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ANALYSIS OF ECONOMIC LOSSES FROM OCCUPATIONAL INJURIES AND OCCUPATIONAL DISEASES

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Abstract. The article analyzes the economic losses associated with occupational injuries and occupational diseases in Kazakhstan over the period from 2014 to 2023. The research is based on data on the number of individuals affected by workplace accidents, the severity of injuries, and the material consequences of these events. The authors highlight trends in the changing levels of workplace injuries, including a decrease in the number of victims until 2017, followed by an increase, especially in recent years. Particular attention is given to a major accident at a mine in the Karaganda region in 2023, which significantly impacted mortality rates and material losses. The article examines the sectoral and regional structure of the material consequences of accidents, emphasizing a substantial increase in economic costs amid the rise in severe injuries and fatalities. The authors also discuss the impact of these processes on the national economy and the need to strengthen occupational safety measures.

Keywords: industrial accident, costs of occupational safety and health, economic losses, industrial injuries, material consequences.

Introduction. Workplace accidents pose a significant threat both to the health and well-being of employees and to the economic stability of companies. In recent years, the scientific community's attention to these issues has increased significantly, driven by a growing recognition of the direct and indirect economic consequences of such incidents. On the one hand, numerous studies highlight the substantial economic losses incurred by employers due to workplace injuries and accidents. On the other hand, the analysis of costs associated with these incidents has become a key component of effective occupational safety and industrial security management.

The International Labour Organization (ILO) emphasizes that countries with lower levels of workplace accidents demonstrate higher levels of competitiveness. According to the ILO, the global damage caused by occupational injuries amounts to approximately 4% of the world's GDP, underscoring the relevance of studying the economic consequences of such incidents [1]. The importance of this issue is further confirmed by numerous studies, including the works of Shalini R.T. [2] and G. Mazzolini [3], which discuss in detail the impact of occupational injuries on economic inequality and workers' incomes.

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The International Labour Organization (ILO) emphasizes that countries with lower levels of workplace accidents demonstrate higher levels of competitiveness. According to the ILO, the global damage caused by occupational injuries amounts to approximately 4% of the world's GDP, underscoring the relevance of studying the economic consequences of such incidents [1]. The importance of this issue is further confirmed by numerous studies, including the works of Shalini R.T. [2] and G. Mazzolini [3], which discuss in detail the impact of occupational injuries on economic inequality and workers' incomes.

Research also shows that a reduction in labor productivity due to injuries can lead to increased wage penalties for injured workers, especially in companies where earnings depend on physical activity. Zaloshnja E. and Miller T.R. [4] demonstrate that work-related road traffic accidents result in annual losses for employers amounting to nearly \$217.5 billion.

In his study, Mainardi S. [5] analyzes wage disparities among workers in the mining industry across different countries and links them to the risks of severe workplace accidents. The study's findings indicate that companies operating in high-risk environments for injuries are compelled to pay higher wages, which, in turn, increases their operating costs.

Authors Adnett N. and Dawson A. re-examine traditional approaches to the economic analysis of workplace accidents [6]. They criticize evaluation methods based solely on compensatory payments to workers and emphasize the need to consider other factors, such as reduced productivity and reputational damage to the company. This study highlights the importance of integrating a more comprehensive approach to cost analysis.

In Weil D. review, methods for assessing the economic consequences of workplace injuries and illnesses are discussed [7]. The author compares various approaches to cost evaluation, including direct medical expenses and indirect losses such as reduced productivity and loss of earnings. This study also examines the social consequences of accidents for workers and their families, demonstrating how these incidents exacerbate economic inequality.

The study conducted by Battaglia M. and his colleagues focuses on the analysis of costs associated with workplace accidents using the example of a large Italian company [8]. The authors note that companies are generally not interested in accurately assessing the damage from such incidents, even though this data could help in developing preventive programs. The research emphasizes the importance of cost analysis as a tool for occupational safety management.

Despite numerous studies conducted in an international context, empirical research analyzing the specific relationship between workplace accidents and the financial performance of companies is still lacking in domestic practice. This study represents the first attempt to conduct such an analysis, covering a wide range of industries with a high risk of injury.

The aim of this study is to assess the impact of workplace accidents on the financial performance of companies. We analyze data across a large number of industries and demonstrate a consistent negative effect of occupational injuries on company profitability. This research not only contributes to the existing literature but also offers methodological tools for further analysis. The following sections discuss the methodology, explain the research findings, and provide concluding remarks.

Main provision. The issue of occupational injuries and diseases is one of the key challenges in the field of occupational safety and worker health in Kazakhstan. Despite efforts to reduce workplace injury rates, statistical data indicate a steady increase in recent years, leading to significant economic losses. These losses are associated not only with compensation payments to victims and their families but also with temporary loss of workers' ability to work, decreased productivity, and increased costs for occupational safety measures.



There is particular concern over the increasing share of severe injuries and fatal accidents, which carry especially serious material consequences. The problem is further aggravated by the insufficient effectiveness of existing measures for the prevention and reduction of workplace injuries, as well as the lack of systematic analysis of the economic consequences of such incidents.

Thus, there is a need for an in-depth study of the economic consequences of workplace injuries, including an analysis of the dynamics of injury rates and the associated material losses. This research will not only help identify the most vulnerable industries and regions but also contribute to the development of more effective measures to prevent workplace accidents and reduce their economic impact.

Materials and methods. This study employs a comprehensive set of methods aimed at a thorough analysis of the economic consequences of workplace injuries and occupational diseases in Kazakhstan over the period from 2014 to 2023. The research is primarily based on statistical methods, including the collection, processing, and analysis of data on the number of individuals affected by accidents, the severity of injuries, the rate of workplace injuries, and the associated economic losses.

To assess the dynamics of workplace injuries and their consequences, time series methods were used, which allowed for identifying trends in the indicators over the analyzed period. A sectoral and regional analysis was conducted using the comparative method, which made it possible to determine the most vulnerable sectors and regions bearing the greatest economic losses from workplace injuries.

In addition, the study employed econometric methods to calculate and model the material consequences of workplace accidents, including the analysis of cost structures and their changes over time.

Results and discussion. The issue of occupational injuries and diseases has deep roots and has always been relevant for any industrially developed country. In Kazakhstan, occupational safety and workplace safety issues began to be actively addressed during the Soviet period, when the first regulations and standards aimed at protecting workers from accidents and occupational diseases were established. However, since gaining independence in 1991, Kazakhstan's economy has undergone significant changes, which have also affected the level and nature of workplace injuries.

In the post-Soviet period, amid economic reforms and the growth of the industrial sector, Kazakhstan experienced an increase in workplace injuries, necessitating the adoption of new legislative and regulatory measures. In the 2000s, modern occupational safety standards were introduced, control over their enforcement was strengthened, and mechanisms for the social protection of injured workers were implemented. Despite these efforts, workplace injury statistics remain high, highlighting the need for further improvements to the occupational safety system.

Statistical data are being collected at the national level in Kazakhstan [9].

The indicators of workplace injuries from 2014 to 2023 demonstrated a dynamic trend, with a decline in the number of injuries due to accidents between 2014 and 2017 (and Table 1), dropping from 2,578 people to 2,034 in 2016 and 2,045 in 2017. This was followed by an increase in 2018–2019, and a decline during the pandemic year of 2020, returning to the 2016 level. However, from 2021 to 2023, there has been a steady rise in the number of workplace accident victims, increasing from 2,133 in 2021 to 2,670 in 2023, representing a 25% growth over two years.

In terms of severity, severe injuries have dominated the structure of workplace injuries, with their share increasing from 38.7% in 2014 to 42.4% in 2016, then decreasing to 40.4% in



2019, and rising again to 44.6% in 2021. Afterward, the share of severe injuries decreased to 41.2% in 2021 and further to 39.8% in 2020. The share of fatalities (deaths) due to injuries declined from 12.4% (257 people) in 2014 to 10.2% (190 people) in 2019. However, in 2020, there was an increase in the proportion of fatal injuries to 11.3% (203 people), followed by another decline to 9.9% (176 people) in 2021. In 2022 and 2023, the fatality rate showed a steady rise to 11.4% (205 people) and 12.3% (246 people) in 2023.

Table 1 – Injury rates by severity of injuries in industrial accidents 2014-2023

Indicators	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Total injuries	2 070	1 921	1 815	1 777	1 906	1 860	1 796	1 782	1 792	2 008
Easy	613	577	550	526	653	688	581	580	610	698
Average	399	335	278	300	240	231	244	232	238	265
Heavy	801	781	769	740	798	751	768	794	739	799
Died	257	228	218	211	215	190	203	176	205	246

The increase in injuries and fatalities in 2023 is linked to the largest mining disaster in Kazakhstan's history, which occurred at the Kostyenko mine in the Karaganda region. On October 28, 2023, at 2:33 a.m., a fire broke out in the mine's working face, followed by an explosion with a blast wave spanning over two kilometers. At the time of the accident, between 227 and 252 people were in the mine, with 208 being evacuated to the surface. Tragically, 46 miners lost their lives, and about 20 people were hospitalized [10].

Table 2 presents data on the number of workdays lost due to workplace accidents, the number of injured workers, and the severity coefficient of occupational injuries across various industries. The overall figures show a total of 72,851 workdays lost, with 2,008 injured workers and a severity coefficient of 36.3. The highest severity coefficients are observed in manufacturing (41.9), agriculture, forestry, and fishing (40.1), and construction (40.1). These industries are also marked by a significant number of lost workdays and injured workers, underscoring their high level of risk.

In particular, manufacturing leads in both the number of workdays lost (20,580) and the number of injured workers (491). On the other hand, the lowest severity coefficients are found in the information and communication sector (23.8) and accommodation and food services (26.4), indicating a lower level of occupational injuries in these sectors.

Exceptions include sectors with particularly low numbers of injured workers, such as finance and insurance, real estate activities, professional, scientific, and technical activities, and other services, where injury rates are notably lower in terms of both workdays lost and injured workers. Overall, the data highlight the need for enhanced safety measures in high-risk industries, particularly in manufacturing and construction.

**Table 2** – The severity of occupational injuries in 2023

Types of activities	The number of working man-days of disability due to an industrial accident	The number of victims of an industrial accident, people	The severity coefficient of occupational injuries
Total	72 851	2 008	36,3
Agriculture, forestry and fisheries	1 643	41	40,1
Mining and quarrying	13 154	342	38,5
Manufacturing industry	20 580	491	41,9
Supply of electricity, gas, steam, hot water and air conditioning	3 845	109	35,3
Water supply; waste collection, treatment and disposal, pollution control activities	1 494	44	34,0
Construction	7 265	181	40,1
Wholesale and retail trade; repair of cars and motorcycles	3 651	100	36,5
Transportation and warehousing	5 970	161	37,1
Provision of accommodation and catering services	369	14	26,4
Information and communication	428	18	23,8
Financial and insurance activities	54		
Real estate transactions	741	19	39,0
Professional, scientific and technical activities	162	15	10,8
Administrative and support services activities	3 751	108	34,7
Public administration and defense; compulsory social security	2 256	69	32,7
Education	2 533	59	42,9
Public health and social services	4 322	208	20,8
Art, entertainment and recreation	501	16	31,3
Provision of other types of services	132	10	13,2

The statistical indicator that describes a portion of the economic losses from workplace accidents is known as the «Material Consequences of Workplace Accidents». This indicator is determined by the amount of compensation paid to the injured worker, calculated as a percentage of their earnings based on the degree of loss of professional capacity. For those entitled to compensation in the event of the breadwinner's death, the damage is compensated in the amount of the breadwinner's average monthly earnings, minus the portion attributable to the breadwinner and other able-bodied dependents who are not entitled to compensation.

In 2014, this indicator amounted to 1,960,325.3 units, followed by a slight decline to a minimum value of 1,278,543.8 units in 2016. In the subsequent years up to 2020, the values remained relatively stable, with minor fluctuations. However, starting in 2021, a sharp increase was observed, reaching a peak of 8,134,962.2 units in 2023, which is more than four times the value of the previous year (4,106,738.9 units). Such a drastic upward trend may indicate significant changes in the studied area, warranting further analysis. This could be attributed to external factors, shifts in the economy, legislation, or working conditions. The spike in 2023



highlights the need for a detailed investigation into the causes of this increase and the development of recommendations to minimize potential risks in the future.

The material consequences of workplace accidents fluctuated between 2000 and 2009, with a decline to a minimum of 156.6 thousand tenge in 2005, followed by an increase to 470.6 thousand tenge in 2008, and then a decrease again to 412.6 thousand tenge in 2009. However, from 2010 to 2019, there was a trend of gradual growth, with the indicator reaching 819.6 thousand tenge. In the period from 2020 to 2022, the value surged sharply from 969.9 thousand tenge to 1,676.9 thousand tenge, representing a 1.7-fold increase. This indicates that the main direct expenses, which contribute to the economic losses from workplace accidents, have been steadily rising at a significant rate over the past three years, both in total and on a per-victim basis.

As seen from the data in Table 3, the per-victim cost in Kazakhstan amounted to 969.9 thousand tenge in 2020, 1,236.2 thousand tenge in 2021 (a 27% increase year-on-year), 1,676.9 thousand tenge in 2022 (a 35.6% increase year-on-year), and 3,046.8 thousand tenge in 2023 (an 81.6% increase year-on-year). The structure of these expenses remained relatively stable between 2020 and 2022, with the largest share consisting of one-time lump-sum benefits, accounting for 54% to 55.5%, followed by disability leave payments (44%-46%), and the smallest share being top-ups to previous earnings when transferring to another job (0.3%-0.6%).

However, in 2023, the structure of these costs changed drastically. The share of lump-sum benefits increased sharply from 54% in 2022 to 62.3% in 2023, driven by a mass workplace accident at a mine in the Karaganda region, which resulted in a large number of casualties, including fatalities.

Table 3 – The material consequences of accidents per victim in 2020-2023 (thousands of tenge)

Years	The material consequences of accidents per 1 victim	including		
		paid according to the disability certificate	the amount of additional payments to the previous earnings when transferring to another job	One-time benefits have been paid
2020	969,9	445,3	2,7	521,9
2021	1 236,2	545,4	4,3	686,5
2022	1 676,9	761,4	9,3	906,2
2023	3 046,8	1 106,8	41,9	1 898,1

Overall, the total material consequences of workplace accidents amounted to 1.971 billion tenge in 2020 (almost 2 billion), 2.637 billion tenge in 2021 (a 34% increase year-on-year), and 4.106 billion tenge in 2022 (a 56% increase year-on-year). From 2020 to 2022, the total material consequences of workplace accidents more than doubled. However, in 2023, this figure sharply increased to 8.135 billion tenge, more than doubling again compared to 2022.

**Table 4** – Material consequences of accidents in 2020-2023, in total in thousand tenge

Years	Material consequences of accidents, total	including		
		paid according to the disability certificate	the amount of additional payments to the previous earnings when transferring to another job	One-time benefits have been paid
2020	1 971 764,0	905 217,7	5 480,5	1 061 065,8
2021	2 636 722,8	1 163 246,7	9 242,1	1 464 234,0
2022	4 106 738,9	1 864 662,3	22 680,9	2 219 395,7
2023	8 134 962,2	2 955 075,0	111 934,3	5 067 952,9

In terms of industry, the mining sector bears the greatest burden in terms of the material consequences of workplace accidents, accounting for 33.7% of the total sum in Kazakhstan in 2020, 39.6% in 2021, and 44% in 2022. The manufacturing sector follows, contributing 27.7% in 2020, 24.5% in 2021, and 27.1% in 2022. The mining sector carries the highest burden in terms of material losses and has increased its share by nearly a third during the 2020-2022 period. In 2023, the situation worsened with a major accident at a mine. In third place in the «negative ranking» is the construction sector, which reduced its share of the total sum from 16.2% in 2020 to 11.6% in 2021, but slightly increased to 12.5% in 2022. These industries highlight the uneven distribution of material consequences across sectors, with mining and manufacturing being the most affected.

The «Transport and Storage» sector significantly reduced its share of the total material consequences of workplace accidents. In 2020, this sector accounted for 8.7% of the total sum in Kazakhstan, slightly decreasing to 8.3% in 2021, and then almost halving in 2022, dropping to 4.6%. This sharp decline highlights a notable reduction in the sector's contribution to overall workplace accident costs during this period.

The remaining sectors contributed less significantly to the material consequences of workplace accidents in 2020–2022. Sectors that exceeded 2% included agriculture, forestry, and fishing with 2.2% in 2020; electricity, gas, steam, hot water, and air conditioning supply, which contributed 2% in 2020, 2.4% in 2021, and 2.1% in 2022; and wholesale and retail trade, repair of motor vehicles and motorcycles, which accounted for 2% in 2020 and increased to 2.6% in 2022. While these sectors play a smaller role compared to mining, manufacturing, and construction, they still have a noticeable impact on the overall economic losses from workplace accidents.

In the regional breakdown (Table 5), from 2020 to 2022, the largest share of material consequences from workplace accidents was concentrated in the Karaganda region, contributing 33.8% of the total in 2020, 40.4% in 2021, and 35% in 2022. The next significant contributor in 2022 was the Ulytau region with 14.5%, followed by the East Kazakhstan region, which contributed 20.1% in 2020, 14.7% in 2021, and 9.3% in 2022. Although the share of East Kazakhstan in the total sum significantly declined, the absolute value of material consequences only slightly decreased from 397 million tenge to 380.6 million tenge. The mid-range contributors include Astana city (4.7% in 2020, 9.9% in 2021, 6.1% in 2022), Mangystau region (4.6% in 2020, 3.5% in 2021, 5% in 2022), and Pavlodar region (3.8% in 2020, 3.2% in 2021, 4.7% in 2022).



Table 5 – The structure of the regional distribution of the material consequences of accidents in 2020-2022 in the Republic of Kazakhstan

Regions	Amount, in thousands of tenge			%		
	2020	2021	2022	2020	2021	2022
The Republic of Kazakhstan	1 971 764,0	2 636 722,8	4 106 738,9	100,0%	100,0%	100,0%
Abai	-	-	104 234,0			2,5%
Akmola	77 415,0	49 037,5	158 485,0	3,9%	1,9%	3,9%
Aktobe	134 970,0	205 141,0	161 170,6	6,8%	7,8%	3,9%
Almaty	19 795,9	26 315,1	103 511,0	1,0%	1,0%	2,5%
Atyrau	46 159,1	38 857,6	84 155,7	2,3%	1,5%	2,0%
West Kazakhstan	30 233,0	19 739,0	44 133,1	1,5%	0,7%	1,1%
Zhambylskaya	53 812,8	81 965,4	55 979,3	2,7%	3,1%	1,4%
Zhetisu	-	-	33 985,8			0,8%
Karaganda	665 767,8	1 065 004,2	1 438 054,5	33,8%	40,4%	35,0%
Kostanay	49 242,9	68 614,3	75 571,4	2,5%	2,6%	1,8%
Kyzylorda	53 116,2	67 249,1	55 398,0	2,7%	2,6%	1,3%
Mangystau	90 121,4	92 223,9	206 857,3	4,6%	3,5%	5,0%
Pavlodar	75 420,5	83 775,9	191 449,8	3,8%	3,2%	4,7%
North Kazakhstan	27 040,8	17 692,8	15 091,2	1,4%	0,7%	0,4%
Turkestan	35 344,8	80 583,7	15 694,0	1,8%	3,1%	0,4%
Ulytau	-	-	594 622,9			14,5%
East Kazakhstan	396 534,7	386 495,7	380 608,9	20,1%	14,7%	9,3%
city of Astana	91 973,8	260 185,0	252 263,0	4,7%	9,9%	6,1%
Almaty	83 277,6	69 061,2	111 815,3	4,2%	2,6%	2,7%
Shymkent	41537,7	24 781,4	23 658,1	2,1%	0,9%	0,6%

Thus, occupational safety is a system that ensures the protection and health of workers during their employment. Investing in occupational safety not only helps prevent accidents and occupational diseases but also increases labor productivity, improves the workplace morale, and reduces costs associated with sick leave payments and compensations.

Conclusion. As a result of the conducted study, a comprehensive analysis of the economic consequences of workplace injuries and occupational diseases in Kazakhstan from 2014 to 2023 was carried out. The obtained data indicate significant problems in occupational safety, reflected in the increase in injury rates and the growing material losses related to workplace accidents. The rising trend of severe injuries and fatalities is particularly alarming, underscoring the need for enhanced measures to ensure workplace safety.

The analysis of the sectoral and regional structure of economic consequences revealed that the mining and manufacturing industries, along with certain regions like the Karaganda region, bear the greatest losses. This emphasizes the need for targeted efforts to improve working conditions specifically in these sectors and regions.

The study also showed that, despite the measures taken and the implementation of modern occupational safety standards, the current system requires further improvement. Based on the findings, recommendations were proposed to reduce workplace injuries, including strengthening enforcement of safety regulations, increasing worker awareness and training, and developing social support mechanisms for injured workers.



Thus, this study makes an important contribution to understanding the issue of workplace injuries in Kazakhstan and offers concrete steps for addressing it, which should help improve working conditions and reduce the associated economic losses.

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ӨНДІРІСТІК ЖАРАҚАТТАНУДАН ЖӘНЕ КӘСІПТІК АУРУЛАРДАН БОЛАТЫН ЭКОНОМИКАЛЫҚ ШЫҒЫНДАРДЫ ТАЛДАУ

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Түйін. Мақалада 2014-2023 жылдар кезеңінде Қазақстандағы өндірістік жарақаттанумен және кәсіптік аурулармен байланысты экономикалық шығындарға талдау жүргізілді. Зерттеу өндірістегі жазатайым оқиғалардан зардап шеккендердің саны, жарақаттардың ауырлығы және осы оқиғалардың материалдық салдары туралы мәліметтерге негізделген. Авторлар соңғы жылдары өндірістік жарақат деңгейінің өзгеру тенденцияларын, соның ішінде 2017 жылға дейін зардап шеккендер санының төмендеуін және одан кейінгі өсуді атап өтеді. 2023 жылы Қарағанды облысындағы шахтадағы ірі апатқа ерекше назар аударылады, бұл өлім мен материалдық шығындардың көрсеткіштеріне айтарлықтай әсер етті. Мақала жазатайым оқиғалардың материалдық салдарының салалық және аймақтық құрылымын талдайды, ауыр жарақаттар мен өлім санының өсуі аясында экономикалық шығындардың айтарлықтай өсуін көрсетеді. Авторлар сонымен қатар бұл процестердің ел экономикасына әсерін және еңбекті қорғау шараларын күшейту қажеттілігін талқылайды.

Түйінді сөздер: өндірістегі жазатайым оқиға, еңбекті қорғау шығындары, экономикалық шығындар, өндірістік жарақаттану, материалдық зардаптар.

АНАЛИЗ ЭКОНОМИЧЕСКИХ ПОТЕРЬ ОТ ПРОИЗВОДСТВЕННОГО ТРАВМАТИЗМА И ПРОФЕССИОНАЛЬНЫХ ЗАБОЛЕВАНИЙ

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Резюме. В статье проводится анализ экономических потерь, связанных с производственным травматизмом и профессиональными заболеваниями в Казахстане за период 2014-2023 годы. Исследование основано на данных о численности пострадавших от несчастных случаев на производстве, степени тяжести травм и материальных последствиях этих событий. Авторы отмечают тенденции изменения уровня производственного травматизма, включая снижение числа пострадавших до 2017 года и последующий рост, особенно в последние годы. Особое внимание уделяется крупной аварии на шахте в Карагандинской области в 2023 году, которая существенно повлияла на показатели смертности и материальных потерь. Статья анализирует отраслевую и региональную структуру материальных последствий несчастных случаев, подчеркивая значительное увеличение экономических издержек на фоне роста числа тяжелых травм и смертей. Авторы также обсуждают влияние данных процессов на экономику страны и необходимость усиления мер по охране труда.

Ключевые слова: несчастный случай на производстве, затраты на охрану труда, экономические потери, производственный травматизм, материальные последствия.

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