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Increasing the Economic Efficiency of Mining Industry Enterprises in Terms of Digitalisation: Example of the East Kazakhstan Region

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Abstract
In the context of Kazakhstan's economic digitalisation, increasing economic efficiency is a top priority. Digitalisation enhances enterprises' financial stability and decision-making speed. This is particularly vital for mining enterprises, a key focus of the "Digital Kazakhstan" state program. This study aims to develop strategies to boost economic efficiency by analysing its essence and evaluating mining enterprises in East Kazakhstan. The methods used in the research include statistical analysis, comparison, structural and logical analysis, and synthesis. The results include determining the essence of economic efficiency, evaluating the dynamics of industrial production indices, production volume, and structure, and assessing economic efficiency indicators of mining enterprises. Five key areas affecting economic efficiency were identified: technology, material resources, management, labour resources, and the general system. The introduction of Big Data digital technology is suggested for each area to significantly enhance efficiency.

Keywords
Digital Technology; Big Data; Profitability; Material Intensity; Capital Productivity.

Introduction

In modern Kazakhstan, as digital transformation reshapes the economy, enterprises should implement digital tools and methods to measure and analyse their economic efficiency (Abdullayev et al., 2024). There is a growing need to identify the factors that influence a company's activity when using resources for production and service provision. The functioning of enterprises has always been the main indicator of economic efficiency because profitability depends on it (Krawczyk, 2022). Therefore, the focus is on the factors that determine it. These factors include natural, material, technical, and labour. The mining industry is one of the priorities in the East Kazakhstan Region. Therefore, there is a growing need in this region to enhance the economic efficiency of mining enterprises, which underscores the relevance of this article.

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Previous studies have examined distinct strategies for enhancing the economic efficiency of enterprises across various industries, yet they have failed to consider the current digitalisation conditions of the economy. The publication by Nurmukhametov (2021) showcases the economic efficiency of innovative processes within an enterprise, using the example of the "Ust-Kamenogorsk Valve Plant" JSC (joint-stock company). They conducted calculations to determine how the innovations affected the value of net profit indicators and the overall financial condition of the enterprise. The effectiveness of two portfolios for the implementation of two projects was also evaluated. The author determined that the Kazakh innovation policy is expressed by an organisational and regulatory nature. However, the article fails to adequately consider economic efficiency, and the resulting conclusions do not support the necessity of assessing the efficiency of an enterprise's innovative development.

Żurakowska-Sawa (2019) analysed the conditions for the economic efficiency of an enterprise, taking into account the stage of the life cycle. The author aims to identify variables that determine the level of economic efficiency using econometric models. As a result of the constructed econometric models and the calculation

of results at different stages of the life cycle, the need to determine microeconomic and macroeconomic factors was determined. Therefore, managers should have access to external information that can significantly impact the enterprise's activities, in addition to its internal economic information. It is obvious that the research is relevant, and its elements can be applied to Kazakh companies. The work of Mukashev (2019) provides recommendations on ways to increase the economic efficiency of the meat industry in the Republic of Kazakhstan. Although theoretical, this paper provides practical recommendations for improving economic efficiency in the national meat industry's development, organized across four distinct levels. A strategy for increasing the economic efficiency of enterprises in the studied industry is also formulated. However, a theoretical study that is not confirmed by practical results is not sufficient.

Ukrainian researcher Radieva (2019) identified the methodological and practical aspects of the economic efficiency of the enterprise. The author has built an influence model of conditions and factors affecting the enterprise's effective activity. Indeed, the presented model can be implemented within any industry. Based on the model, the influencing factors on the increase in profits were determined, which subsequently determined the system of indicators for a comprehensive analysis of the effectiveness of the enterprise activity, which is of significant value to science. Altayeva (2019) evaluated the economic efficiency of civil aviation development in the Republic of Kazakhstan. The article is practical, as the author thoroughly evaluated the economic efficiency of the civil aviation industry. The author substantiates the dependence of economic efficiency on modernisation, personnel, professional development, and compliance with world standards, which is generally true for all industries.

However, in the works mentioned, the specifics of the mining industry in terms of digitalisation were not paid attention to. In this regard, this article aims to analyse the essence of the economic efficiency of an enterprise, evaluate the economic efficiency of the mining industry enterprises of the East Kazakhstan Region (EKR), and develop directions for its increase. This leads to the development of a few hypotheses in the research:

- the industrial production index in East Kazakhstan exhibits a favorable correlation with the economic efficiency of mining enterprises in the region;
- the integration of digital technologies in mining enterprises will lead to improved resource utilization;
- the adoption of digital technologies in the mining industry of East Kazakhstan will result in reduced operational costs and increased profitability.

Materials & Methods

The article is built based on a qualitative study, an analysis of theoretical aspects and existing approaches to evaluating the economic efficiency of an enterprise using world experience and the scientific thought of scientists from different countries. The article's information base included materials from scientific and practical conferences, scientific articles from both international and Kazakh scientists, analytical data from the Bureau of National Statistics of the Agency for Strategic Planning and Reforms of the Republic of Kazakhstan (2022), and consolidated financial statements from "KAZ Minerals Aktogay" LLP (limited liability partnership) (KAZ Minerals PLC, 2017, 2018, 2019, 2020). The basis of the research was the scientific studies of Kazakh, Ukrainian, American, Polish, and Czech scientists. The evaluation of economic efficiency as an example was carried out based on the results of the financial statements of "KAZ Minerals Aktogay" LLP. Statistical data for the mining industry analysis were taken from the statistical reports of the Bureau of National Statistics of the Agency for Strategic Planning and Reforms of the Republic of Kazakhstan (2022) in the East Kazakhstan Region and the Republic of Kazakhstan as a whole.

The article's methodological foundation consisted of both general scientific and specific methods. When determining the essence of the economic efficiency of the enterprise, the methods of systemic knowledge, abstract, axiomatic, and concretised thinking were used. The authors analysed the growth patterns of industrial production in mining enterprises using statistical methods. Their analysis focused on both production volume and structural changes within the mining industry. The comparison method was used during the dynamics analysis of the industrial production index of the mining industry in the East Kazakhstan Region and the Republic of Kazakhstan as a whole. Thus, the results obtained for the region and the country as a whole were evaluated. When calculating the specific density of coal and metal ore mining in the East Kazakhstan Region and the Republic of Kazakhstan as a whole, the comparison method was also used to describe the obtained results. Based on the analysis results, dynamic tables and diagrams of the dynamics of the industrial production index of the mining industry, as well as the dynamics of the volume and structure of production of the mining industry in the East Kazakhstan Region and the Republic of Kazakhstan as a whole, were built.

Using the methods of structural and logical analysis, the dynamics of the economic efficiency of the studied enterprise were evaluated with detailed calcu-

lations and a description of the obtained results. Using the methods of analysis, generalisation, synthesis, and abstraction, the obtained results were described in dynamics, as well as the degree of influence of each performance indicator on the economic activity of the enterprise as a whole was determined. The calculating results of the economic efficiency indicators of the studied enterprise are presented in table form. The generalisation method enables grouping economic efficiency indicators across different enterprise activity domains. These indicators are categorized into distinct subcategories: technological efficiency, which evaluates the process and technological performance; material resource efficiency, measuring resource utilization and procurement effectiveness; enterprise management efficiency, assessing organizational and strategic management practices; efficiency in labour resources use, examining workforce productivity and utilization; and general economic efficiency of the enterprise, providing a comprehensive overview of the organization's overall economic performance.

Through analysis, synthesis, and formalization, we identified how Big Data technologies can be applied to five key areas of enterprise activity: technology, material resources, management, labour resources, and system-wide operations. These areas form the foundation of economic efficiency. For better understanding, digital technology refers generally to all technologies that use digital data for processing, communication, and automation. On the other hand, Big Data digital technologies represent a specific subset of digital technology that is specifically designed to analyse and process large datasets, to extract valuable insights.

We identified key challenges in implementing digital technologies within the mining industry of the East Kazakhstan Region. This approach allowed us to formulate evidence-based conclusions and develop several key propositions, informed by an in-depth review of relevant scientific literature and the findings of previous studies in the field.

Results

The economic efficiency of an enterprise serves as a primary indicator, showcasing the outcomes of its dynamic activity. In the scientific literature, scientists pay enough attention to the essence of the economic efficiency of an enterprise, although their opinions differ in its definition. Several researchers consider economic efficiency as a complex concept aimed at obtaining economic results (Geamanu, 2011); the results of the enterprise activity in comparison with the costs and spent resources (Mykhailenko, 2018; Roszkowska,

2018); a quality indicator reflecting the level of product quality (Sheianova and Sheianova, 2020). An enterprise's economic efficiency can be defined as the economic results of its activities, which showcase the efficient use of various types of resources. This is calculated by comparing the obtained results with the total amount of resources consumed.

According to the Official Information Source of the Prime Minister of the Republic of Kazakhstan (2019), the mining industry accounted for 23.7% of the total industrial production in the region in 2021. The authors suggest that the index of industrial production serves as an indicator of the economic efficiency of the mining industry. Over the past ten years, the index of industrial production of the mining industry in the East Kazakhstan Region has been quite high compared to the index of industrial production of the mining region of the Republic of Kazakhstan as a whole (Fig. 1).
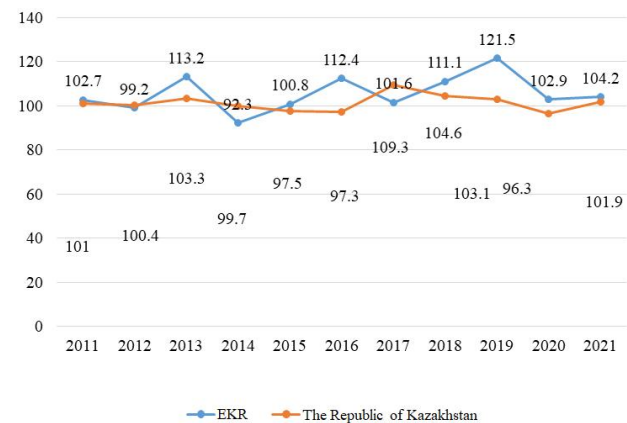

Fig. 1. The index dynamics of industrial production of the mining industry of the East Kazakhstan Region and the Republic of Kazakhstan as a whole in 2011–2021
Source: prepared by the authors based on the data (Bureau of National Statistics. . . , 2022).

As can be seen, the index of industrial production of the mining industry has had unstable dynamics for ten years: either to increase or to decrease. In 2021, it increased both in EKR and in the Republic of Kazakhstan as a whole. Thus, in 2021, the index increased by 5.6 units in the Republic of Kazakhstan and by 1.3 units in EKR. In general, the industrial production index in EKR is higher than that of the entire country. It should be noted that in the Republic of Kazakhstan, the activity of the mining industry is based on the extraction of black coal, oil, natural gas, iron and copper ores, lead, zinc, manganese, and chromium ores, salt, and asbestos (Komilova et al., 2020). In EKR, the mining industry extracts coal, oil, natural gas, iron, and copper ores.

The analysis of the volume and structure of production in the mining industry in 2018–2021, in the EKR (Table 1), showed that over the past four years, the volume of production in value terms has constantly grown by an average of 28.2%. There is instability in the structure of industrial production: growth is changed by recession and vice versa. Thus, in 2019, the production of the mining industry in total industrial production decreased by 5.2% compared to 2018 due to a decrease in the share structure of metal ore mining by 5.5%, the services share in the mining industry by 0.3%, and an increase in the share of crude oil production and natural gas by 0.5%. In 2020, an increase in the share of mining products in total production by 7.9% compared to 2019 is typical. In 2021, the share of mining production in the total volume of industrial production decreased by 1.3% compared to 2020. This was due to a 0.2% decrease in the share of coal mining, a 1.1% decrease in metal ore mining, a 0.1% decrease in mining of other minerals, and a 0.2% increase in the share of provision of services in the mining industry. In natural units, the extraction of mining production indicates an increase in coal and metal ores, while there is a decrease in other minerals.

A comparison of the EKR specialisation in the mining industry in the country as a whole showed the following results. Thus, coal was mined in the country: in 2018 – 118482.5 tons, in 2019 – 115000.4 tons, in 2020 – 113399.1 tons, and in 2021 – 116218.7 tons. Thus, the dynamics of the EKR share in coal mining in the total volume of production in the country as a whole tends to increase: in 2018 – 7.0%; in 2019 – 7.1%; in 2020 – 7.4%; in 2021 – 7.6%. To metal ores in the Republic of Kazakhstan, an annual increase in production is observed: in 2018 – 1253348 tons; in 2019 – 145098.6 tons; in 2020 – 159155.5 tons; in 2021 – 162584.1 tons. The dynamics of the EKR share for the metal ores mining in the total volume of production in the country as a whole shows an oscillatory, but increasing trend: in 2018 – 39.4%; in 2019 – 42.5%; in 2020 – 40.9%; in 2021 – 43.1%. That is, in the region, on average, 40% of the metal ores mining of the country is carried out.

To test the calculation of an enterprise's economic efficiency indicator, one must consider the most successful and economically significant enterprises in the mining industry of the EKR. These enterprises include: "KAZ Minerals Aktogay" LLP, "Artel Staratelei "Gornyak" LLP, "Bakyrchik Mining Enterprise" LLP,

Table 1

Dynamics of the volume and structure of production of the mining industry in the EKR in 2018–2021

Indicator	2018	2019	2020	2021
The volume of industrial production enterprise, a thousand tenges				
Total production of the mining industry	318865933	481202689	600024567	654825250
Coal mining	26969858	30561948	32249999	30243816
Crude oil and natural gas mining	18584120	10751032	8324506	9630426
Metal ores mining	253435133	410474780	521768395	569250600
Other minerals mining	6694604	8153477	10908922	10358527
Services provision in the mining industry	13182218	21261452	26772745	35341881
Structure of industrial production, %				
Total production of the mining industry	22.3	17.1	25.0	23.7
Coal mining	1.4	1.4	1.3	1.1
Crude oil and natural gas mining	0.5	1.0	0.3	0.3
Metal ores mining	19.1	13.6	21.7	20.6
Other minerals mining	0.4	0.4	0.5	0.4
Services provision in the mining industry	1.0	0.7	1.1	1.3
Industrial production in natural units				
Coal mining, a thousand tons	8284.2	8140.9	8390.8	8798.0
Metal ores mining, a thousand tons	49384.2	61716.4	65128.4	70097.8
Other minerals mining, a thousand m^3	904.8	985.0	309.6	278.9

Note: p-value – $p < 0.05$.

Source: prepared by the authors based on the data (Bureau of National Statistics..., 2022).

"Satpayev Mining and Processing Enterprise" LLP, "Vostoktsvetmet" LLP, and "Taskara" LLP (Official Information Source..., 2019). The economic efficiency of the enterprise should be determined through the calculation of a set of indicators. These indicators include the return on assets (ROA), capital productivity, material intensity, productivity, sales efficiency ratio, costs per 1 currency unit of production, costs of production of 1 ton of metal products, cost profitability, and sales profitability. These indicators were chosen because they provided thorough coverage of a wide range of enterprise performance factors in the mining sector (Kerimkhulle et al., 2022b; (Nogoibaeva et al., 2024). They offer a comprehensive picture of the financial performance, resource usage, and operational efficacy of a business. ROA and capital productivity were chosen to evaluate the effectiveness of asset utilization, while material intensity assesses resource efficiency.

Productivity was included to gauge labour efficiency, and the sales efficiency ratio sheds light on the efficacy of distribution. The selection of costs per unit of production and costs for producing one tonne of metal products was selected to assess operational efficiency, which is especially important for mining companies. Finally, sales and cost profitability were chosen as the primary measures of total financial performance.

"KAZ Minerals Aktogay" LLP is the largest enterprise in the mining industry in the Eastern Kurdistan Region. Therefore, the test of the suggested indicators of economic efficiency was made for this enterprise. Table 2 contains calculations of economic efficiency indicators of "KAZ Minerals Aktogay" LLP for 2017-2020. The data for calculating the indicators were taken from the consolidated financial statements of the enterprise for four years, taking into account the data of all enterprise divisions.

Table 2
Dynamics of economic efficiency indicators of "KAZ Minerals Aktogay" LLP for 2017–2020

Indicators	2017	2018	2019	2020
Financial results before tax, a million USD	580	642	726	804
The average cost of fixed assets, a million USD	2602.5	2332.5	2443	2767
Sales volume, a million USD	1663	2162	2266	2355
Material costs, a million USD	1030.7	1120.9	1768.8	1523.7
Number of personnel, person	13003	13772	15637	16086
Distribution costs, a million USD	69	94	91	94
Total costs for the sale of products, a million USD	952	1315	1352	1350
The volume of marketable output, a thousand tons	3919	3892	3879	3753
ROA, %	22.29	27.52	29.72	29.06
Capital productivity	0.64	0.93	0.93	0.85
Material intensity	0.6198	0.5185	0.7806	0.6470
Productivity, USD/person	127893.6	156985.2	144912.7	146400.6
Sales efficiency ratio	0.04	0.04	0.04	0.04
Costs per 1 currency unit of production, USD	0.57	0.61	0.60	0.57
Costs for production of 1 ton of metal products, USD	242.92	337.87	348.54	359.71
Cost profitability, %	60.9	48.8	53.7	59.6
Sales profitability, %	34.9	29.7	32.0	34.1

Note: USD – United States dollar; p-value – $p < 0.05$.
Source: prepared and calculated by the authors based on the consolidated financial statements data of "KAZ Minerals Aktogay" LLP for 2017-2020 (KAZ Minerals PLC 2017, 2018, 2019, 2020).

A key metric of economic efficiency is ROA, which quantifies how well a business uses its resources to turn a profit. It is computed as a percentage by dividing the net income of the business by the entire value of its assets. Regardless of the company's financing structure, ROA is important since it can show how effectively management is employing the company's assets to generate earnings. A high and rising ROA indicates efficient asset management and operational effectiveness for mining companies, since significant assets are needed for operations (Rexha et al., 2024). The calculation result for ROA indicates an increase in profitability from the use of the enterprise's fixed assets in 2017–2019 and a slight decrease in profitability by 0.66% in 2020 compared to 2019. But compared to the results of 2017, the ROA in 2020 was higher by 6.77%. According to the calculation of capital productivity, it can be noted that there was an increase in 2017-2018, in 2019 – no changes, and a decline in 2020 by 0.08 compared to 2019, but compared to 2017, it was an increase by 0.21. This group of indicators indicates that the enterprise uses fixed assets efficiently, and profitability from them is quite high. The calculation of the material intensity indicator in 2020 shows a downward trend of 0.1336 compared to 2019, which indicates an increase in the efficiency of using material costs. The productivity indicator shows either an increase or a decrease. However, in 2020, there was an increase in this indicator of 1487.9 USD/person, resulting in a total of 146400.6 USD/person. It can be seen that this indicates the effective use of the enterprise's labor resources.

The sales efficiency ratio remained stable between 2017 and 2020, with a value of 0.04, indicating a small distribution cost that was consistent with the growth and decrease in the volume of sold products. The cost indicator, calculated for a single currency unit of production, displayed oscillatory dynamics. However, in 2020, the cost indicator stabilized and reached a low point, specifically the value of 0.57 USD, which had a positive impact on the enterprise's overall efficiency. The costs associated with producing 1 ton of metal products have been steadily rising, a trend that negatively impacts the economic efficiency indicator and highlights the high costs associated with metal product extraction. Profitability of costs indicates the profitability of the enterprise even with an increase in the cost for the production of 1 ton of metal products, which is positive for the enterprise and shows the right use of resources. The profitability of sales also indicates the profitability of the enterprise and the effective policy of product sales (Kerimkhulle et al., 2022a; Gunash et al., 2024). Therefore, it is evident that the economic efficiency of "KAZ Minerals Aktogay" LLP is high, and the enterprise is progressing efficiently. Based on the analysis of

the economic efficiency of the enterprise, the authors developed ways to increase it. The suggested indicators for calculation revealed that increasing economic efficiency encompasses the following areas: technology, material resources, management, labor resources, and the overall organizational structure of the enterprise.

At the technological level, an enterprise, to maintain its efficiency, should constantly monitor and implement technological innovations to automatise production. In the era of digitalisation, it's crucial to integrate digital technologies into accounting to calculate all technological indicators effectively. "KAZ Minerals Aktogay" LLP partially employs digitalisation in accounting, but it does not encompass the entire chain of product production and sales. It is believed that the scale of production at the studied enterprise necessitates the introduction of Big Data technology, which considers the entire chain from the initial stage of production to the final result. The management process is continuous and consistent. The introduction of Big Data will simplify this process by enabling managers at all levels to effectively manage even the smallest fragments of operational processes. Using material resources efficiently is key to business success. Therefore, the Big Data digital technology introduction (Shen, 2021; Adadi, 2021; Manyika et al., 2011; Nobanee, 2020; Javaid et al., 2021; Qi, 2020) will help determine the exact amount of use of material resources and reduce the waste. Labour resources are crucial in the introduction of digital technology, as the potential for enterprise digitalization hinges on their qualifications. Maintaining consistency throughout the entire digitalisation process is crucial for uniting all personnel towards the rapid and effective introduction of Big Data technology.

A comprehensive, long-term strategic strategy is necessary for the successful implementation and management of digital transformation in mining organisations. Even while new technologies like Big Data can have an instant positive impact, long-term increases in economic efficiency require constant planning and adjustment. Enterprises can forecast future technical developments, shifting market dynamics, and changing operational requirements by using long-term strategic planning (Danchuk et al., 2021). It makes it possible to create a solid digital infrastructure that can be expanded and changed as needed. Furthermore, it enables the creation of a workforce that is proficient in digital technology using ongoing training and skill enhancement initiatives. East Kazakhstani mining companies may maximise the long-term impact on economic efficiency by integrating digital transformation into the core of their long-term strategy. This will guarantee that their digitalisation initiatives remain in line with broader company objectives.

Discussion

Scientists in Kazakh and global literature have dedicated numerous studies to enhancing the economic efficiency of enterprises. However, there is no single approach that takes into account the conditions of enterprises' digitalization. Thus, Geamanu (2011) believes that the economic efficiency of the enterprise is a complex concept aimed at results with various use cases that are involved in economic turnover. It is economic efficiency that provides for the resource's minimisation per efficiency unit. Mykhailenko (2018) in their works identified two approaches to determining the essence of the economic efficiency of the enterprise: resource and costly. The essence of economic efficiency is connected with the cost ratio of the result to the cost value. The author also describes the subjective nature of economic efficiency, which involves individual evaluation and final results.

Roszkowska (2018) studied the economic efficiency of the enterprise as a qualitative indicator. Thus, the author believes that the economic efficiency of the enterprise is connected with product quality, which is determined by the cost of quality, a set of information necessary for making rational decisions for the enterprise. The author refers to the factors for measuring economic efficiency: the number of wastes in the total number of manufactured products; the amount of material resources spent per unit of output; the number of recycled products; costs of material resources to total sales; and indicators of costs for internal and external disadvantages. The authors assert that the scientific research does not provide a comprehensive understanding of the economic efficiency indicator. Scientists Sheianova and Sheianova (2020) believe that the essence of the economic efficiency of the enterprise in the literature is substantiated in different ways due to different understandings of the efficiency criteria. Thus, the economic efficiency criteria are the results of the enterprise activity, which are compared with costs and resources to ensure such results.

Aubakirova and Isatayeva (2021) studied the need for the digitalisation of the industry in the Republic of Kazakhstan. The authors determined that the industrial enterprise's digitalisation will positively affect economic performance, reliability, and security. In 2018, seven pilot projects were launched in the Republic of Kazakhstan enterprises to introduce digital technologies. For the extractive industry, relevant pilot projects have been launched under the "Industry 2.0" program. The statistical analysis of scientists showed a low level of digital technology use in mining enterprises. This was also found in the current research.

Scientists have identified the barriers that hinder digital technology's introduction in industrial enterprises, such as limited cybersecurity, unauthorised accessibility, information leakage, difficulties in achieving digital standards, and limited suppliers of digital products. It is believed that not all the barriers they mentioned should be applied to all industrial enterprises. Also, in the article of American scientists Goldfarb et al. (2015), the positive results of industrial enterprises' digitalisation, namely high cybersecurity, are described. In the current study, the Big Data technology suggested for implementation has high cybersecurity and limited accessibility to external consumers.

Aubakirova and Isatayeva (2021) also identified successful outcomes from the digitalization of pilot projects, specifically a positive impact on economic efficiency, which aligns with the authors' recommendations. Factors hindering the active introduction of digital technologies into industrial enterprises indicate the lack of financial resources for most enterprises. "KAZ Minerals Aktogay" LLP is an enterprise with international investments and, as was shown before, high economic efficiency; therefore, it is believed that financial resources should be enough to introduce digital technology and achieve even better results with its help.

In their article, Friend (2022) focuses on artificial intelligence (AI) and associated applications, highlighting various effective uses of digital technologies in the mining sector. For example, it talks about how sophisticated machine learning techniques are used to gather data instantaneously and determine meaningful on-site decision variables. This has greatly decreased errors and streamlined procedures. The article also discusses the effective use of sensors to gather data in real-time to locate possible failure planes on earthly and rock surfaces, as well as the application of AI to evaluate worker behaviour and provide targeted corrective training. The application of automated code generation using industrial plug-and-play technology is another noteworthy achievement. It enables ventilation experts to swiftly relocate equipment, such as industrial cooling fans, leading to cost and energy savings. These illustrations show how, when used appropriately, digital technology may enhance safety, decrease environmental impact, increase efficiency, and improve decision-making in the mining industry.

In the article by Yakhina (2018), ways to increase the economic efficiency of "POCR" ("Pavlodar Oil Chemistry Refinery") LLP are substantiated. The author defined economic efficiency through analysis: the production dynamics, costs and income, pricing, accounts payable and receivable, and segments of product positioning and production cooperation. It is believed that such analysis does not sufficiently

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Z. Ospanov et al.: Increasing the Economic Efficiency of Mining Industry Enterprises in Terms of Digitalisation . . .

cover technological and managerial factors; therefore, appropriate improvements are required. The author's results substantiate the advantages and disadvantages of the "POCR" LLP efficiency. But on their basis, ways to increase economic efficiency are not suggested, which is an unfinished study.

Stepanek (2013) studied ways to manage the economic efficiency of the enterprise. The author takes a unique approach to achieving economic efficiency, which involves evaluating both incoming and outgoing parameters. The author attributed the production factors to the input parameters and the obtained results to the output parameters. The author also believes that to determine economic efficiency, it is obligatory to explore the internal and external environment. They refer to external parameters, the relationship with suppliers, investors, participants and customers, and correlate these parameters with the general results of the enterprise. According to the author, this approach is rational. Obtaining such information and performing numerous calculations can be challenging. But, if Big Data technology is introduced, it will be possible to include such parameters in efficiency calculations and thus determine the relationship with external sources that positively or negatively affect it. The author also described the return on equity as one of the important indicators of economic efficiency. In the current study, the authors identified the profitability of products and costs as the key indicators of economic efficiency. The profitability of products reflects the outcome of production and sales, while the profitability of costs indicates the effectiveness of those costs in generating a profit. Not always does the use of equity have a positive effect on economic efficiency (Loxha, 2019).

The Czech scientists Jansky et al. (2013) believe that the main indicators that characterise economic efficiency are cost, price, and productivity. The authors evaluated costs and income. The suggested approach was tested on the example of agricultural enterprises. Scientists have defined economic efficiency only through the ratio of costs and income. The productivity that was described at the beginning of the study was not calculated based on the considered enterprises. The results confirmed that the economic efficiency of the enterprise is not limited only by the ratio of costs and income, but is also supplemented by the need to calculate other indicators. In the paper by Horal et al. (2020), the impact of digital technologies on the efficiency of an oil transportation enterprise was evaluated. Scientists emphasise that there are issues with the use of these technologies and only a small percentage of enterprises have successfully integrated them into their operations. They believe that for enterprises that have introduced digital technologies, it

is necessary to evaluate their efficiency before and after introduction. Scientists have suggested introducing into use the digitalisation efficiency indicator, which is calculated by the ratio of the general efficiency of enterprise digitalisation and the specific efficiency of the business process. The authors completely agree with their conclusions and emphasise that the calculation of such an indicator will serve as an example for other enterprises to decide to introduce digital technology.

Scientists emphasised that when calculating the digitalisation efficiency, a search for problem areas will be carried out and, accordingly, their adjustment. According to the suggested indicator, scientists have built a correlation-regression model for the efficiency of "Ukr-TransNafta" JSC digitalisation. At the same time, the efficiency of the enterprise's activity was chosen as the effective indicator, and the influence factors are costs, cost price, organisational structure, and resource cost. It should be agreed with this approach and the chosen parameters, as they show the efficiency of all processes. Nurmukhametov (2021) determined the economic efficiency of the enterprise through the analysis of net profit, the coefficient of financial stability, solvency, and business activity. Based on the findings of stable economic efficiency, the author recommended mastering innovations for both the enterprise and two types of portfolios. The efficiency of the two portfolios is calculated based on costs, profits, profitability, and preference coefficient. After that, the best portfolio option was chosen for introducing innovations at the enterprise. It is considered effective to use this approach when introducing innovations. In addition, it should be applied when introducing innovations directly into the production process, that is when improving the technical component. Such an approach would be inappropriate when integrating digital technologies into enterprise activities, as it solely considers the technical aspect. In this regard, it should be emphasised that the authors have identified five components that are at the basis of the digitalisation process and, accordingly, affect the economic efficiency of the enterprise.

Altayeva (2019), when calculating economic efficiency, determines it through the number of transported, served, and transit passengers; transported goods; and the level of compliance with International Civil Aviation Organization requirements for flight safety and aviation security. Such an approach can only be applied to transport and aviation enterprises and it is not acceptable in connection to industrial ones. The authors do not describe the need for digitalisation in the studied enterprises. Scientists have considered approaches to determining the economic efficiency of the enterprise in different ways. However, the approach suggested by the authors has its specifics,

as it is necessary under the digitalisation condition. Scientific works typically consider either the features of economic efficiency or the methods of enterprise digitalization. Currently, more than ever, a unified approach is necessary to increase the economic efficiency of mining enterprises in the EKR in terms of digitalisation, which was made in this study.

Conclusions

The research conducted is devoted to finding ways to increase the economic efficiency of mining industry enterprises in terms of the digitalisation of the EKR. It was looked into what makes an enterprise economically efficient, and it was found that the economic results of the enterprise show how efficiently different types of resources are used. This is done by comparing the result with the total amount of resources of a certain type that were used. It was determined that the mining industry is one of the largest in the EKR. The production volumes of the mining industry are growing every year. Therefore, industry enterprises play an important role in the region's economy. The economic efficiency of "KAZ Minerals Aktogay" LLP was evaluated using several key indicators: return on assets (ROA), capital productivity, material intensity, labour productivity, sales efficiency ratio, cost per currency unit of production, production cost per ton of metal products, and both cost and sales profitability. Analysis of these metrics demonstrated that the enterprise operates with high economic efficiency.

Ways to increase economic efficiency have been developed according to five components: technology, material resources, management, labor resources, and general systems. An increase in the economic efficiency of mining industry enterprises will be facilitated by the introduction of Big Data digital technology in enterprise accounting. The enterprises of the studied industry are quite large; therefore, all types of activities and all stages that affect the economic result can be effectively combined using Big Data technology, because it is aimed at working with a large amount of data. Thus, in terms of digitalisation, the main thing for mining industry enterprises is the digital technology's introduction. As a result, enterprises will be able to reduce the time required for gathering necessary information and performing calculations. Also, digital technologies will help reduce all types of costs and increase the enterprise's income. When incorporated into the technological process, digital technologies can assist in resolving issues related to product defects and in calculating marketable, gross, net, and residual products. In further research, attention will be paid to studying the structure of the mining industry enterprises with the specification of ways to introduce Big Data digital technology into each structural unit.

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