Information Support of Economic Security of Mining Enterprises' Competitive Status and its Assessment Taking into Account the Level of Digital Maturity

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ABSTRACT

The article substantiates that the internal security level influences greatly the level of external security of the competitive status. Internal security is determined to become apparent through the productivity value of current costs, product quality, the degree of production capacities use and technical characteristics of equipment. External security of the competitive status should be assessed on the basis of determining the deficiency of the earnings before tax value which is short-received by an enterprise because of discrepancy between its market share and the share of a leading one. The developed indices underlie assessment of economic security of the competitive status of Ukraine's mining enterprises. The methods suggested in the article are used for calculating the level of reserves of internal security of the competitive status for iron ore open pits of mining and concentrating works and demonstrate availability of considerable reserves at all open pits of Ukraine's mining and concentrating works. At the same time, iron content in products of Ukrainian mining enterprises is known to be lower than that at foreign companies and the content of impurities does not meet international market requirements. Due to that, all Ukrainian enterprises are characterized by non-compliance of key indicators that describe their competitive status with threshold values. This testifies to inefficiency of economic security provision and management. To ensure the economic security of enterprises in the future, it is currently proposed to assess the level of digital maturity of the enterprise and, based on the data obtained, develop appropriate measures. These measures should include digitalization of all areas of the enterprise. It is proposed to introduce activities to digitize the value chain, equipment and mineral resources. Important indicators that provide information about the level of economic security in the future are the current level of use of big data and the level of digitalization of product promotion.

Keywords: Security; Competitive status; Digitization of the value chain; Digitization of equipment; Digitization - mineral resource base; Level of use of big data.

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Apoyo Informativo de la Seguridad Económica de la Situación Competitiva de las Empresas Mineras y su Evaluación teniendo en cuenta el Nivel de Madurez Digital

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RESUMEN

El artículo corrobora que el nivel de seguridad interna influye en gran medida en el nivel de seguridad externa de la situación competitiva. La seguridad interna se determina para hacerse evidente a través del valor de productividad de los costes corrientes, la calidad de los productos, el grado de utilización de las capacidades de producción y las características técnicas de los equipos. La seguridad externa de la situación competitiva debe evaluarse sobre la base de la determinación de la deficiencia del valor de los beneficios antes de impuestos que recibe una empresa debido a la discrepancia entre su cuota de mercado y la de una empresa líder. Los índices elaborados sirven para evaluar la seguridad económica de la situación competitiva de las empresas mineras de Ucrania. Los métodos propuestos en el artículo se utilizan para calcular el nivel de reservas de seguridad interna de la situación competitiva de los pozos abiertos de mineral de hierro de las empresas mineras y de concentración y demuestran la disponibilidad de reservas considerables en todos los pozos abiertos de las empresas mineras y de concentración de Ucrania. Al mismo tiempo, se sabe que el contenido de hierro en los productos de las empresas mineras ucranianas es inferior al de las empresas extranjeras y que el contenido de impurezas no cumple los requisitos del mercado internacional. Por ello, todas las empresas ucranianas se caracterizan por el incumplimiento de los indicadores clave que describen su situación competitiva con los valores límite. Esto demuestra la ineficacia de la provisión y gestión de la seguridad económica. Para garantizar la seguridad económica de las empresas en el futuro, actualmente se propone evaluar el nivel de madurez digital de la empresa y, basándose en los datos obtenidos, desarrollar las medidas adecuadas. Estas medidas deberían incluir la digitalización de todas las áreas de la empresa. Se propone introducir actividades para digitalizar la cadena de valor, los equipos y los recursos minerales. Los indicadores importantes que proporcionan información sobre el nivel de seguridad económica en el futuro son el nivel actual de uso de big data y el nivel de digitalización de la promoción de productos.

Palabras claves: Seguridad; Situación competitiva; Digitalización de la cadena de valor; Digitalización de equipos; Digitalización - base de recursos minerales; Nivel de uso de big data.

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1. Introduction

At present, competitiveness makes the basis for long-term and efficient business, brings confidence in future success of every economic entity. In market conditions, the right to exist belongs only to competitive enterprises. Competitiveness is the only road for any enterprise to stable, efficient, promising and socially protected development. So, “competitiveness” is one of the main economic categories of a market economy and scientists and practitioners pay much attention to it on a continuous basis. At the same time, changing conditions of economic activities require provision of security of an enterprise’s competitive status. The concept contains two components - “security” and “competitive status”. The concept “competitive status” itself was first introduced by I. Ansoff (1989). At present, the concept does not have a single definition. This type of security is part of economic security of an enterprise which can be described as “a process of providing stable performance, financial equilibrium and regular earnings as well as ability to implement goals and tasks, to develop and progress at various stages of the lifecycle of an enterprise and in conditions of competitive market changes” (Pylypenko et al., 2019).

The essence of the concept “economic security of the competitive status” is not sufficiently covered in scientific literature. However, issues of enterprise competitiveness, competitive intelligence and its influence on economic security of an enterprise are widely dealt with (Calof (2016), Giannopoulos et al., (2012), Toit (2015)). The present article suggests treating economic security of the competitive status as an economic rivalry state of an enterprise when the required level of any kind of economic results (classic and non-classic) is reached, economic short-, medium- and long-term interests of the enterprise as well as those of its personnel and owners are satisfied regardless of impacts of internal and external factors and actions of stakeholders of any group. Here, it is provided for that if all kinds of resources are used efficiently, an enterprise is able to resist negative consequences of negative impacts of any origin without sacrificing its current and strategic economic interests. In (Mishchuk, 2018), we suggest differentiation of economic security of the competitive status of an enterprise into internal and external ones. However, this research has not received further development. The toolkit for assessing both components of economic security of the competitive status and economic security itself is still underdeveloped.

In view of the above, research into assessment of economic security of an enterprise’s competitive status is of great current interest.

Thus, the purpose of this article is to assess the level of economic security of the competitive status of Ukrainian mining enterprises and the emergence of reserves for its increase.

2. Literature Review

It is worth mentioning that scientists mostly refer the concept “internal competitiveness” to individual projects (Romanchik et al., 2020). Unlike this view, we focus on internal security of the competitive status. In our opinion, it characterizes the ability of any structural subdivision to function efficiently within its enterprise. It is reasonable to assess the level of internal security of the competitive status inside the enterprise at all levels of economic activities and at all its subdivisions.

Achievement of economic security of the competitive status provides for rivalry for the most favorable economic activity conditions in regard to other producers on the market.

As rightly said in (Salter et al., 2016), rivalry stimulates enterprises to look for additional opportunities and their implementation in their activities. The authors of (Mohammad et al., 2010; Gontareva et al., 2020) state that to be able to compete with multiple competitors and maintain their status on the market, companies have to ensure better performance of processes, better prices, quality, etc. Besides the above mentioned, it is reasonable to add factors of keeping up with other companies determined in (Dvorsky et al., 2020): acceptance of product prices by customers and their support of the enterprise in business. Importance of a price in competitiveness establishment is highlighted in (Adabi et al., 2019) as well. In addition, to enhance competitiveness, some scholars

recommend implementation of TQM-based strategies (Taçoğlu et al., 2019), enhancement of the organizational structure and the style of management (Savytska et al., 2019). However, in spite of the sufficient number of current strategies, competitiveness of Ukrainian goods and services remains low. One of the reasons for that is failing to hold and develop the market share (Zos-Kior and Kaliuzhnyi, 2020). Here, the problem is insufficient experience in assessing security of the competitive status on the basis of which managerial decisions can be developed and implemented. All the factors of influence on competitiveness can be divided into external and internal ones (Shah et al 2011). External factors do not belong to the sphere of enterprise management influence and are formed in the market environment. Availability of internal factors of influence on competitiveness depends on the management system of the enterprise and its owners' attitude to the business only (Oliinyk and Buryk, 2018).

3. Materials and Methods

In the competitive environment, such opportunities occur first inside an enterprise itself. Therefore, providing internal security of the competitive status, the enterprise creates conditions for reaching a high level of external security of its own competitive status (see Fig. 1).

It is obvious that both components of economic security of the competitive status require a special assessment toolkit. Its specific nature will depend on the industry an enterprise under study belongs to.

The work (Rubin, 2016) presents differentiation of the competitive status of economic entities participating in competition: the leader, a claimant for leadership, a confident average performer, an outsider.

Figure 1. Conceptual approach to forming economic security of the competitive status of an enterprise

[Designed by the authors]

At that, there are no "leaders in general". So, it is important to distinguish between competitive leadership in performing certain competitive actions and use of available resources on the one hand and competitive leadership in achieving results from these actions on the other hand (Rubin, 2016). In view of this, we find it reasonable to develop an additional criterion of competitive leadership – the level and the state of economic security on the whole and of its individual types including security of the competitive status.

Mining enterprises are strategically important for Ukraine's economy and security. These enterprises employ about 1% of the country's population. Mining enterprises have been occupying leading positions in the list of top-100 Ukrainian budget replenishers for many years (2020). Moreover, the part their tax payments in local budgets makes 40% to 50%. Specificity of such enterprises' production activities impacts the environmental situation in the country. That is why, it is their security of the competitive status that budget, financial, environmental and social security of individual regions of Ukraine depends on. Besides, Ukrainian mining enterprises supply their products to metallurgical companies of Europe (Germany, Austria, Serbia, Turkey), South-East Asia (South Korea, Japan and China) as well as to the USA. So, the role of Ukrainian mining enterprises in the global economic life can hardly be overestimated.

Thus, the article aims to investigate economic security of the competitive status of a mining enterprise and find reserves of its enhancement.

In our opinion, it is important to assess and know reserves of enhancing internal security of the competitive status as it forms (in all structural subdivisions together) the average level of external security of the competitive status of a mining enterprise. Internal security of the competitive status possesses its own specificity of its level assessment. For instance, such an important indicator as the profitability index cannot be calculated at the level of a workplace, a site and even a shop (of an iron ore open pit). Mining and geological conditions of open pit production require consideration as well (Yaseen et al 2018).

We suggest the indices presented in (Turilo et al., 2006) for assessing the level of internal security of the competitive status. Considering them, the level of internal security of the competitive status of an iron ore open pit at a mining and concentrating works can be assessed as follows:

$$L(is) = I_{ccp} \times I_q \times I_p \times I_{sr} \times I_{tc}, \quad (1)$$

where $L(is)$ is the index of internal security of the competitive level of a structural subdivision (an iron ore open pit) at a mining and concentrating works, unit fractions;

I_{ccp} is the index describing the relation of actual and standard (or competitive, planned) current costs productivity for the period under consideration, unit fractions;

I_q is the index describing the relation of actual and standard (competitive, planned) value of iron ore quality for the period under consideration, unit fractions;

I_p is the index describing the relation of actual and standard (or competitive, planned) value of production capacity of an iron ore open pit for the period under consideration, unit fractions;

I_{sr} is the index describing the relation of actual and standard (competitive, planned) stripping ratios of an iron ore open pit for the period under consideration, unit fractions;

I_{tc} is the index describing the relation of actual and standard (competitive, planned) technical characteristics of the equipment at an iron ore open pit for the period under consideration, unit fractions.

The above indices are calculated in the following way (Turilo et al., 2006):

$$I_{ccp} = \frac{CCPa}{CCPs}, \quad (2)$$

where $CCPa$, $CCPs$ are indices describing actual and standard (competitive, planned) current costs productivity for the period under consideration respectively, UAH/UAH;

$$I_q = \frac{Qa}{Qs}, \quad (3)$$

where Qa , Qs are the indices describing actual and standard (or competitive, planned) value of iron ore quality for the period under consideration respectively, %:

$$I_p = \frac{Pa}{Ps}, \quad (4)$$

where Pa , Ps are the indices describing actual and standard (or competitive, planned) iron ore pit production capacity for the period under consideration respectively, t (m³):

$$I_{sr} = \frac{SRa}{SRs}, \quad (5)$$

where SRa , SRs are the indices describing actual and standard (or competitive, planned) stripping ratios at an iron ore open pit for the period under consideration respectively, unit fractions;

$$Itc = \frac{TCa}{TCs}, \quad (6)$$

where TCa , TCs are the indices describing actual and standard (or competitive, planned) technical characteristics of the equipment at an iron ore open pit for the period under consideration respectively, unit fractions.

The absolute criterion of the level of internal security of the competitive status of an iron ore open pit at a mining and concentrating works and the criterion of its level enhancement ($L(is)$) are expressed by the following expressions:

$$L(is) \rightarrow 1 \quad (7)$$

at $lccp \leq 1$, $lq \leq 1$, $lp \leq 1$, $lsr \leq 1$, $lrc \leq 1$;

$$L(is) = L(is)_t - L(is)_{t-1} > 0, \quad (8)$$

where $L(is)_t$, $L(is)_{t-1}$ are the indices of internal security of the competitive status of an iron ore open pit at a mining and concentration works for adjacent time periods t and $(t-1)$ respectively.

To provide qualitative interpretation of assessment of the level of internal security of the competitive status, we suggest applying the scale proposed in [19]:

- at $L(is) < 0$ – a high level of danger;
- at $L(is) = 0$ – a zero (catastrophic) level of security (which is the same as the mean level of danger);
- at $0 < L(is) < 0.25$ – the minimum level of security (which is the same as the low level of danger);
- at $0.25 \leq L(is) < 0.5$ – low security;
- at $0.5 \leq L(is) < 0.75$ – the mean level of security;
- at $0.75 \leq L(is) < 1.0$ – a high level security;
- at $L(is) = 1.0$ – a very high level security.

We suggest assessing the level of external security of the competitive status on the basis of the index proposed in (Mishchuk et al., 2020) and the technique developed in (Nusinova and Molodetska, 2011). This index is a difference between 1 and a relation. The numerator of the relation is earnings before tax (EBT) deficiency caused by failure to achieve the particular index – the object of its liminal value accessiement. We suggest the market share indicator (dp) as such an index. It is reasonable to use the maximum market share value in the industry as a liminal value of a market share during the assessment period. The denominator of the security level index is expressed by the liminal value of earnings before tax ($EBTI$). This value is a sum of the previously determined deficiency and the actual amount of earnings at the enterprise during the assessment period. Here, it is important that, if there is no deficiency of earnings before tax, this value equals zero and is not considered. Besides, if an enterprise makes a loss during the assessment period, further calculations are not performed and the conclusion is drawn about danger for the competitive status. Thus, the index of the level of external security of the competitive status is calculated by the formula:

$$L(dp) = \frac{\Delta EBT(dp)}{EBTI}, \quad (9)$$

where $L(dp)$ is the level of external security of the competitive status, unit fractions;

$\Delta EBT(dp)$ is earnings before tax deficiency determined by the market share, UAH;

$EBTI$ is the liminal value of earnings before tax, UAH.

When determining the EBT amount deficiency, a marginal revenue value should be considered:

$$\Delta EBT(dp) = \frac{MRa}{Va} \times \Delta V(dp), \quad (10)$$

where $\Delta EBT(dp)$ is the EBT amount deficiency determined by the market share, UAH;

MRa is the actual value of the marginal revenue, UAH;

Va is the actual sales value, UAH.

The sales value short-received by an enterprise due to failure to achieve the liminal value of the market share is determined by the formula:

$$\Delta V(dp) = \left(\frac{L(dp)}{dpa} - 1 \right) \times Va, \quad (11)$$

where $\Delta V(dp)$ is the short-received sales value, UAH;

$L(dp)$ is the liminal market share value, unit fractions;

dpa is the actual share value; unit fractions;

Va is the actual sales value, UAH.

It is very important here to assess the threshold volume of sales (VI) which is the value an enterprise could receive at the liminal market share:

$$VI = Va + \Delta V(dp) \quad (12)$$

The following expression can serve as a criterion of the level of external security of the competitive status:

$$L(dp) \rightarrow 1 \quad (13)$$

4. Results And Discussion

The suggested approach has been used for assessing the level of internal security of the competitive status at mining enterprises of Ukraine. It should be noted that data from all mining enterprises of the country were used for the investigation. However, for illustration purposes, Table 1 presents assessment data on mining and concentrating works of Kryvyi Rih iron ore basin only.

The calculations show that in 2018 the level of internal security of the competitive status decreased at all mining enterprises of Ukraine as compared with that in 2017. Still, it remained high at the PrJSC "Northern GZK". At the PrJSC "Central GZK" internal security of the competitive status dropped from the mean to a low level, at the other enterprises (the PRJSC "InGZK" and the JSC "Southern GZK") – from high to mean. For better understanding the obtained data, it is necessary to understand the specific character of the enterprises' activities (Table 2).

The suggested approach has been used for assessing the level of external security of the competitive status at mining enterprises of Ukraine. It should be noted that data from all mining enterprises of the country were used for the investigation. However, for illustration purposes, Table 3 presents assessment data on mining and concentration works of Kryvyi Rih iron ore basin only.

The PrJSC "Northern GZK" is a leader by the market share index. In 2017 as well as in 2018, its indices equaled 1 and testified to a very high level of external security of the competitive status. In 2017, the JSC "Southern GZK" demonstrated a high security level, too.

The PrJSC "InGZK" demonstrated a mean level, the PrJSC "Central GZK" – a low level of external security of the competitive status.

Table 1. Dynamics of indices forming the general level of internal security of the competitive status of Ukraine's mining enterprises in 2017-2018

Indices of internal security of competitive status	Mining and concentrating works (GZK)			
	PrJSC "Northern GZK"	PrJSC "Central GZK"	PrJSC "InGZK"	JSC "Southern GZK"
Years: 2017				
Index <i>I_{ccp}</i> , unit fractions	0.970	0.950	0.950	0.965
Index <i>I_q</i> , unit fractions	1.000	0.970	0.999	0.998
Index <i>I_p</i> , unit fractions	1.000	0.852	1.000	0.996
Index <i>I_{sr}</i> , unit fractions	0.975	0.961	0.975	0.971
Index <i>I_{tc}</i> , unit fractions	0.959	0.918	0.961	0.943
Index of level of internal security of competitive status, unit fractions (<i>L(is)</i>)	0.907	0.693	0.889	0.878
Qualitative interpretation of internal security level	High	Mean	High	High
Years: 2018				
Index <i>I_{ccp}</i> , unit fractions	0.960	0.912	0.960	0.952
Index <i>I_q</i> , unit fractions	0.997	0.918	0.995	0.994
Index <i>I_p</i> , unit fractions	0.993	0.810	0.854	0.890
Index <i>I_{sr}</i> , unit fractions	0.987	0.902	0.977	0.914
Index <i>I_{tc}</i> , unit fractions	0.950	0.801	0.921	0.925
Index of level of internal security of competitive status, unit fractions (<i>L(is)</i>)	0.891	0.490	0.734	0.712
Qualitative interpretation of internal security level	High	Low	High	High

Source: calculated by the authors

Table 2. Key factors impacting the level of internal security of the competitive status of Ukraine's mining enterprises

Key impacting factors		
Product quality (iron content)	Production structure	Production method
PrJSC "Northern GZK"		
Concentrate: 66%; pellets: 62%, 63%, 65%	2 open pits	Complete cycle of raw material preparation, open pit mining of ferruginous quartzite
PrJSC "Central GZK"		
Concentrate: 67,5% , 68,2%; pellets: 65%	3 open pits, 1 underground mine	Both underground and open pit mining
PrJSC "InGZK"		
Concentrate: 64 – 67%	1 open pit	Continuous technology
JSC "Southern GZK"		
Concentrate: 67,5%; sinter: 62% (non-fluxed), 50-57% (fluxed)	1 open pit	Open pit mining

Source: calculated by the authors

Table 3. Results of assessing the level of external security of the competitive status of mining enterprises in 2017-2018

Index	2017	2018
Liminal value of market share, %	22.4	23.4
PrJSC "Northern GZK", 000 UAH		
Threshold sales volume	23 190 396	26 325 429
Short-received sales volume	-	-
Marginal revenue per 1 UAH of volume	51%	49%
EBT deficiency	-	-
Liminal EBT value	9 502 718	9 886 428
Security level $L(dp)$, unit fractions	1.00	1.00
PrJSC "Central GZK", 000 UAH		
Threshold sales volume	23 282 274	26 189 733
Short-received sales volume	12 554 697	14 813 093
Marginal revenue per 1 UAH of volume	47%	44%
EBT deficiency	5 895 298	6 558 930
Liminal EBT value	9 197 747	9 126 772
Security level $L(dp)$, unit fractions	0.36	0.28
PrJSC "InGZK", 000 UAH		
Threshold sales volume	23 683 983	25 924 309
Short-received sales volume	7 701 617	7 345 269
Marginal revenue per 1 UAH of volume	53%	45%
EBT deficiency	4 093 249	3 323 564
Liminal EBT value	11 059 096	9 325 419
Security level $L(dp)$, unit fractions	0.63	0.64
JSC "Southern GZK", 000 UAH		
Threshold sales volume	23 857 521	26 402 664
Short-received sales volume	3 398 563	4 992 850
Marginal revenue per 1 UAH of volume	65%	62%
EBT deficiency	2 204 011	3 092 231
Liminal EBT value	13 087 787	11 795 756
Security level $L(dp)$, unit fractions	0.83	0.74

Source: calculated by the authors

In 2018, most of the enterprises under study faced decrease of the security level. The PrJSC "Northern GZK" kept a high level, the JSK "Southern GZK" and the PrJSC "InGZK" – a mean level, and the PrJSC "Central GZK" – a low level of external security of the competitive status.

This dynamics completely correlates with the dynamics of the level of internal security of the competitive status at the enterprises under analysis.

To draw final conclusions on the level of security of the competitive status of an enterprise, ($L(SCS)$), the worst scenario is the most reasonable. It provides for selection of the lowest value:

$$L(SCS) = \min\{L(is); L(dp)\} \quad (14)$$

The approach like that is reasoned by the fact that external security of the competitive status is conditioned by not only the level of internal security but also by other factors. At different periods, the security level is impacted by such factors of various intensity as the political situation in the country, established or severed economic ties, current law, etc. These factors play a significant role in Ukraine during the period under study: lost traditional sales markets represented by metallurgical works in East Ukraine, the instable political situation, volatile legislation and exchange rates, increasing energy and railway transportation tariffs, etc. So, provision of a high level of internal security of the competitive status is a necessary and sufficient condition of reaching the same level of

both external security and general economic security of the competitive status.

Table 4 presents the results of determining general economic security of the competitive status of mining and concentrating works.

Table 4. Results of assessing general economic security of the competitive status of Ukraine's mining and concentrating works

Enterprise	Quantitative value, unit fractions		Qualitative value, unit fractions	
	2017	2018	2017	2018
PrJSC "Northern GZK"	0.907	0.891	High	High
PrJSC "Central GZK"	0.36	0.28	Mean	Mean
PrJSC "InGZK"	0.63	0.64	Mean	Mean
JSC "Southern GZK"	0.83	0.74	High	High

Source: calculated by the authors

The calculations demonstrate that the level of general economic security of the PrJSC "Northern GZK" corresponds to a high level, but the quantitative value of internal security level is lower than that of external one.

One of the reasons for that is increased current and capital costs for production of pellets with 65% iron content in 2017, investment of 2.5 bn UAH in fixed assets renovation: 11 open tip trucks and 2 large bulldozers were purchased, 4 watering machines were reequipped, railway transport underwent overhaul, measures for enhancing environmental performance were financed. Strategically, such steps are to facilitate increase of the level of internal security of the competitive status.

At the PrJSC "Central GZK" and PrJSC "InGZK", the level of general economic security of the competitive status conforms to external security and is correspondingly characterized as a mean one. Excess of the level of external security over internal one resulted from a number of measures. In particular, the PrJSC "Central GZK" completed reconstruction of the pelletizing plant which allowed premium class pellet production characterized by uniformity of size and increased hardness. As a result, the enterprise widened its sales markets in 2018 and sold 40 k t of pellets to Great Britain. In 2017, the PrJSC "InGZK" acquired 50 pit trucks BelAZ, 1 towing tractor, 2 excavators, 2 drilling rigs, 10 Caterpillar trucks. As a result, the enterprise increased its current and long-term costs but facilitated its economic security of the competitive status in a long-term period.

In 2017, the JSC "Southern GZK" demonstrated a lower level of external security than internal one. In 2018, the opposite situation occurred – internal security was lower than external one. This was caused by overhauls of two sections of Concentrating Plant 1 that required about 400 M UAH in 2017. The continuing overhaul of the technological section at the Concentrating Plant in 2018 required over 680 M UAH for renovation and replacement of engineering constructions. Besides, 63 M UAH were invested in renovation of mining equipment in 2018: 2 large pit trucks BelAZ were purchased.

Thus, the undertaken steps testify to a very special role of iron ore open pits in providing economic security of the competitive status. Therefore, search for ways and methods of assessing reserves of enhancing internal security of the competitive status of an iron ore open pit is gaining significance.

Efficient technical, organizational and economic innovations are leading to considerable changes in the level of pit competitiveness and economic security of the competitive status of a works as a whole. In its turn, revealing reserves for increase of internal security of the competitive status requires first substantiation and development of a corresponding index. So, further on the work deals with development of indices for assessing reserves of enhancing internal security of the competitive status of iron ore open pits.

Reserves of internal security of the competitive status can be determined in two directions:

- 1) taking security of the competitive status of a similar subdivision which is a leading one in the industry (either a national or an international regional and global level) as a basis for comparison;
- 2) taking security of the competitive status of an iron ore open pit under consideration and for which it is calculated according to standard or substantiated planned data as a basis for comparison.

These directions determine two types of reserves of internal security of an iron ore open pit: market and intracompany reserves respectively. We suggest to assess them according to the formulas:

$$RMI = L(is)s - L(is)as \quad (15)$$

$$Rli = L(is)p - L(is)a \quad (16)$$

where RMI is the level of market reserves of security of the competitive status of an iron ore open pit;

$L(is)s$, $L(is)as$ is the index of internal security of the competitive status of an iron ore open pit calculated on the basis of data of a similar structural subdivision and the one under assessment respectively;

Rli is the level of intracompany reserves of security of the competitive status of an iron ore open pit;

$L(is)p$, $L(is)a$ is the index of internal security of the competitive status of an iron ore open pit calculated on the basis of data of a structural subdivision under assessment on the basis of standard (planned) and actual data respectively.

In equation (15) indices of internal security of the competitive status of an iron ore open pit calculated on the basis of data of a similar structural subdivision ($L(is)s$) and internal security of an iron ore open pit calculated on the basis of data of a structural subdivision under assessment ($L(is)as$) are determined applying similar methods, i.e. indices and coefficients that are their components are calculated on the basis of the relation of standard (planned) and actual data on the open pit under assessment and a similar one (Mishchuk et al., 2020).

Let us consider specific features in calculations of the index of internal security of the competitive status of an iron ore open pit and a level of reserves for its enhancement. For this, let us use the index that describes influence of current costs productivity on establishing security of the competitive status of the given structural subdivision and is a component of the general indices $L(is)s$ and $L(is)as$.

When calculating the index of internal security of the competitive status of an iron ore open pit, the index of current costs productivities relation ($Iccpi$) may look like the following:

$$Iccpi = \frac{CCPia}{CCPiC}, \quad (17)$$

$$Iccpi = \frac{CCPia}{CCPip}, \quad (18)$$

where $CCPia$ is the index describing actual current costs productivity of a structural subdivision under assessment – an iron ore open pit for the period under consideration, UAH/UAH;

$CCPiC$ is the index describing current costs productivity of a an iron ore open pit-competitor for the period under consideration, UAH/UAH;

$CCPip$ is the index describing standard (planned) current costs productivity of a structural subdivision under assessment – an iron ore open pit for the period under consideration, UAH/UAH.

The current costs productivity index calculated by formula (17) is of higher priority as compared with the current costs productivity index calculated by formula (18), as it allows being informed of

and considering the most advanced global trends in development of iron ore production. Use of this index facilitates establishment of strategic and tactic aims of developing a structural subdivision under assessment, and provide reaching a level of security of the competitive status corresponding to the level of security of the competitive status of a similar structural subdivision which is a leading one in the given industry (at national, international, regional and global levels).

When calculating market reserves of iron ore open pit security by formula (15), the index of the relation of current costs productivities for a similar open pit and a pit under assessment respectively will look as follows:

$$Iccpis = \frac{CCPisa}{CCPisp}, \quad (19)$$

$$Iccpias = \frac{CCPiаса}{CCPisp}, \quad (20)$$

where $Iccpis$ is the index describing the relation of actual and standard current costs productivity at a similar open pit;

$CCPisa$ is the actual current costs productivity at a similar open pit;

$CCPisp$ is the standard (planned) current costs productivity at a similar open pit;

$Iccpias$ is the index describing the relation of actual and standard current costs productivity of an open pit under assessment;

$CCPiаса$ is the actual current costs productivity of an open pit under assessment.

Let us extend formulas (15) and (16) and add variants of their modification.

Market reserves of security of the competitive status of an iron ore pit resulted from actual activities of objects-competitors during a certain time period (RM'):

$$RM' = \left(\frac{CCPa}{CCPs} \times \frac{Qa}{Qs} \times \frac{Pa}{Ps} \times \frac{SRa}{SRs} \times \frac{TCa}{TCs} \right)_s - \left(\frac{(CCPa)as}{(CCPs)s} \times \frac{(Qa)as}{(Qs)s} \times \frac{(Pa)as}{(Ps)s} \times \frac{(SRa)as}{(SRs)s} \times \frac{(TCa)as}{(TCs)s} \right)_{as} \quad (21)$$

where $\left(\frac{CCPa}{CCPs} \times \frac{Qa}{Qs} \times \frac{Pa}{Ps} \times \frac{SRa}{SRs} \times \frac{TCa}{TCs} \right)_s$ – is the product of relations of actual and standard indices that build the index of internal competitiveness of a pit-analogue,

where $\left(\frac{(CCPa)as}{(CCPs)s} \times \frac{(Qa)as}{(Qs)s} \times \frac{(Pa)as}{(Ps)s} \times \frac{(SRa)as}{(SRs)s} \times \frac{(TCa)as}{(TCs)s} \right)_{as}$ – is the product of relations of actual indices that build

the index of internal security of the competitive status of a pit under assessment and corresponding standard indices that build the index of internal security of the competitive status of a pit-analogue.

Marginal complete market reserves of security of the competitive status of an iron ore open pit are assessed by the formula (RM''):

$$RM'' = \left[1 - \left(\frac{(CCPa)as}{(CCPa)s} \times \frac{(Qa)as}{(Qa)s} \times \frac{(Pa)as}{(Pa)s} \times \frac{(SRa)as}{(SRa)s} \times \frac{(TCa)as}{(TCa)s} \right)_{as} \right] \quad (22)$$

where $\left(\frac{(CCPa)_{as}}{(CCPa)_s} \times \frac{(Qa)_{as}}{(Qa)_s} \times \frac{(Pa)_{as}}{(Pa)_s} \times \frac{(SRa)_{as}}{(SRa)_s} \times \frac{(TCa)_{as}}{(TCa)_s} \right)$ – is the product of relations of corresponding actual and

standard indices that build the index of internal security of the competitive status of a pit under assessment and a pit-analogue.

Internal reserves of security of the competitive status of an iron ore open pit (Rli) without considering the market situation (the formula is auxiliary):

$$Rli = \left(1 - \frac{CCPa}{CCPs} \times \frac{Qa}{Qs} \times \frac{Pa}{Ps} \times \frac{SRa}{SRs} \times \frac{TCa}{TCs} \right)_{as} \quad (23)$$

where $\left(\frac{CCPa}{CCPs} \times \frac{Qa}{Qs} \times \frac{Pa}{Ps} \times \frac{SRa}{SRs} \times \frac{TCa}{TCs} \right)_{as}$ – is the product of relations of actual and standard indices that build the index of internal security of the competitive status of a pit under assessment.

Table 5 presents calculations of reserves of internal security of the competitive status for iron ore open pits of mining and concentrating works of Kryvyi Rih region, Ukraine on the basis of the given methods.

Table 5. Results of assessing reserves of internal security of the competitive status for iron ore open pits of mining and concentrating works of Kryvyi Rih region, Ukraine, 2018

Name	Value, unit fractions
Iron ore open pit of PrJSC "Northern GZK"	0.41
Iron ore open pit of PrJSC "Central GZK"	0.12
Iron ore open pit of PrJSC "InGZK"	0.48
Iron ore open pit of JSC "Southern GZK"	0.28

Source: calculated by the authors

The obtained data show availability of large reserves at all open pits of Ukraine's mining and concentrating works.

Ukrainian mining companies today have little focus on Industry 4.0 (Mishchuk et al., 2019, 2020). In the long run, this threatens the existence of enterprises. Accordingly, in the conditions of exhaustion of opportunities of extensive growth and relative technological conservatism of the branch, digitalization creates preconditions for ensuring economic security of mining and metallurgical enterprises in the conditions of growth of supply and minimal increase of demand for products. Given the above, we can conclude that one of the key strategic indicators of the effectiveness of economic security management is the level of digital maturity of the enterprise. Given the complexity of this indicator, it is important to substantiate its components (Mishchuk et al., 2019):

- Digitization of the value chain ($D_{value\ chain}$). It involves the formation of a parallel chain of digital models - duplicates that combine virtual and real world and are a prerequisite for operational, effective and focused management actions:

$$D_{value\ chain} = \frac{\text{number of business processes of the value chain with digital analogues}}{\text{total number of business processes of the value chain}} \quad (24)$$

- Digitization of equipment ($D_{equipment}$). Specialists of mining and metallurgical enterprises note that the creation of exact copies of certain units allows you to adjust the schedules of their maintenance and efficiency, and each change that the actual change at the facility is duplicated in its digital version. The virtual duplicate also allows you to simulate a particular impact that is relevant when changing resource supply, periods of volatile demand for products and the action of other factors:

$$D_{equipment} = \frac{\text{number of equipment at the enterprise with digital analogues}}{\text{total number of equipment at the enterprise}} \quad (25)$$

- Digitization of mineral resource base ($D_{m.r.base}$) allows to minimize the cost of development and extraction of minerals, to optimize geological and technical measures of field development from drilling to extraction of hard-to-extract ferrous quartzites, to create an informative analytical-analytical base chemical and mechanical characteristics of ore deposits, visualize the reservoir, analyze alternative mining plans in real time:

$$D_{m.r. base} = \frac{\text{number of digitized fields}}{\text{total number of fields}} \quad (26)$$

Level of use of big data ($L_{big data}$) is a key driver of productivity growth of production systems, but this factor is especially important for mining and metallurgical companies operating terabytes / petabytes of information on the composition of the charge, the melting temperature of metals, physicochemical properties of alloys, etc. Implementation of projects to work with BigData allows us to state today their significant impact on the parameters of mining and metallurgical production: reducing the cost of ferroalloys in steel production by 12%, reducing energy consumption by 7%, increasing the productivity of rolling mills by 23% reducing the cost of scrap 18%:

$$L_{big data} = \frac{\text{applied number of methods for processing unstructured data sets}}{\text{required number of methods for processing unstructured data sets}} \quad (27)$$

Thus, the resulting indicator of digital maturity ($D_{maturity}$) of the enterprise is calculated by the formula:

$$D_{maturity} = \frac{D_{value chain} + D_{equipment} + D_{m.r.base} + L_{big data}}{4} \quad (28)$$

The level of digital maturity of the enterprise refers to the analytical projection "Operational perfection". At the same time, digitalization is also important in ensuring the market stability of mining and metallurgical companies, in particular the use of global platforms for product promotion and blockchain. The transition to global platforms for product promotion and digitalization of its supply creates the following advantages that create the preconditions for increasing cash flows:

- involvement in the processes of creating added value of supply chain management of consumers, which expands the customer base and ensures its sustainability;
- monitoring the needs of consumers, analysis of market proposals for rapid response to dynamic changes in market conditions;
- increasing the degree of personalization - offering a unique specification of the range for each client. Business practitioners note that in the future only those metallurgical companies that are able to offer consumers not a product, but a complex solution: a combination of new materials (alloys) with unique properties, technical engineering solutions for the use of new alloys in specific products.

At the same time, blockchain technologies provide a payment guarantee, accelerate business processes of shipment of the company's products and optimize the costs that accompany cash transactions. Thus, one of the resulting indicators of economic security management at the strategic level of the analytical projection "Market stability" should be an indicator of the level of digitalization of product promotion ($D_{product promotion}$):

$$D_{product promotion} = \left(\frac{S_{global platforms}}{Stotal volume} + \frac{S_{blockchain}}{Stotal volume} \right) / 2 \quad (29)$$

where $S_{global platforms}$ - is the volume of sales based on global platforms in a certain period;

$Stotal volume$ - is the total volume of sales for a certain period;

$S_{blockchain}$ - is the volume of sales using blockchain technology.

We can supplement this list of indicators. It all depends on current trends in the world and in the industry.

5. Discussion

When assessing internal security of the competitive status of an iron ore open pit as a structural subdivision of a mining and concentrating works, the current costs productivity index is the main component in formulas (1), (21 - 23), the other indices are auxiliary (to this or that degree) and, depending on tasks, specificity and conditions of such assessment, may be corrected, for instance with the help of their significance coefficients.

The above said may help rank them according to influence of these factors on the level of internal security of the competitive status of an open pit.

Reserves of enhancing external security of the competitive status of enterprises consists in increased product quality and opportunities to broaden sales markets. Thus, the key markets of 2018 were:

- for the PrJSC "Northern GZK" – Ukraine (67.3%), China (15.4%), Poland (9.5%), Slovakia (5.7%), other countries (2%);
- for the PrJSC "Central GZK" - Poland (23.3%), Romania (22.2%), Serbia (18.2%), Hungary (14.9%), Czechia (10.6%), Slovakia (5.5%), other countries (5.3%);
- for the PrJSC "InGZK" - Ukraine (77.6%), Slovakia (10.7%), Czechia (5.3%), China (3.5%), other countries (3%);
- for the JSC "Southern GZK" - China (50.9%), Ukraine (33.1%), Poland (8.9%), Czechia (6.2%), other countries (0.9%).

The imperfect export structure like that characterizes danger of concentrating on a limited number of sales markets which is escalated by recent events such as the COVID-19 pandemic and quarantine, closure of borders in developed countries. That is why, export diversification is one of the directions to increase the level of external security of the competitive status. However, this cannot be reached without decreasing iron ore products costs and increasing their quality up to the world standards.

At the same time, iron content in products of Ukrainian mining enterprises is known to be lower than that at foreign companies and the content of impurities does not meet international market requirements. Due to that, all Ukrainian enterprises are characterized by non-compliance of key indicators that describe their competitive status with threshold values: product sales volumes, earnings and the level of the competitive status security. This testifies to inefficiency of economic security provision and management. That is why, the level and the state of economic security at Ukrainian mining enterprises is dangerously dependent on the market situation. Considering the trends of late 2019 – 2020, this enables forecasting decrease of the economic security level of the enterprises under study in the near future. Thus, it is necessary to form a methodological toolkit to enable assessment of results of management and economic security provision at operating and strategic levels. It is advisable to focus on analytical projections that reveal internal (operating) preconditions for providing economic security and external forms (market stability). Application of these projections will enable assessing the achieved level of compliance with internal standards, industry average values and the best business practices. Corresponding dynamic parameters of economic security such as product quality, export diversification, the customer loyalty index, etc. possess high scientific explanatory potential concerning disclosure of causations that condition the current and the desirable levels of economic security of enterprises.

6. Conclusions

Thus, the above recommendations on necessary use of the category "internal security of the competitive status" and the presented methodological approaches to qualitative assessment of the category enable:

- 1) performing complex comparison of security of the competitive status inside an enterprise at all levels of its economic activity and at all its subdivisions;

2) revealing reserves and developing ways of enhancing security of the competitive status at all structural subdivisions of a mining and concentrating works;

3) developing a system of stimulating increase of the level of security of the competitive status at all structural subdivisions of a works;

4) performing systemic control of the whole process of enhancing the level of security of the competitive status of a works and its structural subdivisions (an iron ore open pit).

The authors suggest assessing external security of the competitive status on the basis of determining the value of earnings before tax deficiency which is not received by an enterprise due to non-compliance of its actual market share with the share occupied by a leading enterprise.

The PrJSC "Northern GZK" is the industry leader with its high level of external security of the competitive status in 2017-2018. The security level at the other mining enterprises has decreased from mean (the JSC "Southern GZK", the PrJSC "Ingulets GZK") to low (the PrJSC "Central GZK"). The increased level of internal security of the competitive status will facilitate increase of external security.

Development of the above indices will facilitate opportunities to assess reserves of increasing security of the competitive status of iron ore open pits at mining and concentrating works. For this, the article has solved the following tasks:

1) developed the index of security of the competitive status of an iron ore open pit;

2) determined methodological approaches to calculating two types of reserves of internal security of the competitive status of an iron ore open pit: market (external) and intracompany (internal);

3) determined opportunities and conditions for modifying the index of security of the competitive status of iron ore open pits at mining and concentrating works.

The suggested methods were used for calculating the level of reserves of internal security of the competitive status of iron ore open pits at mining and concentrating works. There were revealed considerable reserves at all open pits of Ukraine's mining and concentrating works.

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