

Bankruptcy and bonity models use for the prediction of the mining organization development

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Abstract

Nowadays, due to the worldwide crisis, there is a necessity to predict and make a prognosis for the future development of the companies from the view of their financial health. Mainly mining organizations in Slovakia face a problem with creditworthiness when a number of companies declared bankruptcy. The paper has the ambition to predict development in chosen Slovakian mining organization through the most used bankruptcy and bonity models, which brings results, serving for comparing with companies in time and sector. The results were evaluated according to the individual areas of financial position that influenced the development the most. Such results are profitable for the sustainable development of mining organizations together with providing the energetic independence of the countries.

Keywords

mining and extraction companies, economic development, creditworthiness, financial stability



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Introduction

The financial health of the company is represented by its creditworthiness. Creditworthiness can also be understood as a certain indicator expressing the trustworthiness of an economic entity and, thus, the ability of an economic entity to repay its obligations. Bonita is often understood as a company rating, although its content is somewhat broader, but the rating as such is part of it. For a well-functioning and stable company, the evaluation of the company's creditworthiness is necessary for the evaluation of trends based on historical financial data, as well as for the compilation of predictions for the further development of the company's creditworthiness. Thanks to the evaluation of creditworthiness, companies can also predict the credit risk, which is also crucial when applying for a loan, not only from the bank's point of view but also from the point of view of the company. From the bank's point of view, a creditworthy company will be less risky and have a higher chance of obtaining foreign capital - a loan under more favourable conditions, e.g. lower interest rate, repayment amount and repayment period adapted to the needs of the company. The good creditworthiness of the company also reflects the economic stability of the entity. Through the application of financial analyses to specific creditworthiness and bankruptcy models, it is possible to identify the strengths of the company and possible financial threats that can weaken the creditworthiness of the company. Evaluating the creditworthiness of the company through financial indicators can lead to possible measures that can strengthen the creditworthiness and stability of the company. This topic is still relevant, as the assessment of the company's financial health and prediction of further development are key to strategic and tactical management decisions in a well-functioning and healthy company.

The number of companies with deteriorating creditworthiness in Slovakia is constantly increasing. It is also evidenced by the results of the company CRIF - Slovak Credit Bureau, which ensures the operation of credit registers, bank and non-bank, through which banking entities, savings banks, leasing companies and other companies can verify their creditworthiness and creditworthiness entities to repay their obligations (CRIF, 2023; <https://www.crif.sk>). From 2006 to March 2021, 4,412 bankruptcies were declared in Slovakia, and 875 restructuring of business and non-business entities - debtors - were allowed. According to CRIF, the year-on-year increase in bankruptcies in the second quarter of 2021 was up to 83% higher, and restructuring in the second quarter of 2021 increased by up to 150% year-on-year. The company also experienced several shadow bankruptcies. From the point of view of legal form, most companies in bankruptcy in 2021 were companies with limited liability, i.e. 27 bankruptcies and 1 joint-stock company and one non-profit organization. As for restructuring, from the legal point of view, restructuring was allowed for 3 limited liability companies and 1 joint stock company.

In accordance with the mentioned, the goal of the contribution is to find out the influence of the pandemic on the economic situation of the mining industry, determining the possible decline of the mining organizations. Only positive, sustainable development of the mining industry, presenting the primary sector, could influence the positive, sustainable development of secondary sectors connected to the mining activities.

Literature review

Credit and bankruptcy models, which provide information on the financial health of the company, play an important role in assessing the creditworthiness of companies. Although they do not point to specific sources of problems, they can warn of potential problems or bankruptcy of the company in time. According to Šmejkal and Rais (2003), creditworthiness models represent diagnostic models answering the question of whether the company is good or bad. They can evaluate the company with one synthetic indicator or coefficient through the purposeful selection of indicators that best contribute to its classification. Compared to bankruptcy models, these models are mainly based on theoretical knowledge. They depend on a large amount of data about the results in a certain industry, market segment, or database of comparable companies.

In literary sources, we come across a number of credit and bankruptcy models that are based on a mathematical-statistical basis. In practice, creditworthiness and bankruptcy models are applied in combination with financial indicators in order to achieve a comprehensive view of the company's management and to predict the development of the company's economic health. According to Karas and Reznakova (2015), there is extremely limited literature about how such application of prediction indexes affects the stability of the model's accuracy. The accuracy can be increased by consideration of the conditions for the use of the prediction indexes in concrete situations and concrete countries (Csikosova et al., 2019).

Tanaka et al. (2019) introduced a novel framework for models and a methodology for assessing the vulnerability of industrial economic activities, finding that bankruptcy criteria differ across industries. They also proposed a method of analyzing the vulnerability of industrial economic activities in various countries and industries, using the predicted likelihood of bankruptcy and company information. The mining industry is important for the economy as the primary sector. It is necessary to predict its economic development (Camska, 2013).

The bankruptcy of mining companies has been studied by Syamni et al. (2018), showing that the bankruptcy prediction scores of the Ohlson and Altman modifications were found to be the dominant prediction models that affected the mining companies in Indonesia. Bankruptcy in Polish mining companies is studied by Jonek-Kowalska and Majtan (2013), who found that the reasons for bankruptcy risk increase in the mining industry are mostly mistakes in management, changing mining-geological conditions as well as very high prices and demand fluctuations concerning energetic resources, as well as government's support for social-political reasons. Mining companies in the Czech Republic were also studied by Cerny et al. (2019) by the solvency and bankruptcy models. The research proves that selected benchmarks, such as Altman's model and Taffler's model, may be used on their own. The importance of benchmarking is strengthened by the fact that many authors consider benchmarking to be an integral part of strategic management. In this connection, Vanek et al. (2013) focused on major limestone producers in the Czech Republic.

The research of Kozel et al. (2022) showed that the useful bankruptcy models for Czech mining companies are the IN05 Index, Altman's analysis and the Taffler index. Camska (2016) found through the research that already existing models predicting financial distress still have enough power and accuracy for decision-making, and there is no need for the creation of a new one. Therefore, we used the well-known indexes in our research (see part methodology). Since Slovakia has a similar historical and economic development as post-communist countries, the same indexes can also be applied in Slovakian mining companies.

Methodology

The main goal of our work will be to deal with the creditworthiness of selected small and medium-sized companies - specifically mining companies operating in Slovakia. For the needs of the analytical part, we apply selected creditworthiness models:

- Králičkov quick test,
- IN 05 index
- creditworthiness index)

According to Králiček quick test, three categories are evaluated: financial stability, income situation and overall situation. Based on information from the financial statements, we calculated the relevant indicators for 2020 and 2021, which we then evaluated using the point method, with 1 point representing very good results, 2 points representing good results and 3 points representing average results (Camska, 2016). For the research needs, we chose from the credibility indices or from the IN indexes. The last modification of this index is index IN 05 since it is a complex variant. When calculating the creditworthiness index, unlike the IN 05 index, the effect of Cash Flow on the company's creditworthiness is also taken into account (Kozel et al., 2022)

From the findings resulting from the credit rating models we selected, we noted that some of the results of the analyzed companies might face financial risks that could threaten their credit rating. That is why we decided to apply one of the most famous bankruptcy models - the Altman model (Csikosova et al., 2019)

Individual creditworthiness and bankruptcy models contain various financial indicators evaluating the liquidity, profitability or indebtedness of the company and others, which enable a multidimensional view of the creditworthiness and overall financial health of the company.

The evaluated companies are operating in the mining industry in the territory of the Slovak Republic:

- ALAS Slovakia, Ltd.,
- Slovenské magnezitové závody, joint stock company,
- VSK MINERAL, Ltd.,

The company ALAS Slovakia, Ltd., with a seat in Bratislava, was founded in 1992 and belongs to medium-sized enterprises. The company specializes in natural quarried stone, gravel and concrete. The main activity is the mining and processing of aggregates and the production of transport concrete (www.alas.sk).

Slovak Magnesite Company, joint - stock company with a seat in Jelšava, carries more than 120 years of tradition. Currently, the company is the largest mining and processing magnesite plant in the Slovak Republic. According to the Statistical Office, the company has 500-999 employees. The company's production program is oriented towards the production of bulk dead-fired magnesite refractory products, caustic magnesite and slag-forming additives. These products are used in the steel, chemical, construction, and agricultural industries and in the industry of the production of incandescent materials (www.smzjelsava.sk).

Company VSK MINERAL, Ltd., with a seat in Košice, was established in 2006 through the transformation of the company. According to the statistical office, it employs 50-99 employees. VSK MINERAL, Ltd. is a member of the international group VSK MINING GROUP, which deals with the extraction of mineral deposits. The list of deposits and mined raw materials of VSK MINERAL, Ltd. is as follows:

- Vechec – andesite (building stone), quarry stone, stone rubble,
- Gretla (Spišská Nová Ves IV) – dolomite limestone, quarry stone, stone rubble,

- Brekov – dolomite limestone, quarry stone, stone rubble,
- Slanec – andesite, quarry stone, stone rubble,
- Horná Štubňa – andesite, quarry stone, stone rubble,
- Sedlice I – dolomite, quarry stone, stone rubble,
- Honce – limestone, quarry stone, stone rubble,
- Hubošovce - andesite, cyclone, hackle, road verge, paving stone, quarry stone, stone rubble,
- Garden – andesite, quarry stone, stone rubble,
- Breziny – andesite, quarry stone, stone rubble,
- Dargov – andesite, stone rubble, quarry stone, plinth stone,
- Mokrý Lúka – granite, quarry stone, stone rubble,
- Husiná I. (Stone Valley) – basalt, quarry stone, stone rubble,
- Veľká Tňa – tuffs, cyclone,
- Markušovce – high-percentage limestone (www.vskmineral.sk)

We will evaluate the results of these models and compare both selected companies and the results of individual companies within different models. We will summarize the overall findings, evaluate and propose appropriate solutions to improve not only the creditworthiness but also the creditworthiness of the three mining companies we selected. In addition to the suggestions resulting from our findings, we also define possible other measures that companies can apply to improve creditworthiness and creditworthiness.

The method of ex-ante financial analysis is often used to evaluate the creditworthiness of companies, and through selected financial indicators, their development in time or space is compared in the company (e.g. companies operating within the same industry that are comparable to each other). The goal of this analysis is to predict the development of the financial side of companies and to prevent problems and financial decline with its help. Data from financial accounting are considered to be significant sources of data for the analysis of a company's creditworthiness. The data from the financial reports of mining organizations had been obtained directly from the analyzed organizations, as well as via the database Finstat (<https://finstat.sk/>)

Results

Quick Test

Based on the test, we evaluated the mentioned 3 categories. Financial stability ALAS Slovakia, Ltd and SMZ, a.s. have an index of 1 for both monitored periods and are therefore in a grey zone that may represent financial instability, but these businesses are not necessarily at risk of bankruptcy. VSK MINERAL, Ltd. had an index of 1.5 for both periods under review; it is also in this grey zone.

The revenue situation of all three monitored companies was variable in both years. While ALAS Slovakia, Ltd. slightly worsened its revenue situation with a point score of 1.5 compared to the previous year, when the company had higher performances and a point score of 2. However, we can say that according to this index, the company is in the grey zone. In the case of the other two enterprises, this index improved. In particular, SMZ, a.s. were in the grey zone from the perspective of the revenue situation in 2020, and in 2021, there was a significant increase in performance and an improvement in this index so that we can label this company as creditworthy (achieving a period rating of 4). Smaller mining company VSK MINERAL, Ltd. is in the grey zone, but the income situation index recorded an increase in 2021 compared to 2020. The results of the evaluated areas are in Tab. 1.

Tab. 1. Quick test applied in chosen mining organization in 2020-2021

	ALAS Slovakia, Ltd.		SMZ, a.s.		VSK MINERAL, Ltd.	
	2020	2021	2020	2021	2020	2021
A (financial stability)	1.00	1.00	1.00	1.00	1.50	1.50
B (income situation)	2.00	1.50	2.50	4.00	2.00	2.50
C (total evaluation)	1.50	1.25	1.75	2.50	1.75	2.00
% of Equity on capital	63.93%	66.93%	53.67%	42.23%	49.22%	45.80%
	1 point	1 point	1 point	1 point	1 point	1 point
Debt repayment period in years	1.776	1.437	0.493	2.332	4.813	3.452
	1 point	1 point	1 point	1 point	2 points	2 points
CSF on performance	12.87%	11.24%	8.92%	1.91%	5.43%	3.84%
	1 point	1 point	2 points	4 points	3 points	4 points
Total capital profitability	11.79%	12.18%	9.59%	4.25%	16.52%	19.97%
	3 points	2 points	3 points	4 points	1 point	1 point

Source: own processing according to Financial reports of the mining organizations

The overall assessment of the situation of the selected companies is relatively favourable, as the index has values of 1.25 to 2.5 in both monitored periods and is closer to the upper limit of the grey zone index. We can say that companies are not at risk of bankruptcy. Companies also have the potential to improve their creditworthiness in the future, which we judge by the favourable index of earnings and by the growing trend of sales of the selected companies. We noticed a slight decrease in the index evaluating the overall situation only at the company ALAS Slovakia, p. r. o. However, in terms of significance, the company is not in danger. A very favourable improvement in the company's overall situation occurred in the case of SMZ, a.s. In the case of VSK MINERAL, ltd. We also recorded a slight positive increase in the index when evaluating the overall situation of the company. The development of organizations is obvious in Figure 1.

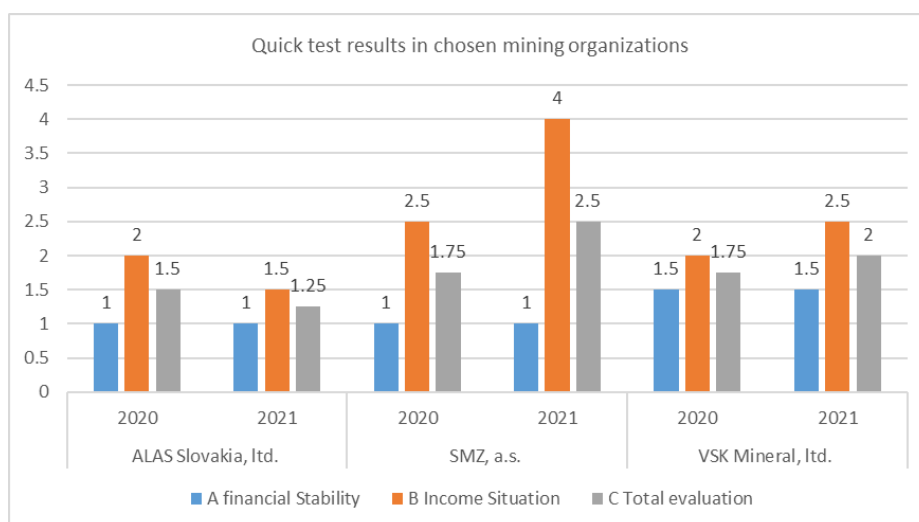


Fig. 1. Comparison of the Quick test results in mining organizations

Index IN 05

For the overall evaluation of the IN 05 index for the year 2020 for the mentioned companies, we can state that a significantly high value was achieved by ALAS, Slovakia, Ltd., up to 3.266, which is a significantly higher value than the recommended benchmark value of 1.6. In 2021, there was even a significant increase in the IN 05 index up to 4.506. Therefore, we can assume a relatively satisfactory financial situation for this company, and it is, therefore, a relatively creditworthy company even according to the year-on-year trend.

SMZ, a.s., was higher in the interval of the grey zone with a value of 1.25 in 2020, i.e. in the area of no wins. In 2021, due to a significant decrease in assets, EBIT and total revenues, there was a significant decrease in the IN05 index to a value of 0.875. The company has reached risk values and may face critical threats or financial problems. However, this company is not necessarily in danger of bankruptcy due to the increasing trend of total revenues; however, the decreasing trend of profit can be threatening for the company.

VSK MINERAL, Ltd., which has the IN 05 index for the year 2020, is very close to the border, where the company is facing critical threats and may face financial problems in the future. In 2021, this index fell to 0.806, which was mainly due to the impact of the decline in EBIT. In order to improve the creditworthiness of this company, we would suggest, based on the results of the IN 05 index, primarily reducing short-term loans and short-term liabilities, or to reduce foreign capital (also long-term due to the relatively high-cost interest). Table 2 illustrates the development of the IN 05 index in all analyzed mining organizations in the analyzed period.

Tab. 2. Index IN 05 in analyzed mining organizations in 2020-2021

	ALAS Slovakia, Ltd.		SMZ, a. s.		VSK MINERAL, Ltd.	
	2020	2021	2020	2021	2020	2021
Index IN 05	3.266	4.506	1.250	0.875	0.897	0.806
A	2.773	3.024	4.803	4.166	1.970	1.845
B	50.546	83.972	0.000	0.000	5.737	6.044
C	0.129	0.112	0.089	0.019	0.054	0.038
D	1.606	1.302	1.031	1.060	0.593	0.604
E	0.400	0.380	0.606	0.388	0.790	0.505

Source: own processing according to Financial reports of the mining organizations

Bonity Index

Table 3 summarizes the results of the Bonity index, applied in the analyzed mining organization in the analyzed period, which speaks about the level of creditworthiness of the organizations.

Tab. 3. Bonity Index in the mining organizations in 2020-2021

	ALAS Slovakia, ltd.		SMZ, a. s.		VSK MINERAL, ltd.	
	2020	2021	2020	2021	2020	2021
Bonity index	2.739	2.649	2.201	0.994	1.427	1.172
x1	0.429	0.464	0.247	0.171	0.120	0.158
x2	2.773	3.024	4.803	4.166	1.970	1.845
x3	0.129	0.112	0.089	0.019	0.054	0.038
x4	0.080	0.086	0.086	0.018	0.092	0.064
x5	0.086	0.086	0.062	0.056	0.098	0.084
x6	1.606	1.302	1.031	1.060	0.593	0.604

Source: own processing according to financial reports of the mining organizations

In the overall assessment of the creditworthiness index, we can say that all monitored companies are creditworthy and are not at risk of bankruptcy in the short term (based on historical data for 2020 and 2021). According to the general interpretation of the VSK MINERAL credit rating index, ltd. the financial situation is good. However, we can once again recommend VSK MINERAL, ltd. partial reduction of foreign capital to optimize the company's creditworthiness or for better credit ratings of the company overall in the market within the industry. In comparison with ALAS Slovakia, ltd. with the SMZ, a. s., which achieved a very good creditworthiness index according to the reference table in 2020, since it was at the value of two, we can claim that these companies are creditworthy according to the creditworthiness index. In 2021, however, there was a reversal in the case of the SMZ,a.s. the solvency index dropped very significantly to 0.994 points, which is on the border with a good situation and may represent a certain signal that the company may face some problems. The company increased its total capital with foreign capital, and the company's profit after tax was more than 5 times lower, although the total company's performance was higher by approximately 20 mil. €. Due to the historical development of the company's financial data, we do not necessarily assume bankruptcy, but for a better credit rating, we would recommend reporting higher profits in the next period, especially in case of an increase in foreign resources. ALAS Slovakia, ltd., from our analysis, we can rate it as a company with a very good credit rating. Even despite the smaller drop in the credit rating index from 2.74 points to 2.65 points, the company is in the upper limit of the index. Therefore, we do not assume that it could face financial problems or that it would belong to businesses with a weak credit rating (see Figure 2).

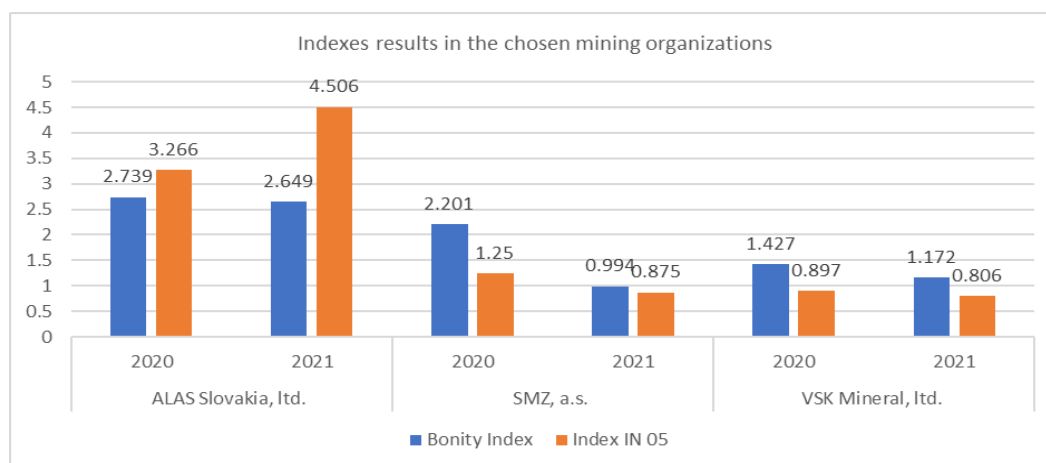


Fig. 2. Comparison of the IN 05 and Bonity index in mining organizations in 2020-2021

In the comparison of the results of the creditworthiness index and the IN 05 index, we reached very similar conclusions in the case of all companies. In the case of the creditworthiness index, all selected companies were creditworthy, while ALAS Slovakia, ltd. and SMZ, a.s. also had this index higher in 2020, but in 2021, the company faced certain problems (especially lower reported profit), as there was a significant drop in the creditworthiness index. After evaluating the results of the IN 05 index, we concluded that VSK MINERAL, ltd.

is right on the border of critical threats and the grey zone, so according to this model, we can assume financial problems of this company, but we do not consider them necessarily critical.

Altman model

Overall evaluation of Altman's model for SMZ, a.s. in 2020, it reached an approximate value of 2.35 and then in 2021, it decreased to 1.92. In both monitored periods, we evaluated that the company is in the grey zone, which is an area of unsuccessful results. Although the company does not face significant financial risks, the downward year-on-year trend is worrying, and if this trend persists, the company may face bankruptcy. The worst overall results were ALAS Slovakia, ltd., whose Z-score was approximately the same in both observed periods, approx. 1.6. With such a Z-score, it is more than likely that the company is facing critical financial problems and may be at risk of bankruptcy. Mentioned is obvious from the data in Table 4.

Tab. 4. Altman model in chosen mining organizations in 2020-2021

	ALAS Slovakia, ltd.		SMZ, a. s.		VSK MINERAL, ltd.	
	2020	2021	2020	2021	2020	2021
Altman model	1.643	1.671	2.349	1.923	3.826	3.292
x1	0.122	0.090	0.113	0.471	0.022	-0.023
x2	0.215	0.171	0.136	0.096	0.263	0.262
x3	0.129	0.112	0.089	0.019	0.054	0.038
x4	1.773	2.024	2.578	1.759	0.970	0.845
x5	0.229	0.262	0.794	0.707	3.018	2.618

Source: own processing according to financial reports of the mining organizations

We evaluated the overall results of the mentioned models and displayed them in the common table Tab. 5. For an easier comparison of the achieved results of individual models; we also used an evaluation colour scale.

Tab. 5. Overall evaluation and comparison of chosen mining organization in 2020-2021

	ALAS Slovakia, ltd.		SMZ, a. s.		VSK MINERAL, ltd.	
	2020	2021	2020	2021	2020	2021
BONITY evaluation						
Bonity index	2.739	2.649	2.201	0.994	1.427	1.172
Index IN 05	3.266	4.506	1.250	0.875	0.897	0.806
Quick test						
Financial stability	1.00	1.00	1.00	1.00	1.50	1.50
Income situation	2.00	1.50	2.50	4.00	2.00	2.50
Total evaluation	1.50	1.25	1.75	2.50	1.75	2.00
Bankruptcy prediction						
Altman model	1.643	1.671	2.349	1.923	3.826	3.292

Evaluation Scale:

Company with good creditworthiness
Company in the grey zone – bankruptcy cannot be predicted
Company in the grey zone – bankruptcy is not probable
Company in the grey zone – not probable bankruptcy
Line of grey zone – the company can be threatened by critical financial threats

The analyzed mining companies were mostly creditworthy, but in the case of some model results, we noted weaker creditworthiness or possible financial threats. The results of the credit models for the mentioned companies differed slightly, which was caused by the indicators that the models took into account. According to a quick test, we evaluated the financial stability, revenue situation and overall situation of the company for the mentioned companies. The financial stability of ALAS Slovakia companies, ltd. and SMZ, a.s. was the weakest. VSK MINERAL, ltd. had slightly better financial stability but was still in the grey zone. In terms of revenue and overall stability, the companies achieved relatively satisfactory results. They were mostly in the grey zone, but

the bankruptcy of the companies was only very unlikely. From the point of view of the creditworthiness index, we evaluated ALAS Slovakia, Ltd. as relatively creditworthy, and the IN 05 index for this company reflected similar results. The largest decrease in 2021 compared to 2020 was recorded at SMZ, a.s. whose credit rating has decreased quite significantly; it is even possible that the company will face financial problems - we obtained these results from the credit rating index and also from the IN 05 index. VSK MINERAL, Ltd. according to the creditworthiness index, it was in the grey zone, and according to the IN 05 index, the company fared worse, so it may face financial problems. This model generally evaluated some indicators more strictly. We considered the results obtained from the quick test to be the most complex results of the model for evaluating the company's creditworthiness. Based on the bankruptcy model - Altman's model, the company VSK MINERAL, Ltd, SMZ, a.s. also had relatively satisfactory results. ALAS Slovakia, Ltd. was the worst. The results of this bankruptcy model were largely influenced by the company's financial stability, which was also reflected in the quick test.

Discussion and Conclusion

In order to increase the creditworthiness not only of a financially healthy company but especially of a company facing financial problems or bankruptcy, strategic and tactical measures are necessary within the framework of crisis management, which can lead to a positive development of the creditworthiness of these three companies. The mentioned proposals can also be applied to other companies, as we encountered mostly similar problems within the mining industry, such as the need for restructuring of the capital structure, modernization, innovation and development of technologies, product lines, expansion of exports and greater involvement in various construction projects, etc.

The decline and bankruptcy of many mining organizations had been caused by the emergence of the pandemic. Many of them were forced to take immediate measures to protect the health and life of employees and their families, as well as maintain financial stability in connection with the economic slowdown (Forwarczny, 2020). Manowska et al. (2017) showed that to provide financial stability, it is necessary to create a new policy of restructuring within the industry and aid further development. In case of problems with financial stability, it is necessary to make consolidation schemes used for mining organizations to limit the risk of mining (Jonek-Kowalska, 2019). In Europe, mining companies were consolidated due to market risk (lack of efficiency, progressing decarbonization, prohibition of subsidizing mining production by the state) and, subsequently, the risk of bankruptcy. Also, Birn et al. (2023) pointed out how various political, economic and social mechanisms can influence the bankruptcy of the mining organizations. Together with individual indexes for decline prediction, according to Juarez (2011), it is necessary to follow a complex model of health to determine relationships among aggregate indicators of financial statements.

Environmental and socio-economic problems associated with mining activities remain very concerning issues throughout the country. However, financial health is affected not only by mining activities but also by further collaboration between citizens, mining companies, government institutions, and other stakeholders (Otamonga and Pote, 2020). Additionally, Wozniak et al. (2022) addressed the need to follow up on sustainable development in relation to a group of mining companies, indicating the role and importance of environmental, social, and governance disclosures by industry players.

The results of the paper can be used for the sustainable development of mining organizations, together with the creation of policies and the provision of energetic independence for countries, including Slovakia. The research is limited because the paper extends to the single indexes, not regarding the influence of the financial statements, such as balance sheet, loss and profit statement and cash-flow statement, as suggested by (Juarez, 2011). Ex-post analysis is rather reliable and useful for prediction; however, ex-ante analysis is limited to the assumption of following up on the trend and rationality of the economic subjects. Due to the behavioural aspects of the managers making financial decisions, it is necessary to use ex-ante as a support tool and consider behavioural finances (Das, 2022). Future research will consider the mentioned influence and examine the relationship between mining, training, and dialogue aspects and the associated adverse environmental and health outcomes that are needed to characterize the impact of mining activities on health and the environment more adequately.

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