the second investigated period

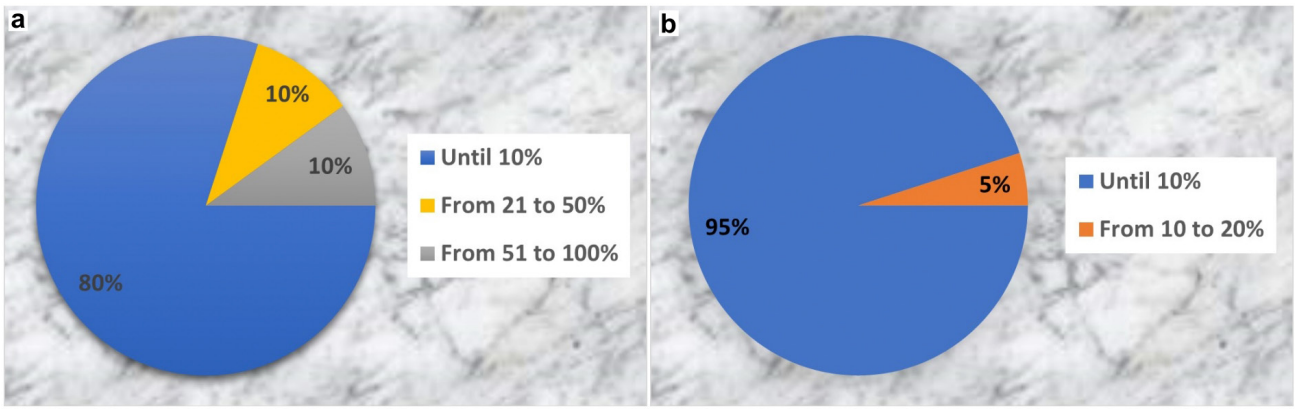


**Figure 8:** Experiences of companies with remote work for (**a**) the first investigated period and (**b**) for the second investigated period

but 80% of companies report that less than 10% of their employees work from home, 10% of companies report that 20-50% of employees work from home, and another 10% of companies report that more than 50% work from home. Only 1 out of 20 companies report that they had to decrease the number of employees during the first COVID-19 wave. As positive effects of COVID-19 on the company's business, the respondents mentioned network (online) communication in the first place and changes in the internal organization of the company's work in second place.

The results of the second investigated period show that all companies operated continuously without stopping production and that it was not necessary to call on government support for companies affected by the COVID-19 pandemic. The decrease in demand was rather small (see **Figure 7b**) and 85% of the enterprises said that they did not experience any drop in demand, 5% said that the drop in demand was between 5-10 and 10% said that the drop in demand was less than 5% disruption. Again, most participants cited the disruption of the freedom to travel as the biggest obstacle in business and at the second level, participants said that the government has not found an adequate way to deal with the new situation.

As in the first period all companies have had experience with remote working, but 95% of companies report that less than 10% of their employees work from home (see **Figure 8b**), and only one company said that 10-20% of workers worked from home. Only 1 out of 20 companies report that they had to decrease the number of employees during the second COVID-19 wave. As positive effects of COVID-19 on the company's business, the respondents mentioned network (online) communication in first place and changes in the internal organization of the company's work in second place.

When they asked which are the biggest obstacles in business (graded by the strength of influence from 1-strongest to 5-weakest) companies pointed out 3 of them with an almost similar grade: non-entrepreneurial climate (the business climate in Croatia is still restrictive and not encouraging), and lack of workers. As additional problems in doing business in Croatia, participants pointed out several problems:

- Impossibility of debt collection and large taxes and levies paid to the government,
- Unfair competition and inconsistency of policy in environmental protection,
- Slow implementation of administrative procedures and bureaucratization.

In March 2020, Zagreb was hit by a powerful earthquake with a magnitude of 5.3, and in December of the same year, an even more massive earthquake with a magnitude of 6.4 occurred near Petrinja. The Zagreb earthquake caused €11.5 billion in damage, and the Petrinja earthquake caused €5.5 billion (**URL11, 2023**). When asked about how the earthquakes affected their work, 2 out of 20 companies answered that they had to stop production and 3 out of 20 said that they had to increase production capacity. According to answers given by the companies' representatives, any other natural disasters didn't have any impact on the companies' production.

## 4. Discussion

In this kind of research, sampling is very important. Surveys using non-probability sampling (**Adeoye, 2023**) have disadvantages. It can rightly be considered subjective, as the researchers select the sample themselves and it can be challenging to defend the representativeness of the sample, so the conclusions should be generalized with caution in relation to the total number of companies. However, non-probability sampling is also used in the study of mining companies at the global level and for various purposes (**Khubana et al., 2022; Mohammadfam et al., 2022**), so it is not an inappropriate research tool. Moreover, in this study, the results of the survey were not only interpreted by themselves, but most of them were related to measurable economic indicators. For this reason, the authors of this study applied this research methodology and thus obtained results that can be considered relevant in the mining sector in Croatia.

For the production of mineral raw materials, the country-level results (see **Table 1** and **Table 2**) show that for most mineral raw materials there was no decrease in production in 2020 compared to the non-pandemic year 2019. There was only a small decrease of 5700 $m^3$ for dimension stone extraction (see **Table 1**). This is in line with the results of the survey, where only 45% of respondents (see **Figure 7a**) noticed a decrease in demand in the short first study period, and already in the second study period (see **Figure 7b**) only 15% of companies noticed a minimal decrease in demand. For this reason, companies generally did not reduce their production in 2020 and other pandemic years.

The number of employees at the state level began to decrease before the pandemic in the last quarter of 2019, and this downward trend in the final period of the year continued in the pandemic years from 2020 to 2022 (see **Figure 3**). For this reason, this reduction cannot be explicitly connected to the pandemic, especially since only one company in the survey indicated that it had to reduce the number of employees in the first survey period.

The results at the country level (see **Table 3**) show an increase in total revenue, while a decrease in profits was only seen in 2020 and can be connected to the pandemic disruptions in the market and the need for larger investments. This also shows that the recovery from the COVID-19 crisis was much faster compared to the non-pandemic crisis of 2008.

The biggest positive effect associated with the pandemic in the survey is the improvement of online communication and the internal organization of the company's work, including remote work. Successful companies have communicated online before, but the pandemic has caused

them to invest more in the hardware infrastructure and software programs and to provide additional training to employees, which has increased the effectiveness of communication even during the greatest outage. On the other hand, the increase in total revenue can be attributed to changes in the company's internal work organization, which was highlighted in the survey as another positive consequence of the pandemic.

In general, the impact of the pandemic on the Croatian mining sector is due to crisis management, and the application of restrictive measures to combat the pandemic. The fact that the Croatian authorities applied the measures in the first wave, when the hard lockdown was applied, was quite different from the other pandemic waves, when the measures were among the mildest in the European Union (**Hale, 2021**). However, this reaction did not come on its own, but was the result of a series of events in 2020. Although the government of the Republic of Croatia was preparing to continue the stricter measures and decided on December 23rd, 2020 (**URL12, 2020**), to introduce a restriction in traveling outside districts and the place of residence, as well as a strict prohibition of any kind of people gathering, this decision had to be changed (**URL13, 2020**) because Petrinja was hit by a strong earthquake on December 29th, 2020, and the free movement of people who had helped in this natural disaster was necessary. In addition to that considering the very negative public perception of restrictive measures and Croatia's strong focus on tourism, the decision for milder measures was logical and ultimately good from the perspective of the Croatian economy.

The authors of this study were inspired by previously published significant papers (**Jovitt, 2020; Krzysztofik et al., 2020; Gałas et al., 2021; Mitev and Galabova, 2022; Kekeç et al., 2022; Wang et al., 2023**), but they wanted to make a paper with a different methodological approach, so they determined the perception of the pandemic in the companies, which is why the surveyed companies were carefully selected, as well as the people in the companies who hold management positions. In this way, a complete picture of the impact of the COVID-19 pandemic on the mining sector in Croatia is obtained.

It is necessary to discuss the results of this research in relation to previously published papers on the same topic. According to published research (**Jowitt, 2020**), most governments allowed mining to continue during the COVID-19 pandemic, although not as usual, with some limited restrictions on the containment of COVID-19. There are some notable exceptions where the crisis led to the temporary closure of individual mines, the cessation of mining in certain regions, or, in rare cases, the closure of a country's entire mining industry. Mexico and South Africa are countries who completely closed mining operations in March 2020 for a short period of time. The research in this study shows that Croatia did not resort to the closure of mining or any other industry during any pandemic wave. This turned out to be a very good move, because the shutdown would have caused great economic damage and a much larger decrease in the gross domestic product.

In heavily polluted countries like India, temporary lockdowns can improve environmental quality (**Mandal and Pal, 2020**), but it is not a long-term and sustainable solution. Due to the structure of the mining sector, which is focused on the production of construction materials, and the more modern technology it uses, there was no decrease in mining-related pollution in Croatia during the pandemic period. This should be seen in light of the fact that the reduction of pollution in Croatia is on more stable foundations, which will be increasingly linked to the European transition to a green and sustainable transformation of the entire economy.

According to a previous study in Croatia (**Sataic, 2021**) on micro, small and medium enterprises operating in various sectors, wages and social contributions for staff, payment of bills and rents are among the most common financial problems during the lockdown, while other business problems mostly concern the decrease in orders, disruption of logistics, increased financing difficulties and inability to deliver existing orders. Also, according to previous studies (**URL2, 2021; Roška et al., 2023**), only the mining and construction sectors recorded an increase in the number of employees and total income in the first pandemic year of 2020. This study confirms these results for the first pandemic year, but also for other years. Compared to other Croatian industries affected by the COVID-19 crisis (**Rogić Dumančić et al., 2020; Bašić, 2021; Lovrinčević et al., 2021; URL2, 2021**), the research conducted for this study shows that the mining sector was resilient and experienced production and income growth in all years of the pandemic.

After the end of the COVID-19 pandemic, and the Croatian mining sector in Croatia has managed to cope and recover from this crisis. The question arises about the future challenges in the mining sector in Croatia as a part of the mining sector of the EU. The authors believe that future research should be focused on changes in the mining industry which will be driven by Green Deal Industrial Plan for the Net-Zero Age, The Net-Zero Industry Act and Critical Raw Materials Act.

## 5. Conclusions

Based on the analysis of economic indicators at the state level of the Republic of Croatia and the conducted survey in mining companies, the following can be concluded:

- Surveys using non-probability sampling can be used when investigating crisis situations in mining companies, but these results should still be interpreted depending on measurable parameters.
- The results of the survey and the statistical data show that the mining sector is crisis-resistant and

that natural disasters such as the earthquakes in Zagreb and Petrinja not only did not have a negative impact on the production of mineral commodities, but the production of mineral commodities even increased which correlates with the intensive construction works done after the earthquakes.

- According to statistical data, the sector recovered much faster compared to the financial crisis of 2008.
- Most positive experience gained during the COVID-19 time are better internal organization which include online communication and remote work which remained in use after the pandemic.
- Considering the impact of COVID-19 on other industry sectors, mining together with the construction industry proved to be significantly more resilient.

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## Appendix A

Appendix A contains list of questions. Before the conducting questionnaire participants are clearly informed about durations of the first COVID -19 wave and second COVID -19 period.

| No. | Question |
|---|---|
| 1. | Name of the company? |
| 2. | Main economic activity?<br>a) Production of construction materials, b) Services in mining |
| 2.1. | If you choose answer b), please specify the service |
| 3. | Number of employees?<br>a) ≤10 b) 11-50 c) 51-250…d) >250 |
| 4. | When was the company founded?<br>a) 0-5years ago b) 5-10 years ago c) more than 10 years ago |
| 5. | Number of mining engineers employed in the company:<br>a) 0 b) 1 c) 2-5 d) >5 |
| 6. | Did you have to stop production during the first COVID -19 wave? |
| 6.1 | If you answered Yes, please indicate the period |
| 7. | During the first COVID -19 wave did you use government support for the companies affected by the COVID-19 pandemic? |
| 8. | During the first COVID -19 in which percentage you experienced drop in demand?<br>a) 0% b) <5% c) 5-10% d) 11-50% e) 51-100% |
| 9. | What are the main obstacles to doing business during the first COVID -19 wave?<br>a) Disruption of the movement of goods and people b) inability of the authorities, c) increase in bureaucracy, d) preventive COVID-19 measures |
| 10. | Did you have implemented remote work (work from home) during the first wave of COVID -19?<br>(If yes, please indicate the percentage of workers who did remote work)<br>a) <10% b) <10-20% c) 21-50% d) 51-100% |
| 11. | Did you had to decrease number of employees during the first wave of COVID -19? |
| 12. | Please name the positive effects of COVID-19 on the company's business during the first wave of COVID -19? |
| 13. | Did you have to stop production during the first COVID -19 period? (If yes please indicate the period) |
| 14. | During the second COVID -19 period did you use government support for the companies affected by the COVID-19 pandemic? |
| 15. | During the second COVID -19 period in which percentage you experienced drop in demand?<br>(If yes please indicate the drop percentage)<br>a) 0% b) <5% c) 5-10% d) 11-50% e) 51-100% |
| 16. | What are the main obstacles to doing business during the second COVID -19 period?<br>Disruption of the movement of goods and people b) inability of the authorities, c) increase in bureaucracy, d) preventive COVID-19 measures |
| 17. | Did you have implemented remote work (work from home) during the second COVID -19 period?<br>(If yes, please indicate the percentage of workers who did remote work)<br>a) <10% b) <10-20% c) 21-50% d) 51-100% |
| 18. | Did you had to decrease number of employees during the second COVID -19 period? |
| 19. | Please name the positive effects of COVID-19 on the company's business during the second COVID -19 period? |
| 20. | Did you have to stop production after the earthquakes in Zagreb and Petrinja? |
| 21. | Did you have to increase production after earthquakes in Zagreb and Petrinja? |
| 22. | Did you have to stop production because of any other natural disasters? |
| 23. | Did you have to increase production because of any other natural disasters? |
| 24. | What are the biggest obstacles to doing business in Croatia? |
| 25. | Any other experience you would like to share |

SAŽETAK

## Utjecaj COVID-19 krize na rudarsku djelatnost u Republici Hrvatskoj

Rudarstvo kao ljudska djelatnost dijeli sudbinu čovječanstva u svim globalnim situacijama koje pogađaju planet. To su manjim dijelom pozitivni učinci poput otvaranja svjetskoga tržišta, industrijske revolucije i sl., a većim dijelom negativni učinci poput raznih sukoba ili pandemija koje imaju globalni karakter. COVID-19 pandemija imala je nezapamćen utjecaj na sve sektore društva, što opravdava znanstveni interes za procjenu njezina utjecaja na globalnoj i lokalnoj razini. Nedavno je Svjetska zdravstvena organizacija proglasila kraj pandemije, nakon čega je to učinila i Vlada Republike Hrvatske, što je ujedno i kraj istraživačkoga razdoblja za izradu ovoga rada. U radu je procijenjen utjecaj pandemije na hrvatski rudarski sektor. Uz statističke podatke o proizvodnji obrađeni su rezultati ankete gospodarskih subjekata iz područja rudarstva te su izneseni zaključci o upravljanju poduzećima u kriznim situacijama.

**Ključne riječi:**
krizni menadžment, proizvodnja, pozitivna iskustva, hrvatsko gospodarstvo, rudarske tvrtke

## Authors' contribution

**Zlatko Briševac (1)** (Ph.D. in mining engineering, Associate Professor at the University of Zagreb, Faculty of Mining, Geology and Petroleum Engineering) designed the research methodology, conducted the survey, and presented the results. **Vječislav Bohanek (2)** (Ph.D. in mining engineering, Associate Professor at the University of Zagreb, Faculty of Mining, Geology and Petroleum Engineering) collected state economic data on mineral raw materials, conducted the survey and presented the results.