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TAŞKIN DENIZ YILDIZ[1]

Loss of profits occurring due to the halting of mining operations arising from occupational accidents or reasons related to legislation

Introduction

Investment projects are directed towards the goal of optimally using limited economic resources as a way to get maximum benefit from them. To reach the forecasted goals (with minimum duration, minimum cost) in investment projects (Köse and Kahraman 2009), it is important that mining activities and production continue without ceasing (Yıldız 2020f). While making decisions on whether planned production activities are feasible, a great variety of environmental, organizational, and technical conditions are considered (Bąk 2018). A mining feasibility study should include a detailed engineering design and cost estimates assumed by a large project team (Buchanan 1998). What could unexpectedly increase these costs in the operating period? This is one of the most critical questions for mining investors because investors would like to know what they will obtain a certain period after they make investments. After these calculations, investors make comparisons and reach a decision.

✉ Corresponding Author: Taşkın Deniz Yıldız; e-mail: tdyildiz@atu.edu.tr

[1] Adana Alparslan Türkeş Science And Technology University, Department of Mining Engineering, Turkey; ORCID iD: 0000-0003-4043-2257; Scopus iD: 57216370111; Researcher iD: ABH-8072-2020; e-mail: tdyildiz@atu.edu.tr

At this point, the total operating profit (OP) they will obtain from the goods they produce during the lifetime of the operation gains importance for investors. Profit is the value that is attained after selling the product obtained from the activity and is estimated at the beginning (Unay 2000; Yıldız 2020f). In mining enterprises/operations (MO), an unexpected cost, which could significantly decrease the OP, may occur with downtimes of mining operation.

Mining activities go through various stages, from exploration to final material production and its transport. Environmental pollution occurs in all of them (Namin et al. 2011). Moreover, occupational health and safety (OHS) problems are also added to this (Kahraman et al. 2019; Yıldız and Maral 2020; Maral and Yıldız 2020). To completely comply with market requirements, in recent years MO have been practicing standardized systems for quality, OHS, and environmental management (Bąk 2007, 2008; Bąk and Nowak 2019). It is expected that decisions on mining technology which affect the technical and organizational structures of MO are always taken according to the analysis result in the planning stage (Mokrzycki 2000; Bąk 2020). This is because the new technical revisions thought to be made in the operating stage in terms of OHS to prevent mining occupational accidents (OA) can result in high costs or maybe not even getting done.

In developed and developing countries, economic development depends on the production of natural resources (Pearce et al. 2006; Unaldi 2009). Operating these resources economically is highly important for the steadiness of the economic development of countries. Halting mining activities due to OA or other reasons resulting from legislation can slow down this development (Yıldız and Maral 2020; Maral ve Yıldız 2020). Since mining activities depend on natural conditions, there is actually more risk in each mining investment project compared to other industrial projects. Mining requires production in the ever-changing environmental conditions due to the variety of natural conditions. For this reason, it includes more than one risk starting from the production stage to the final transport. Considering the difficulty of working conditions and the intensity of danger that could occur in the working environment, underground mining workplaces fall into the “very hazardous class” category of Law No. 6331 on OHS in Turkey (Karpuz and Hindistan; Demirel 2017; Ökten and Fisne 2017; Yıldız 2017; Yıldız and Haner 2017; Akçin et al. 2019; Kahraman and Özdemir 2019; Şensöğüt and Yavuz 2019). Open-pit mining also contains dangers and risks (Kasap and Subaşı 2017; Şafak et al. 2018). Both in underground and open-pit MO, OHS problems occur in the production process. The production process consists of key activities such as excavation, ground support and transport along with secondary-tasks required for these such as the installation of equipment and systems, their operation and providing material support. In any moment of this process, OA may occur as a result of the negations emerging in the harmonization of environmental conditions, the machines used and the employees (DDK 2011; Bayraktar et al. 2018; Şensöğüt et al. 2019; 2020). Occupational accidents and occupational diseases cause serious costs in terms of employees, employers, and national economies (Koc and Akbiyik 2011; Metin 2017). Employees working in mines can get injured, lose limbs, and lose their lives as a result of OA. Occupational accidents do not only harm employees but also employers significantly. Firstly, an employer whose workplace hosts an OA weakens the morale of the employees. Legal and administrative procedures, treatment costs, pensions against incapacity to work, labor and workday losses, losses of production, customer losses resulting from orders being late in delivery adversely affect the corporate image bringing high costs for the employer. Furthermore, decreases caused by OA in productivity, social expenditures for employees, and premium and tax losses place a burden on national economies with significant costs (Özkan 2007; Kasap 2011; Metin 2017). These emerging costs are much more than the required investments made to prevent OA and occupational diseases (Tug 2014; Metin 2017). Costs resulting from OA considerably weaken the employers' competitive capacities by lowering their profits (Guvercin 2015; Kılkıs 2016). For this reason, because the risk of OA is high in MO, MO would like to know to what extent it is possible to lower operating costs (OC) by making them controllable on an ongoing basis (Yuvka et al. 2000). Studies regarding the cost of OA will be a significant guide for each MO in their practices to prevent accidents (Arslanhan and Cunedioglu 2010). Additionally, calculating the OP losses which occur as a result of inactivity of MO due to OA will also help in calculating the total cost arising from OA in MO.

In the presence of uncertainties regarding conducting a mining project, there is a need for mining to be performed profitably (Bastida 2001). According to a study, mining projects are generally conducted in which the planned budget is exceeded at the rate of ~62% (Maragakis 2016). One of the most important reasons for this, especially in Turkey, is the legislative amendments that cannot be predicted. Because of legislative amendments in recent years in Turkey, mining investors pay high land-use permit fees due to the land overlaps before obtaining an operation permit (Yıldız 2019, 2020a, e, f). Additionally, there are some problems in these land conflicts due to permit processes (Yıldız 2020b, d, h, 2021; Yıldız and Kural 2020). These problems and delays during the permit process can also create financial losses (Yıldız 2020d). Another major financial burden on MO is taxes (Yıldız 2022). Other investors apart from those in mining pay a total of four types of taxes to the state: corporate tax, social security premium, withholding tax, and stamp tax. Mining investors, on the other hand, pay ~8 types of taxes and fees in total, including state rights, mining licensing fees, land permit costs, mine closure, and rehabilitation fees (Köse 2020; Mining Professionals 2020; Yıldız 2020c). Even if there are incentive encouragements (Aksoy et al. 2020) for the mining sector, the acquisition with high land costs may make the economical extraction of minerals profitless (Szewczyk and Kacprzak 2013). The more the costs of MO increase, the minimum operable grade of mineral ore it is to produce will take an upward trend, parallel to the increase in costs. This situation will mean that some MO will no longer be operable and they will be closed (Cetin 2018; Liu et al. 2019; Yıldız 2020f). Under these financial conditions, Turkish mining is in a more sensitive position in the presence of unexpected costs. In Turkey, MO conduct their production in line with the forecasted production plan in operating projects. In MO, operation activities cannot be actively performed for 365 days. There are compulsory days in the year upon which operations do not occur. However, times in which they do not conduct activity as a result of halting mining due to OA or reasons resulting from legislation are unexpected situations. Halting the activities of mining operations (MO) during the lifetime of the operation due to these reasons (OA or resulting from legislation) causes OP losses in MO because of these unworked periods. From time to time, these OP losses reach critical rates which can bring out an OC risk in these MO.

The effects of OA costs are spread over a long time, and it cannot be detected which generations and which process will be impacted (Ofluoglu 1996). For this reason, it becomes difficult to make a clear calculation of all costs in the event of an OA. Considering this situation, this study aimed to examine OP losses from production resulting from the halting of MO only as a result of other factors such as OA and legislation. Around the world, in parallel to the increase in the significance of OHS, scientific studies regarding the matter has also gained importance. However, there has not been much scientific work regarding the economic dimensions of OA and they mostly remained on a theoretical level. In literature, there is almost no detailed study regarding OP loss or OC risks of MO resulting from the halting of MO. Considering this deficiency in literature, this article is able to both contribute directly to decreasing OP losses and OC risks and indirectly to preventing mining accidents. Mining companies that are aware of the significant high-profit losses of MO due to OA will appropriate more funds for OHS.

1. Scope and method

In the study, a survey was first conducted with the permanent supervisors (PS) working in the MO by using "SurveyMonkey" in April, May, and June 2019. Survey questions were answered by PS and by the finance and accounting departments at the MO, where PS work, by consulting the PS to these departments. A total of 235 PS filled out the survey on behalf of the MO – permanent supervisors are mining engineers who are constantly present in the MO. A total of 58 PS answered all of the questions examined in this study. These questions concerned: whether the activities they conducted during the lifetime of the MO were halted due to (OA or others subject to legislation) reasons; the number of days not worked from the start of operation activity of the halted ones until now; annual active days worked; time elapsed since the beginning of MO activities, mineral group(s) (MG); (open-pit/underground) MO method; annual OC; OC per mine (run-of-mine) (TL/ton); pit sale price; ore production amount. In addition to these questions, MO were asked whether they had an OA involving death/severe injury as an open-ended question. All these questions were analyzed together according to the MG and MO method differences. A total of 44 MO where the PS answering the questions worked are open-pit and 14 of them are underground. A summary of the MG stipulated by the legislation in Turkey is presented in Table 1. For a detailed version of this summary table, see Article 2 of the Mining Law, Of. G. 1985 (Yıldız 2019). It is unknown how many of the 58 MO answering the survey had OA and how many of them were halted due to legislation reasons apart from OA. It was preferable not to ask a different question on the basis that the MO filling out the survey would consider this distinction as a detail. By using the parameters stated in Table 3, annual OP losses emerging from the unworked day losses due to the aforementioned reasons in the MO were calculated (MO have losses of profit due to the downtime). However, the most important factor is that the MO continue paying the fixed costs even though there is no production on the unworked days. It was highly important to determine what the total fixed costs of the aforementioned MO having OA were. In the conducted survey, only the average annual OC of the MO were obtained. As it was assumed that "fixed costs paid due to the halting of operations" and "variable costs" would not be answered due to being seen as detail and these costs were not separately asked about in the survey. To make a comparison, an evaluation was also made on the matter of how much of a share the profit losses of MO have within the OC. For this, "profit losses on an annual basis on average" of MO were proportioned to "annual OC on average." In all calculations, the mean values of data ranges stated in the survey answers were used for each MO for different MG stated in Table 1. In this way, the mean values for each MG were calculated.

Table 1. MG in Turkish mining legislation (summary)

Tabela 1. Grupy surowców mineralnych (MG) w tureckim prawodawstwie górniczym (wyciąg)

1st Group Minerals	1(a)	Sand and Gravel
	1(b)	Clays and rocks used in cement and ceramics industries
2nd Group Minerals	2(a)	Aggregate rocks and rocks for ready-mix concrete and asphalt
	2(b)	Dimension stones, marble, travertine, granite, andesite, basalt, etc.
	2(c)	Ground/milled rocks for industrial use (calcite, etc.)
3rd Group Minerals		Salts (incl. sea, lake, and spring water), CO_2 gas (except geothermal, natural gas and petroleum areas), Hydrogen sulfide
4th Group Minerals	4(a)	Industrial minerals
	4(b)	Peat, lignite, hard coal, anthracite, asphaltite, bituminous schist/shale, coccolith/sapropel
	4(c)	Metallic ores, rare earth elements/minerals
	4(ç)	Radioactive minerals
5th Group Minerals		Precious and semi-precious stones

Source: Yıldız 2020.

2. Halting mining activities

Halting mining production activities that are contradictory to the mining operating project and pose a danger to the safety of life and property was forcasted (Topaloglu 2011; Article No 29 of Mining law, Of. G. 1985; Article 35 of Mining Regulations, Of. G. 2017).

In a broader expression, MO can be halted due to force majeure (such as flood, fire, earthquake, firedamp explosion, collapse and landslide), and unexpected situations (unexpected changes under ore grade, geology, marketing, transportation and infrastructure conditions, and situations such as not obtaining the required permits from other institutions under the legislation), and due to OA or the activities of MO that do not comply with OHS and other legislations (Of. G. 1985; Maral and Yıldız 2020; Yıldız and Maral 2020). In Turkey, OHS in minerals and the related audit mandate are mainly under the responsibility of the Ministry of Labor and Social Security. The Ministry of Energy and Natural Resources (MENR), on the other hand, audits the minerals not in terms of OHS but according to the provisions of the Mining Law. With the provisions of Mining Law, MENR is given the authority to *halt the activity regarding mining production in case of the determination that the activity poses a hazardous situation in terms of safety of life and property* (Yıldız 2015). In Turkey, in 2018, 8088 MO were audited by MENR. As a result of this audit, the activities of 2500 MO were temporarily halted (TMD 2019). These numbers show that the halting of mining activities is a frequent situation that happens among MO in Turkey (Maral and Yıldız 2020; Yıldız and Maral 2020). To determine whether MO were halted or not, the MO who participated in the survey were asked the question *Up to today, has there been a loss or disruption which you didn't foresee regarding your MO activities in consequence of legal amendments in mining and related legislation?* (Figure 1). This question does not only include the halting of MO but also whether they received administrative fines due to the activities which were not under the legislation.

Of the 210 MO answering this question, 7.62% were only fined with a penalty for activity halting, and 9.52% of them received both penalties for activity halting and an administrative fine. These results show that in total, 17.1% of the MO answering this survey (36 MO) were fined with a penalty for activity halting. Additionally, 58 MO stated that they had production/profit loss as a result of halting their MO. This situation shows that 22 of 58 MO, whose activities were halted in certain parts of their MO, halted their activities within their MO bodies without being fined for activity halting as a result of ministries' audits.

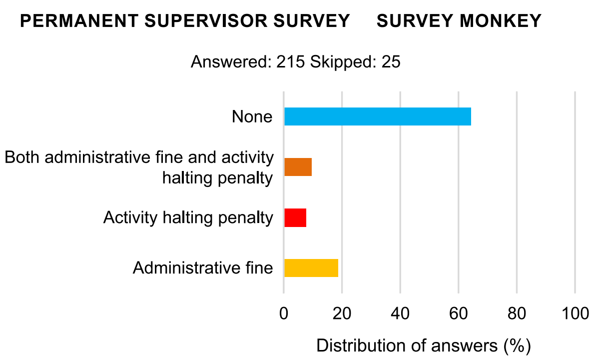

Fig. 1. Distribution of administrative fines and penalties for halting activities of MO

Rys. 1. Rozkład kary administracyjnej i kary za wstrzymanie działalności (MO)

2.1. Halting of mining activities in the case of an OA

As explained in the sections above, the most economically damaging halting type for MO is OA. Of all OA, those involving death and severe injury are the most severe. The MO who participated in the survey were asked the question *Has any OA involving death or severe injury occurred in your MO starting from the operating activity until now?* Table 2 shows the answers of only 7 of the 58 MO which were halted due to OA or other reasons resulting from legislation. Among the other 51 MO, it can be assumed that there could be MO that did not answer the question for not wanting to reveal that there was OA involving death or injury in their MO. In other words, among 58 MO, there might be MO that were halted because of OA that did not involve death/severe injury in their MO.

Table 2. Whether MO had OA involving death/severe injury

Tabela 2. Zestawienie czy w operacjach górniczych (MO) wystąpiły wypadki przy pracy (OA) ze zgonem/ciężkimi obrażeniami

MG	MO method	Number of MO	OA involving death/severe injury
1(a)	Open-pit	2	OA involving one death and one severe injury in one of the MO
1(b)	Open-pit	2	OA involving one death and three severe injuries in one of the MO
2(a)	Open-pit	18	OA involving one death in one of the MO, and one severe injury in the other
2(b)	Open-pit	13	N/A
4(a)	Open-pit	6	N/A
4(b)	Open-pit	2	N/A
	Underground	8	OA involving one death, two severe injuries in one of the MO, and two severe injuries in the other
4(c)	Open-pit	1	N/A
	Underground	6	OA involving one death in one of the MO
For all MO	Open-pit	44	N/A
	Underground	14	N/A
	Total	58	N/A

2.2. Halting of the activities due to works not performed under legislation

This category, excluding the heading above, includes the MO whose mining activities were halted not because of an OA but because of reasons resulting from the legislation

(Section 3.2). Especially because underground mining is riskier than open-pit mining, in Turkey, 15 underground coal MO in Zonguldak Coal Field were included in the survey. These MO were asked the survey question whether their activities were halted or not because of unsuitableness of OHS in their MO during the MO activity period. It was determined that 53.33% of MO encountered a penalty for halting activity at least once during the MO activity periods (Özturk et al. 2019). These numbers show that halting the MO specifically due to the unsuitableness of OHS, excluding OA, is frequent.

3. Days unworked in MO and losses in profit

3.1. Ore production costs and amounts

"Cost" is the monetary expression for pecuniary resources that are used to achieve a certain goal. "Production" from the perspective of MO, on the other hand, can be defined as the activities of removing the mineral from its natural deposit and bringing it to the surface by bringing labor, capital, and other means of production together (Uygun 2014b). To ensure this, the term "Production cost" is used. To learn the costs per ton of mineral produced, the MO were asked the question, *How many TL/ton is the average cost per ton of the mine you work for?* OC (TL/ton) per ton of mineral according to different MG are presented in Figure 2.

After the investment is completed and the production is started, any kind of expenditure to conduct the production is named OC (Sarac 2008; Köse and Kahraman 2009). The average annual OC distribution of the MO participating in the survey is presented in Figure 3 according to the different MG.

The production amount of the useful mineral is set according to the demand in the market. As long as the demand increases, the amount of ore offered to the market can be increased accordingly. For example, the demand for coal in the winter months is higher than in the summer months. Additionally, the production of some ores – especially those with strategic significance – is reduced or increased depending on the current world policy (Saltoglu 2008). By considering this variability, the annual average of ore production during the years of operation of the MO can be evaluated. Notably, without exceptions, MO complete production every year during their lifetime as planned. To learn the annual production amount in MO, the question *How many tons/year is your ore production amount annually?* was asked. The variation of the annual ore production amounts according to different MG is presented in Figure 4.

In Turkey, considering the relation the mineral deposits have with the mineralization dimensions and tectonic structure, the scale of production of the MO can be evaluated in the ranges of 5,000–50,000 tons/year and 50,000–500,000 tons/year for underground MO, and in the ranges of 10,000–100,000 tons/year and 100,000–1,000,000 tons/year for open-pit MO. Open-pits with a production amount of over 1,000,000 tons/year and underground

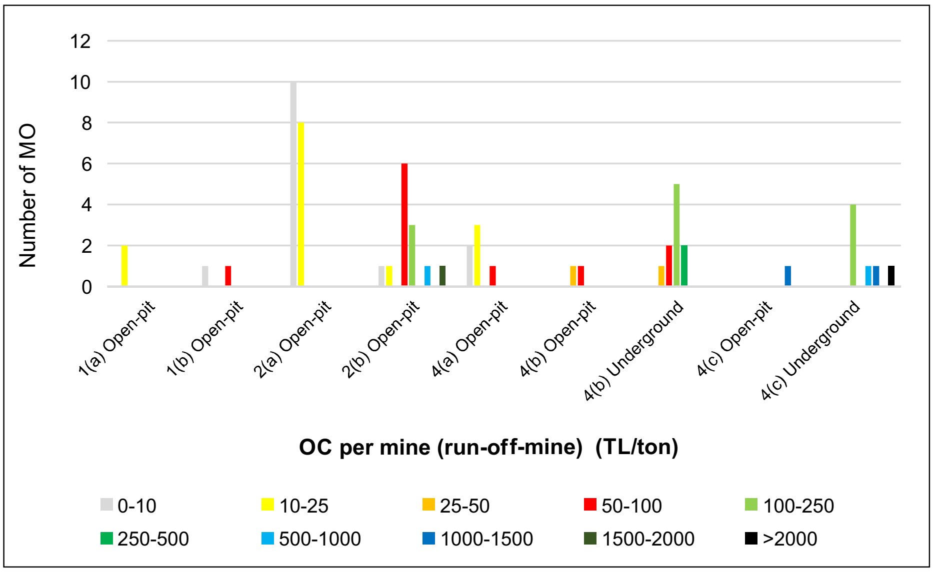

Fig. 2. OC per mine (1 US$ = 4.84 Turkish Liras (TL) (08/06/2019) (CBRT 2020))
In Figures 2 and 5, ">2000 TL" is accepted as 2000–2500 TL, in other words, 2250 TL is accepted as its average

Rys. 2. Koszty operacyjne (OC) kopalni (1 USD = 4,84 lir tureckich (TL) (08.06.2019) (CBRT 2020))
Na rysunkach 2 i 5 „2000 TL" jest akceptowane jako 2000–2500 TL, innymi słowy, jako średnią przyjmuje się 2250 TL

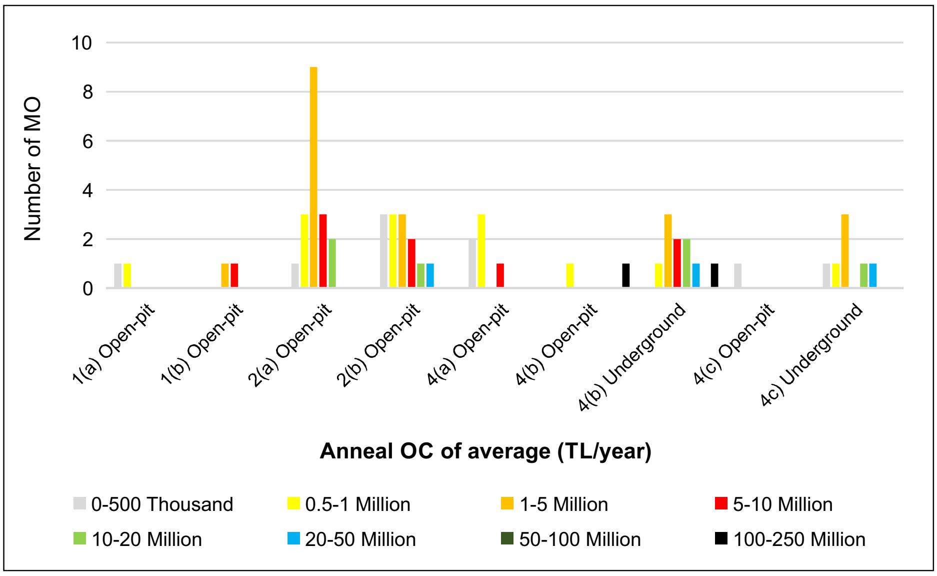

Fig. 3. Average annual OC

Rys. 3. Średnioroczne koszty operacyjne (OC)

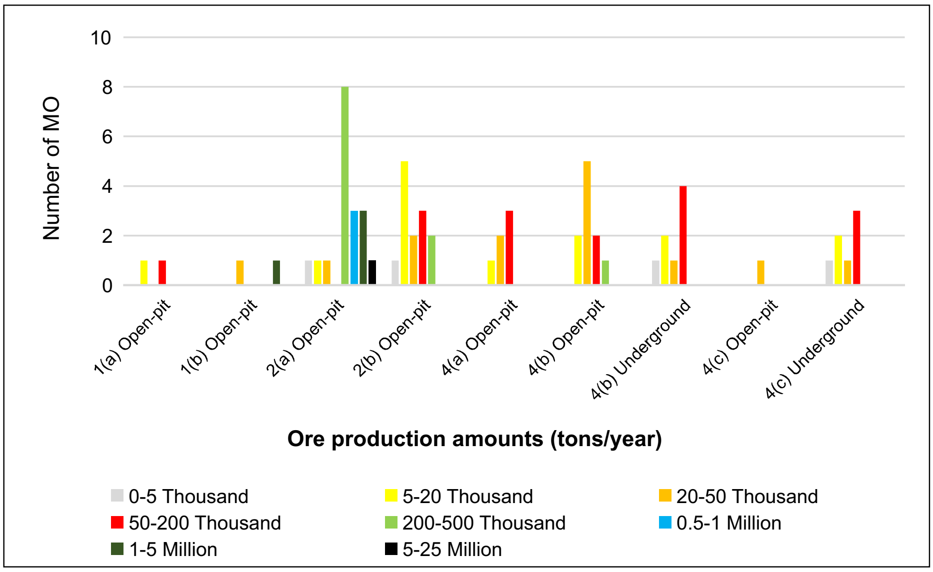

Fig. 4. Ore production amounts

Rys. 4. Wielkość wydobycia rudy

MO with the production of over 500,000 tons/year are defined as large-scale mines. In line with the definitions stated above, the production scales of MO in Turkey commonly fall under the small and medium scaled MO group, excluding hard coal, brown coal, iron, gold, feldspar, and some natural stone MO (TUMMER 2010). According to this scale, none of the underground MO answering the survey are large scale, 6 are medium scale, and 11 are small scale. Of the open pit, 5 are large scale, 22 are medium scale, and 14 are small scale. This distribution also shows that the MO participating in the survey are mostly medium- or small-scale MO, which is similar to the distribution across Turkey (Figure 4).

3.2. OP according to different MG

The main purpose of mining investments is the desire to make a profit, as it is in every area of investment. The ores produced as a result of the mining activities are sold in the market. After the cost is calculated, profit should be made. The MO starts to earn income only by selling its products after it starts production. Sales revenues depend on the amount of ore that the MO will produce in a year and on the selling price of this ore in the market (Sarac 2008). Sale prices vary according to the mineral types. Profit (TL/ton) = Sales price (TL/ton) – cost (TL/ton). Therefore, to calculate the OP obtained from a ton of mineral, pit sale prices are required in addition to cost data. MO were asked the question, *What is the average pit sale price of the MO you work for?*. Sale prices (TL/ton) and different pits and MG are given in

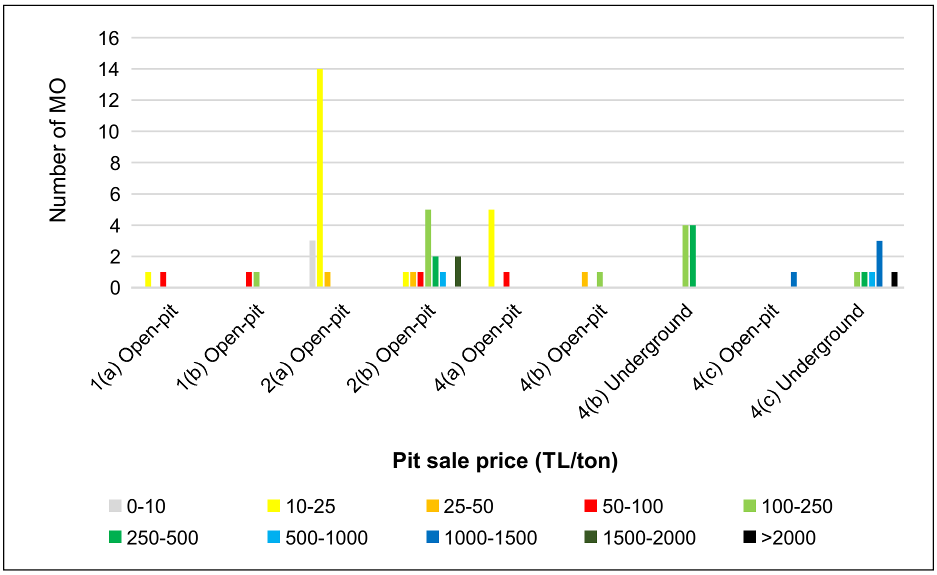

Fig. 5. Pit sale prices

Rys. 5. Ceny sprzedaży w kopalniach

Figure 5. In addition, for different MG and MO methods, the OC per mine (TL/ton), pit sale prices and mean values of the annual OP totals are presented in Table 3.

3.3. MO activity periods and times unworked

Operational downtimes emerging as a natural result of production processes are necessary from a productivity point of view and are under the control of MO executives. It is not possible to avoid these time losses. For instance, unworked times emerge as a result of reasons such as maintenance and repair of machines and benches, cleaning before and after production, and the handling of materials (Uygun 2014a). Or, for instance, for shift change overs, ~20–40 minutes of non-production occur in MO.

Additionally, it is a natural and well-known situation that open-pits cannot make production in winter by their very nature, or even if they do, there is too little production. Because compulsory periods of nonoperation in open-pits have structural characteristics under season conditions, rising costs in these times constitute a part of the general production costs of that year. These costs are distributed over the whole year and are added to OC (Uygun 2014a). Days other than these time losses in MO are defined as "active working days" within the year. MO participating in the survey were asked the question *How many days are active production on average annually in your MO?* Change of the number of the annual active day in MO according to different MG are presented in Figure 6. The average number of active

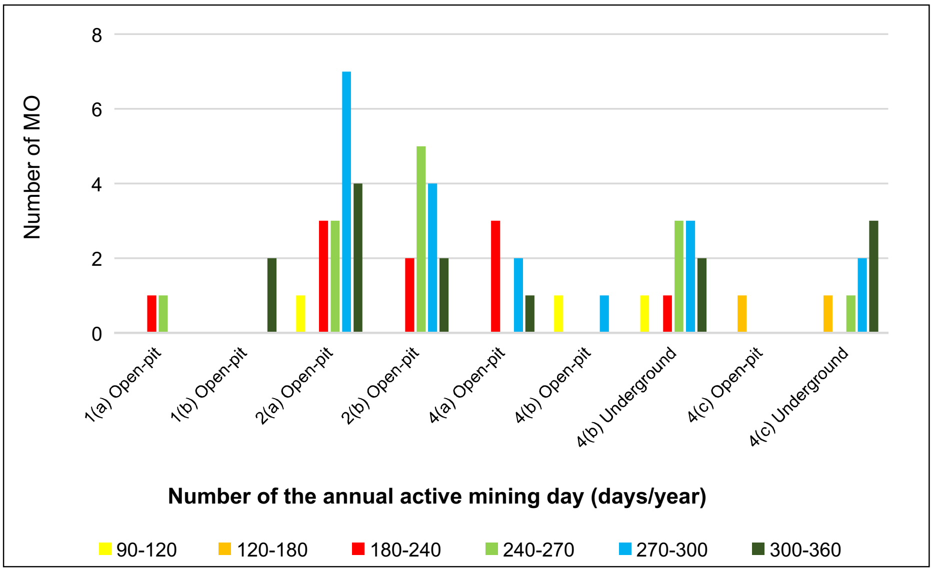

Fig. 6. Number of days of active production in the MO

Rys. 6. Liczba dni aktywnej produkcji w działalności górniczej (MO)

working days in underground MO is higher than those in open-pits (Table 3). "The number of active production days in MO" is not used in the calculations in Table 3. However, to make a comparison with the number of unworked days in mines that were halted due to OA and other reasons, these data are presented in Table 3.

Periods of nonoperation that are not the natural result of the production process are generally beyond the control of MO executives. Such periods are frequently encountered in MO because of the characteristic of the sector. The periods of nonoperation occurring when production is halted due to reasons such as the closure of open-pit ways in winter and the flooding of mines are examples of such times. In contrast to open-pits, downtime in underground MO in winter is not a natural situation arising from the structural characteristics of the MO. Underground MO conduct their works the same in winter as they do in other seasons under normal conditions. However, in mines found in mountain regions where infrastructure investments are insufficient, the situation is different. Underground coal MO in these regions open roads that could be considered as primitive with regard to their capabilities of carrying both the ores they extracted to the main storage locations and the transport of people and materials. When these roads are closed due to floods or landslides under severe winter conditions, as the transportation of ores produced in the mine cannot be performed, the production is obliged to be halted until the road is open again. Halting the production due to these reasons is not a natural situation that always occurs in the underground MO. Therefore, the costs corresponding to unworked periods due to the halt of production during the period of opening of the closed roads or emptying mines filled with water because of a flood are removed from production costs. These are losses for the financial year defined as "the accounts of costs and losses of the unworked part" (Uygun 2014a). Halting production in this way can be considered within the scope of halting the activity of MO by not being able to conduct the production planned in the mining operating project. MO were asked the questions *In the MO you are working for, has a continuing activity been halted for any reason (OA or resulting from the legislation)? If so, what is the time of the total operating loss of time being unworked due to these reasons during the MO activity period?* (Table 3). Based on these data (H), the annual OP losses due to the aforementioned unworked day were calculated. Without a doubt, because of these unexpected halts of activity, the MO can also go through losses due to various other reasons within the scope of unworked times.

For instance, the MO may encounter the risk of failing to fulfill their promise to sell due to the unexpected downtime. In such cases, sometimes these MO might buy mineral ore from other MO for much higher prices than their own production cost to fulfill their promises (Uygun 2014c). However, this practice may not be achieved to the desired extent in every case, and it can cause OP losses for the MO. As stated above, the MO can encounter usual or unexpected time losses during their operating period. Obtaining information about the activity periods of the MO until the date examined in the study enables calculation of the annual OP losses, and comparison of the annual OC with these OP losses by considering the days unworked. The MO were asked the question *For how many years has there been MO activity in the MO you work for?*, for use in the calculations in Table 3. The change of these periods according to different MG are presented in Figure 7.

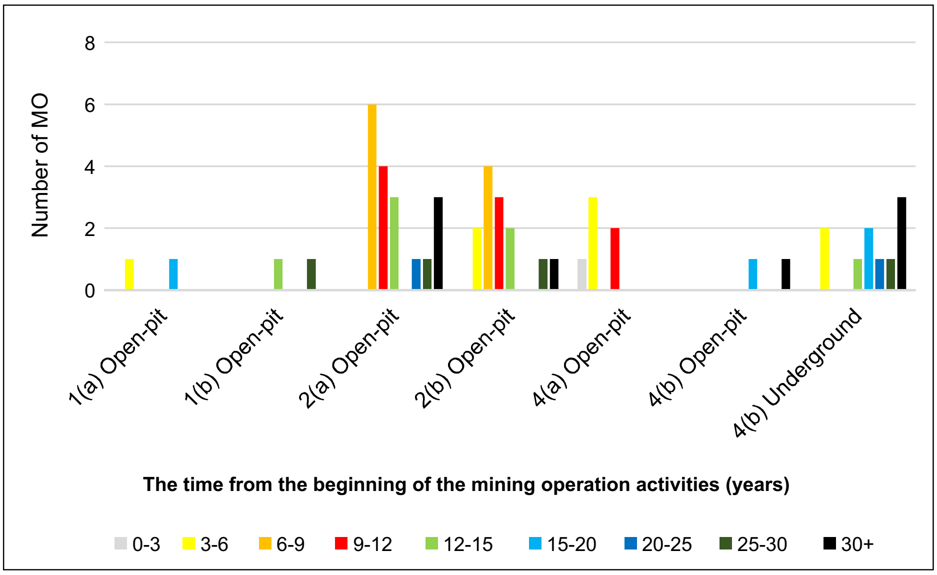

Fig. 7. Time elapsed since the beginning of the MO activities
(In Figure 7, "30 years": 30–40 years, so the average was considered to be 35 years)

Rys. 7. Czas, jaki upłynął od rozpoczęcia działalności górniczej (MO)
(na rysunku 7 „30 lat": 30–40 lat, więc za średnią uznano 35 lat)

Table 3. Losses for the unworked days due to OA and legislation reasons

Tabela 3. Utrata zysków z dni wolnych od pracy z przyczyn OA i przepisów prawnych

A	B	C	D	E	F	G	H	I	J	K	L	M	N_1	N_2	P	R
1(a)	O	2	16.3	48.8	32.5	255	15	275	68,750	5,738	54,195	11.0	9,925	1.08	500,000	3.77
1(b)	O	2	32.5	90.0	57.5	330	8	4,598	1,517,500	34,489	888,068	20.5	64,433	0.13	5,250,000	2.12
2(a)	O	18	9.7	19.3	9.5	268	125	4,907	1,450,000	678,761	5,507,054	15.7	328,254	3.57	4,555,556	8.54
2(b)	O	13	247.9	456.2	208.3	269	77	357	93,077	10,950	1,247,602	12.3	166,882	2.74	5,942,308	7.68
4(a)	O	6	18.3	30.4	12.1	255	299	326	76,250	124,992	966,538	6.0	211,746	25.23	1,791,667	10.17
4(b)	O	2	52.5	110.0	57.5	195	203	5,858	1,562,500	871,241	73,463,346	26.3	2,167,830	8.02	88,000,000	14.94
	U	8	184.4	290.6	106.3	276	114	305	80,000	13,025	980,232	20.0	127,865	4.04	11,125,000	2.32
4(c)	O	1	1100.0	1350.0	250.0	150	8	833	125,000	6,250	1,562,500	17.5	89,286	0.29	500,000	17.86
	U	6	550.0	979.2	429.2	303	51	173	52,083	1,683	657,999	15.4	111,013	3.70	9,958,333	3.73
For all MO	O	44	109.3	188.8	79.5	261	125	2,664	777,045	339,527	6,170,881	13.9	316,413	6.13	8,136,364	8.06
	U	14	341.1	585.7	244.6	287	87	249	68,036	8,164	842,132	18.0	120,642	3.90	10,625,000	2.92
	Mean	58	165.3	284.6	119.3	268	116	2,081	605,905	259,543	4,884,631	14.9	269,158	5.59	8,737,069	6.82

A: Mineral group, B: MO method, C: Number of MO, D: OC per mine (TL/ton), E: Pit sale prices (TL/ton), F: OP (TL/ton) (F) = (E) – (D), G: Number of days of active production in the MO, H: Total number of unworked days due to OA and legislation during the activity period of the MO, I: Ore production amounts (tons/day), J: Ore production amounts (tons/year), K: Total production loss (tons) for unworked days due to OA and legislation reasons during the MO activity period of the MO, (K) = (H) × (I), L: Total OP loss (TL) of unworked days due to OA and legislation during the MO activity period of the MO, (L) = (F) × (K), M: Time elapsed since the beginning of the MO activities (years), N_1: Annual OP loss of unworked days on average due to OA and legislation (TL/year), $(N_1) = (L)/(M)$, N_2: Annual OP loss of unworked days on average due to OA and legislation, $N_2\ \% = [N_1/(F \times J)] \times 100$, O: Open-pit, P: Annual OC on average (TL/year), R: The ratio of the average annual OP loss of the unworked days due to OA and legislation to the average OC, $(R\%) = (N_1/P) \times 100$, U: Underground MO.

3.4. Annual OP loss due to unworked time losses

In Table 3, the profit losses emerging as a result of unworked operating days due to OA and other reasons are calculated. The symbols representing the statements in Table 3 are presented at the bottom part of Table 3. Table 3 shows that for the MO answering the survey, "G" is low for 4(a) and especially for 4(b) and 4(c) open-pits. However, the analysis was made by only considering "H". "L" takes the highest value by with average values of 2,167,830 TL/year for 4(b) open-pits, 328,524 TL/year for 2(a) open-pits and 211,746 TL/year for 4(a) open-pits.

Estimating the potential OP can be conducted, for example, by using Monte Carlo Simulation (Krzak 2002; Varol et al. 2019). However, in this study, an average OP value for all MO, whose average OC and selling prices were only obtained for 2019, was calculated. It was considered that the rate of the depreciation of money for the coming years would affect all the examined parameters evenly. In other words, the depreciation of money for each passing year would have an even effect on OP and OC. This situation can be considered for the loss of profits calculated by benefitting from "H". The N_2 average of all MO is 5.59%. The aforementioned losses are proportioned to OC. The average of "R" has the highest values of all MG with its values of 8.54% for 2(a) open-pits, 10.17% for 4(a) open-pits, 14.94% for 4(b) open-pits, and 17.86% for 4(c) open-pits. The average of "R" is 6.82% for all MO (Table 3). If it is considered that there are MO not participating in the survey despite the halts of OA and legislation, it can be assumed that the average of "N_2" and "R" can be much higher for both the MO answering the survey and all MO in Turkey. Considering that one MO answered the survey for 4(c) open-pits, and two for 4(b) open-pits, we cannot generalize. However, it shouldn't be ignored that the aforementioned MO answered the question within the data security provided by SurveyMonkey. Considering the average results emerging in this situation, it can be concluded that unworked days due to OA or reasons arising from legislation highly decrease the OP. In fact, it draws attention that the "L" mean values of MO continuing their activities have a higher value compared to other MGs with their 73,463,346 TL value for 4(b) open-pit coal mines. It is seen that for 2(a) open-pit, 4(a) open-pit, 4(b) open-pit, and 4(b) underground mines, "H" is much higher than other MG. MO experienced this loss of time during their MO activity periods. For the MO in the aforementioned MG answering the survey, "H" values can exceed one year on average when these MO expire their lifetime (Table 3).

4. How to prevent OP losses arising from the halting of mining operations as a result of OA

The recovery of investment costs and OC and moving into OP depends on acquired revenue from mineral selling (Krowiak and Kaziuk 2002). Sales price is always one of the largest risks in mining design and economic calculations for feasible production (Akbari

Dehkharghani 2018). One of the main factors affecting the profit level of minerals is the cost of the tradable mineral products (Mokrzycki 2000). For instance, let us consider it from the perspective of coal mining which has more accidents and halting of mining activities (Bilim et al. 2018). The profit and loss of companies are essentially determined by coal prices. The cost of coal mining is 90% steady and the projects assumed to lower it will only be useful in the long-term. Cyclically changing coal prices causes substantial damages to companies when the prices are low, which leads to bankruptcy or the need for reconstruction (Sierpińska-Sawicz et al. 2020). There is a dependency between cost and production in coal MO (Gawlik 2008). There can be changes in the unit cost of coal from time to time. The decrease in the production cost of coal can cause a decrease in the demand for coal from time to time (Gawlik 2006; Głodzik et al. 2009). To increase profitability, it is necessary to lower the production cost. One of the most important criteria in decreasing the fair values is the rate of utilization of production capacity (Głodzik and Woźny 2004; Magda 2018). It has been proven that long-term marginal production cost forms the basis of coal prices. This cost can be estimated based on average long-term costs and increasing costs (Suwała 2001). Actually, for all MG, these matters are similar (Yıldız 2022). Productivity is the issue that gains more importance each passing day in terms of the success and profitability of MO (Rogers et al. 2019; Kahraman et al. 2020). Increasing the productivity in MO can decrease the usual time losses in MO. Therefore, the number of active working days can be increased (Maral and Yıldız 2020; Kahraman 2021). Increasing the number of days worked within the year also increases ore production (Magda et al. 2005). Determining the periods of MO downtime and investigating the reasons peculiar to each MG or MO will increase ore production, and profitability.

In MO, the period of an accident with the least lost time corresponds to the period with the most production. Sometimes, halting the hazardous occupation instead of performing it, halting and evaluating these risks before starting work, and waiting for their effect to decrease can ensure having less OA. Thus, discontinuations and labor losses arising as a result of OA do not occur. Also, if the hazards are eliminated by providing a secure environment for the working employees prior to working, there will be no need to waste more time removing the hazards. In this way, employees will be able to start working immediately, and this will reflect positively in production (Mining Turkey Magazine 2019).

Particularly in underground MO methods, suspending production and resuming the activity after a while is rather difficult (Tatar et al. 2015). For instance, sometimes, starting reproduction after OA as a result of collapse, fire, flood, or firedamp explosion in the underground mine can take months or even years. It should be noted that in the case of a possible OA, the MO will not only get to the point of being suspended but also closed. During this process, although the firm continues to pay fixed costs, it cannot obtain sales revenue as it does not begin production. Large mining accidents result in great damage or usually bankruptcy for a company (Tug 2014; Bilim 2015). Another challenge that the employer will have to go through is having the legislation made much more difficult. After the loss of life, the state, rightfully enforces harsh sanctions to forestall this issue and meet public expectations. These sanctions to be brought instantly put serious costs on the employers and in some MO, the practices which are not necessary for terms of OHS but stipulated in legislation as a requirement can be turned into an obligation. In this way, it should be noted that the occurrence of an unfortunate OA in an MO also affects the activities of other employers and there will be different costs (Tug 2014). In addition, a big OA occurring all of sudden can adversely affect the view of the public towards the mining sector to a large extent. These emerge as an indirect cost in the long term. Considering these results, for both OP not to decrease and the other direct and indirect costs not to occur, efforts should be made to not suspend mining activities due to mining OA and other factors. The most important strategy is to give more importance to OHS and to appropriate more funds.

Occupational health and safety significantly contributes to labor productivity and the economic growth of companies (Bilim and Bilim 2018). According to a study conducted by MENR, in exchange for making an OHS investment of 1 Euro, on average in MO, there is a return of OA prevention of ~2.2 Euro. Surely, while presenting OHS criteria, the necessity for economic operability of minerals should not be forgotten. For both operable mine production to continue and OHS to be a priority, these costs should reach the optimum level.

Conclusion and suggestions

The haltings resulting from OA or legislation can severely damage mining companies. N_2 average of all MO is 5.59% (Table 3). Similarly, it is remarkable that the ratio of loss only from haltings resulting from OA and the legislation to OC is 6.82% on average. This study only shows a cost to MO from the losses in profit emerging as a result of not producing on the unworked days and the haltings resulting from OA or legislation. Nevertheless, when mines are halted, as a result of the production-time losses, the high forest land permit fees, license fees, financing fees, and other fixed OC continue to be paid. Surely, while presenting OHS criteria, the necessity for economic operability of minerals should not be forgotten. Moreover, the total of these costs can reach much higher levels when compensation to employees and other direct and indirect costs emerge as a result of OA. As a result of giving importance to OHS and mining operation which is consonant with the legislation, there will be no such additional costs in MO whose mines are not suspended because of OA and reasons arising from legislation.

As a result of the analysis, it was determined that "L", "R" and "N" values of MO constitute a high share. Considering that these values (Table 3) of, for example, open-pit coal MO that have a big average on OC and production amounts are high to this extent, it is beneficial for both coal mine investors and MENR planning coal supplies to make more detailed studies on this matter. Considering the results, it is suggested that coal MO should be examined closely with regard to preventing OA and other haltings relating to legislation. In particular, MO appropriating more funds for OHS will not only ensure regulatory compliance and the prevention of OA but also will prevent the profit losses and other high costs resulting from the halting of mining. In this article, only the losses arising from the halting of MO in different MG due to OA and other reasons were analyzed. Other studies to be made on the matter of direct/indirect cost types and profit losses resulting from the halting of mining operations and decreasing the number of active working days of mines within the year can supplement this article.

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LOSS OF PROFITS OCCURRING DUE TO THE HALTING OF MINING OPERATIONS ARISING FROM OCCUPATIONAL ACCIDENTS OR REASONS RELATED TO LEGISLATION

Keywords

mine safety, occupational health and safety, safety economic, safety investment, working days lost

Abstract

In the event of occupational accidents in mining, investors can calculate approximately how much loss will be incurred at the time of the accident. However, in halting mining as a result of occupational accidents or legislation, investors, will perhaps not care about how much of a loss to profits will arise due to the resulting downtime of mining operations. The reason for this is that there is no such halting in mining operation as yet and mining activity is continued. Avoiding halting mines due to occupational accidents and legislation would enable the prevention of unexpected costs resulting from these time losses. The aim of this study was to find out how much the loss of profits resulting from the downtime of mining enterprises due to the aforementioned reasons are in total, and how much the ratio of loss of profits to annual operating costs is on average on an annual basis. To determine the loss of profits and to minimize the accidents in enterprises, permanent supervisors, who are assigned in the enterprises where they are working, were given a survey through the SurveyMonkey program. Of the 235 permanent supervisors who filled out the survey on behalf of the mining enterprises, 58 answered all of the multiple-choice questions examined in the study. These questions were analyzed together according to different mineral groups and differences in mining operation methods. As a result of the analysis, it was determined that the annual loss of profits of mining enterprises resulting from the aforementioned periods of downtime, and the ratio of these values to the annual operating costs constitute a rather significant share. The aim of the article was to raise awareness to have mining companies appropriate more funds for occupational health and safety.

STRATY ZYSKÓW POWSTAŁE W WYNIKU ZATRZYMANIA PRACY GÓRNICZEJ WYNIKAJĄCE Z WYPADKÓW PRZY PRACY LUB Z PRZYCZYN WYNIKAJĄCYCH Z PRZEPISÓW PRAWNYCH

Słowa kluczowe

bezpieczeństwo górnicze, bezpieczeństwo i higiena pracy, bezpieczeństwo ekonomiczne, bezpieczeństwo inwestycji, stracone dni robocze

Streszczenie

W przypadku wypadku przy pracy w górnictwie inwestorzy górniczy mogą obliczyć, jaką w przybliżeniu poniosą stratę. Jednak w przypadku wstrzymania wydobycia wynikającego z wypadków przy pracy lub ustawodawstwa, inwestorzy być może nie będą dbać o to, jak bardzo wzrośnie strata zysku z powodu strat nieprzepracowanego czasu w górnictwie. Powodem jest to, że nie ma jeszcze obowiązkowego wstrzymania w działalności wydobywczej i w takim przypadku kontynuuje się działalność górniczą. Unikanie zatrzymywania kopalń z powodu wypadków przy pracy i przepisów pozwoli zapobiec nieoczekiwanym kosztom wynikającym z tych strat czasu. W publikacji postawiono sobie za cel ustalenie, na ile łącznie składają się straty zysku wynikające z nieprzepracowanych okresów działalności operacyjnej przedsiębiorstw górniczych wstrzymanych z tych przyczyn i ile wynosi średnioroczny stosunek strat zysku do rocznych kosztów eksploatacji. Aby określić te straty w zysku i zminimalizować wypadki w przedsiębiorstwach, przeprowadzono ankietę w ramach programu „SurveyMonkey" wśród osób stałego nadzoru pracującego tych w przedsiębiorstwach. Spośród 235 stałych nadzorców, którzy wypełniali ankietę w imieniu przedsiębiorstw górniczych, 58 odpowiedziało na wszystkie zadane w badaniu pytania wielokrotnego wyboru. Pytania te analizowano łącznie według różnych grup surowców mineralnych i różnic w metodach eksploatacji górnictwa. W wyniku przeprowadzonej analizy ustalono, że roczne straty zysku przedsiębiorstw górniczych wynikające z postojów oraz stosunek tych wartości do rocznych kosztów eksploatacji stanowią średnio znaczący udział. Tym samym w artykule podjęto próbę uświadomienia, że firmy górnicze przeznaczają więcej środków na bezpieczeństwo i higienę pracy.