

Development and Application of a Methodology for Analyzing Costs of Ensuring Safe Work in High-Risk Industries: Theoretical and Practical Aspects

This scientific article presents a study focused on the development and application of a methodology for analyzing costs of ensuring safe work in high-risk industries. The article examines the theoretical and practical aspects of this methodology, emphasizing their significance and applicability in various industries with high levels of occupational risk. The presented theoretical foundations and practical recommendations for the application of the methodology for analyzing costs of ensuring safe work will enable organizations in high-risk industries to make informed decisions and optimize their budgets, with the aim of enhancing workplace safety and reducing the likelihood of occupational injuries. This study holds practical significance and can serve as a basis for further research and development in the field of occupational safety in high-risk industries. The objective of this research study is to develop and apply a methodology for analyzing costs of ensuring safe work in high-risk industries with a high incidence of occupational injuries. The methodology employed in this study involves a systematic analysis of key cost factors associated with occupational safety, including equipment procurement and maintenance, training and education programs, and preventive measures to mitigate and respond to workplace injuries. The development of relevant tools and models for evaluating cost-effectiveness and optimizing safety expenditures in these industries is also considered. The findings of this study highlight the importance and applicability of the developed methodology in high-risk industries. The analysis of costs associated with ensuring safe work provides valuable insights into budget optimization and decision-making processes. It enables organizations to enhance workplace safety and reduce the incidence of occupational injuries effectively. The practical significance of this research lies in its provision of evidence-based recommendations and practical guidelines for organizations operating in high-risk industries. The methodology offers a systematic approach to analyze and manage costs related to occupational safety, allowing companies to allocate resources efficiently and improve overall safety performance. This study contributes to the existing literature by presenting an original methodology tailored to high-risk industries with a focus on cost analysis and optimization. Its value lies in providing a comprehensive framework that combines theoretical foundations with practical applications, addressing the specific needs and challenges of industries characterized by a high risk of occupational injuries.

Keywords: *occupational safety and health, costs, cost accounting, occupational injuries, occupational risk*

Introduction

At the current stage of the development of occupational health and safety in Kazakhstan, there is an urgent need for improvement in the processes of reporting, monitoring, and analyzing the Occupational Health and Safety Management

1 System (OHSMS), abbreviated as OHSMS. However, the measures taken in the
2 country to update the legislative and regulatory framework have proven to be
3 insufficiently effective. Currently, there is a noticeable increase in the number of
4 fatal workplace injuries and incidents with serious consequences. In light of these
5 circumstances, it is crucial to take additional measures to improve the situation in
6 the field of occupational health and safety and ensure the safety of working
7 conditions.

8 Safety and occupational health issues at enterprises can be addressed through
9 several possible solutions. One approach is the development and implementation
10 of new equipment and technology, personnel training, updating normative-
11 methodological documents, and promoting occupational health and safety.
12 However, implementing these measures involves certain resource Costs, and now
13 enterprises are responsible for seeking financing for occupational health and safety
14 measures.

15 In the past, the state bore the main economic burden of occupational health
16 and safety, but currently, the responsibility for this has entirely shifted to
17 enterprises. However, not all enterprises were prepared for such a changed
18 situation, both from a moral and an economic standpoint. Only a few of the
19 enterprise managers realize that expenditures on occupational health and safety
20 should be seen as essential investments to ensure production efficiency.

21 Regrettably, many enterprises fail to consider the costs of occupational health
22 and safety in their performance analysis and do not evaluate the effectiveness of
23 these expenditures.

24 In the context of digitalization across various industries, it is crucial to
25 automate the labor-intensive process of accounting for and analyzing occupational
26 health and safety Costs. This will enable enterprises to more accurately determine
27 costs, analyze their effectiveness, and make informed decisions in the field of
28 occupational health and safety, contributing to improving working conditions and
29 enhancing production efficiency.

30 31 32 **Literature Review**

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34 In contemporary Kazakhstani literature dedicated to the economics of
35 occupational health and safety, materials on this subject are not encountered as
36 frequently. However, overseas, methods for analyzing costs in the field of health
37 and safety at work have already been developed and put into practice. The most
38 prevalent research in this area has been conducted by scholars such as Thomp E.,
39 Feng Y., Rohani Z., Zeparkson P., Ibarondo-Davilia M., and Lopez-Alonso M.,
40 Jung S. and Kim K., Akchay K. and Yilmaz M., Tutunchian S., Riana-Kasallias
41 M., Nagata T., Guido J.M., and others. The works of the aforementioned
42 researchers encompass the analysis and evaluation of costs related to accidents,
43 indirect and direct Costs, uninsured risks, costs borne by insurers, and
44 mathematical modeling of costs in the field of occupational health and safety.

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1 **Methodology**

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3 The study was based on the methodological foundation of the formal-logical
4 approach, which represents a universal tool for analyzing organizational issues. In
5 addition to this, special methods such as the systemic-structural approach and
6 functional analysis of occupational health and safety tools in the management
7 system were employed during the research. These methods were applied to
8 achieve a more profound and comprehensive examination of occupational health
9 and safety issues and to ensure safe conditions within the organization.

12 **Research Results and Discussion**

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14 According to the research by Tridenyozhkina M.D. and Kozlova Y.V., all
15 occupational health and safety Costs can be divided into several major groups:
16 expenditures on specialized job assessments, Costs on medical examinations, costs
17 for purchasing personal protective equipment, and training Costs. Additionally,
18 there are Costs related to measures to improve working conditions and
19 occupational health, costs for compensating work in hazardous and dangerous
20 conditions, and contributions to mandatory social insurance for occupational
21 accidents and occupational diseases.

22 In the study conducted by Arefyev S.N. [1], it was found that investments in
23 occupational health and safety in the form of current Costs can yield significant
24 benefits over time, which can be recouped within a relatively short period.

25 Budgets are prepared for specific periods and represent a financial plan
26 considering current and prospective goals and objectives of the enterprise. They
27 should be based on the allocation of Costs [2].

28 Among a series of works describing the principles of forming Costs for
29 ensuring safe work, we can highlight the study [3], which provides a detailed
30 description and justification of seven principles: priority, cost-effectiveness,
31 stimulation and motivation, social and public-private partnership in the field of
32 occupational health and safety, minimizing the "human factor," and professional
33 development.

34 The conducted analysis revealed 4 general principles of forming Costs for
35 ensuring safe work (according to the Budget Code of the Republic of Kazakhstan):

- 36
37 - the principle of justification and recognition of Costs for ensuring safe
38 work. Costs must be justified and incurred within the scope of
39 occupational health and safety activities. The Costs related to ensuring
40 safe work include costs associated with meeting the established safety and
41 occupational health requirements, as well as enhancing workplace safety.
42 Costs related to the absence of workplace safety, including payments for
43 accidents, are also covered;

- 1 - the principle of effectiveness and economic efficiency. Costs should be
2 directed towards achieving the results outlined in the occupational health
3 and safety policies and/or programs, as reflected in the Action Plan for
4 reducing occupational risks, while ensuring the highest economic
5 efficiency with minimum costs and limited resources.;
- 6 - the principle of responsibility and regulatory compliance. Costs should be
7 determined considering compliance with the norms of legislation and
8 established limits for expenditures by multiplying the normative by
9 quantitative indicators;
- 10 - the principle of functionality and target measurability. Costs should have
11 a functional purpose, be capable of separate measurement, and ensure
12 comparability of data.

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14 The mentioned principles are fundamental in the process of forming the
15 budget for occupational health and safety.

16 The analysis of occupational health and safety Costs requires the
17 consideration of various factors, such as reducing benefits for unsatisfactory
18 working conditions, preventing accidents and occupational diseases, as well as
19 decreasing employee turnover and other indicators.

20 The majority of financial resources are allocated for the implementation of
21 occupational health and safety measures, while only a small portion of the funds is
22 used for compensation and reimbursement of damages related to working in
23 unfavorable conditions, accidents, occupational diseases, and emergencies.

24 To assess the potential savings that can be achieved through improving
25 occupational health and safety conditions, it is necessary to conduct an analysis of
26 costs and Costs in this field. Among the key indicators of costs and Costs, the
27 following can be highlighted:

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- 29 1. Costs for occupational health and safety measures necessary to comply
30 with legislatively established normative requirements.
- 31 2. Expenditures for compensations for work in hazardous and dangerous
32 conditions that arise when it is not possible to completely eliminate
33 hazards.
- 34 3. Payment of insurance contributions for mandatory social insurance
35 against industrial accidents and occupational diseases.
- 36 4. Costs related to accidents, occupational diseases, and emergencies that
37 cannot be fully covered by insurance payments.
- 38 5. Fines and payments related to the breach of contractual obligations and
39 other Costs associated with it.

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41 Conducting such an analysis will allow evaluating the degree of economic
42 efficiency and exploring prospects for additional investments in the field of
43 occupational health and safety from the perspective of the enterprise or
44 organization. Therefore, cost management and the assessment of socio-economic

1 effectiveness are key components for successful occupational health management
2 and achieving positive outcomes at the enterprise.

3 Measurement of Costs related to workplace accidents is a mandatory element
4 in cost management within the Occupational Health and Safety Management
5 System (OHSMS). From a financial perspective, employers are interested in
6 improving the situation in this area by considering economic, variable, direct, and
7 internal Costs.

8 *Economic and non-monetizable Costs.* Non-monetizable Costs include the
9 physical suffering of the injured party and the emotional stress experienced by
10 their family. During legal proceedings, attempts are made to give them a monetary
11 evaluation when assessing the degree of harm. However, this can only be an
12 approximate attempt since it is impossible to determine the damage that cannot be
13 compensated with money.

14 Indeed, economic losses are those that can be specifically measured. These
15 are losses associated with tangible objects or services that have a definite market
16 value or can be roughly assessed by a qualified specialist. Economic losses
17 encompass the financial Costs of the worker and their family, losses incurred by
18 the enterprise, as well as losses for society as a whole.

19 *Direct and indirect Costs.* Increasing insurance premiums, Costs for legal
20 settlement, and equipment restoration are typically typical examples of direct
21 Costs at the organizational level. Possible examples of indirect Costs (Costs that
22 do exist but are not calculated for various reasons) may include the following:

23

- 24 – Disruption of the production process immediately after the accident.
- 25 – Moral impact on colleagues at work, leading to reduced productivity.
- 26 – Involvement of personnel in the accident investigation process.
- 27 – Costs for hiring and training new employees.
- 28 – Decreased quality and productivity of work due to inexperience of newly
29 hired staff.
- 30 – Damage to equipment and materials (if not accounted for within regular
31 accounting procedures).
- 32 – Reduced product quality after the accident.
- 33 – Decreased productivity of injured workers transferred to lighter duties.
- 34 – Costs for maintaining reserve capacity to cover losses associated with
35 accidents.

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37 The ratio of indirect to direct Costs varies from less than 1:1 to more than
38 20:1, depending on the industry and calculation methodology. Therefore,
39 obtaining information about these Costs can serve as a significant incentive for
40 addressing the situation and making necessary improvements.

41 *Internal and external costs play a significant role in the field of occupational
42 health and safety.* The existence of external costs sets a boundary between the
43 incentives that influence decision-making and the interests of society as a whole.
44 These costs are largely compensated for through funds provided by both workers
45 and society as a whole. External costs include various components, such as:

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- Medical Costs and loss of worker's wages (both current and future), not covered by compensation payments.
- Time and resources spent by the worker's close ones on their treatment and care.
- Lost working time and participation in daily life due to the consequences of the accident.
- Payments from budgetary and extrabudgetary funds.

The magnitude of external costs indicates that in many cases, reducing occupational risks aligns more with the interests of society as a whole rather than individual enterprises.

Therefore, the implementation of economic management methods in the occupational health and safety system at an enterprise involves selecting socio-economic indicators that reflect the state of occupational health and safety, taking into account the organization's capabilities, specific activities, and the number of employees.

Occupational safety and health in Kazakhstan is one of the key priority areas aimed at ensuring the safety and well-being of workers in the workplace. Statistical data related to occupational health and safety plays a crucial role in understanding the current situation and developing effective strategies to improve conditions in enterprises and organizations. Let's examine real figures and recognize the socio-economic significance of statistical observations on the state of occupational health and safety in Kazakhstan.

Industrial accidents and occupational diseases result in economic losses for society and enterprises. Monitoring these Costs helps to assess the impact of occupational hazards on the country's economy. In 2022, the total expenditures of enterprises aimed at improving workplace safety and occupational health amounted to 271,892,843.2 thousand tenge (Table 1). This includes loss of working time, medical Costs, and insurance payments. The magnitude of these economic losses underscores the importance of reducing workplace injuries and enhancing occupational safety.

1 **Table 1.** *Costs of enterprises aimed at measures to improve workplace safety and*
 2 *labor protection for 2018-2022*

№	Наименование затрат	2018	2019	2020	2021	2022
1	Costs of insurance against accidents at work, the amount of the insurance premium, thousand tenge	25 002709,0	31 809212,0	31 965 503,0	34 787 584,0	59 562 081,0
2	Mandatory occupational pension contributions, thousand tenge	476 492,0	507 742,0	526 111,0	542397,0	592 250,0
3	Compensation costs for work in harmful and other unfavorable working conditions, thousand tenge	125 266153,0	138 752 316,0	96 864 387,4	109898640,1	207631773,3
4	Material consequences of accidents, thousand tenge	1 532 656,2	1 730 202,4	1 971 764,0	2 636722,8	4106738,9
	Total	152 278 010,2	172 799472,4	131327765,4	147 865343,9	271892843,2

3 Source: [4], [5], [6]

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5 Analysis of the data on occupational health and safety expenses in
 6 Kazakhstan from 2018 to 2022 reveals key trends and changes in the financial
 7 commitments of enterprises towards providing safe working conditions for their
 8 employees. The expenses on accident insurance continuously increased throughout
 9 the observation period. Particularly significant growth was observed from 2020 to
 10 2021 when the insurance premium amount increased by 70%, indicating a
 11 potential rise in insurance rates and an increase in the number of accidents.

12 The expenses on mandatory professional pension contributions also increased
 13 each year, but more moderately compared to insurance. This indicator
 14 demonstrates a stable growth and may indicate increased attention to the pension
 15 security of workers.

16 The expenses on compensations show different dynamics in different years.
 17 Particularly significant decrease in expenses was observed from 2019 to 2020,
 18 after which they sharply increased in 2021 by more than two times. This is related
 19 to the revision of compensation rules and changes in labor legislation.

20 Expenses on material consequences are also increasing, but at a less rapid
 21 pace compared to other occupational health and safety expenses. In 2022, a more
 22 significant increase in expenses was recorded compared to previous years.

23 Thus, the total expenditures on occupational health and safety in Kazakhstan
 24 continue to increase, indicating heightened attention to the safety and social

1 protection of workers. It is important to note that certain categories of expenses
 2 (such as insurance and compensations) exhibit high variability in different years,
 3 requiring further analysis and justification of the reasons for such fluctuations.
 4 Continuous improvement of the occupational health and safety system and social
 5 support for workers is a key factor in ensuring sustainable and safe development of
 6 production in Kazakhstan. Attention to these expenditures allows for optimizing
 7 budgetary expenses and focusing efforts on providing a high level of safety and
 8 well-being in the workplace.

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11 **Conclusions, Proposals, Recommendations**

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13 The authors propose a Methodology for Analyzing Occupational Health and
 14 Safety Costs, which allows evaluating the effectiveness of resources invested in
 15 ensuring safe working conditions at the enterprise. This methodology will utilize
 16 the following formulas:

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18 1. Calculation of total occupational health and safety costs (OHSC) for a
 19 specific period of time:

$$20 \quad OHSC = C_{iai} + C_{mpc} + C_{comp} + C_{mat} \quad (1)$$

21 where:

22 C_{iai} - Costs of industrial accidents insurance,

23 C_{mpc} - Mandatory professional pension contributions,

24 C_{comp} - Compensation for working in hazardous and other adverse working
 25 conditions,

26 C_{mat} - Material consequences of accidents.

27 2. Calculation of average costs for occupational safety and health per year
 28 (COHSY):

$$29 \quad COHSY = \frac{OHSC}{n} \quad (2)$$

30 where:

31 n - The number of years in the analyzed period (for example, 5 years).

32 3. Calculation of the Occupational Safety and Health Expenditure Growth
 33 Index (OSH EGI) for a specific period of time:

$$34 \quad OSH \ EGI = \frac{OHSC_{Final} + OHSC_{Initial}}{OHSC_{Initial}} * 100\% \quad (3)$$

35 where:

36 $OHSC_{Initial}$ - Occupational Safety and Health Expenditure at the beginning of
 37 the period,

38 $OHSC_{Final}$ - Occupational Safety and Health Expenditure at the end of the
 39 period.

40 4. Calculation of the Average Occupational Safety and Health Expenditure
 41 Growth Index (AOSH EGI) for a specific period of time:

$$42 \quad AOSH \ EGI = \frac{C_{30T_{конец}} + C_{30T_{конец}}}{C_{30T_{начало}}} * 100\% \quad (4)$$

43 where:

1 $AOHSC_{Initial}$ - Average Occupational Safety and Health Expenditure at the
 2 beginning of the period,
 3 $AOHSC_{Final}$ - Average Occupational Safety and Health Expenditure at the end
 4 of the period.

5 5. Calculation of the Occupational Safety and Health Expenditure Efficiency
 6 Coefficient (OSHEEC):

$$7 \quad OSHEEC = \frac{OSHE}{COHSY} * 100\% \quad (5)$$

8 where:

9 OSHE - The indicator of occupational safety and health efficiency is
 10 determined based on statistics of accidents and occupational injuries.

11 6. Calculation of the Return on Investment in Occupational Safety and Health
 12 coefficient (ROI-OSH):

$$ROI - OSH = \frac{Savings}{COHSY} * 100\%$$

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14 where:

15 Savings - the amount of savings obtained through the improvement of
 16 working conditions and the reduction of accidents.

17 The authors note that this Methodology includes expenses that can be
 18 obtained from open data of national statistics. The Methodology may include:
 19 costs for individual and collective protective equipment, training expenses,
 20 certification of production facilities for working conditions and assessment of
 21 professional risks, periodic medical examinations, and so on.

22 The proposed Methodology for analyzing occupational safety and health
 23 (OSH) expenses provides companies and organizations with the opportunity to
 24 conduct a comprehensive analysis of their investments in the field of occupational
 25 safety and health. Calculating the total OSH expenses and average expenses per
 26 year allows assessing the expenditure volume over a certain period of time and
 27 identifying expense trends. The growth indices of OSH expenses enable the
 28 evaluation of changes in expenses in percentage terms, helping to identify the
 29 reasons for increases or decreases in costs.

30 The coefficients of efficiency and return on investments allow the assessment
 31 of how effective the resources invested in occupational safety and health were, and
 32 how they contributed to cost savings and increased safety in the workplace.
 33 Analyzing data based on these coefficients and the efficiency indicator enables
 34 companies to make informed decisions on optimizing budgetary expenditures and
 35 further enhancing the occupational safety and health system.

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38 **Conclusions, Proposals, Recommendations**

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40 The article presents a methodology for analyzing occupational safety and
 41 health (OSH) expenses in high-risk industries, which represents a comprehensive
 42 approach to assessing the effectiveness of investments in occupational safety and
 43 health. The methodology includes an examination of key expenses, such as

1 workplace accident insurance, mandatory professional pension contributions,
2 compensation for hazardous work, and material consequences of accidents.

3 The proposed analysis method allows for the identification of key factors
4 influencing the effectiveness of occupational safety and health expenses and
5 determining an overall efficiency indicator that consolidates all the metrics into a
6 single numerical value. This enables the comparison of results over different time
7 periods and facilitates informed decision-making regarding the optimization of
8 occupational safety and health expenditures.

9 A high overall efficiency indicator for occupational safety and health
10 expenses indicates a diligent effort to ensure employee safety and reduce the risk
11 of accidents. However, a low indicator may suggest the need to review the
12 occupational safety and health strategy and further improve the management
13 system.

14 Indeed, based on the proposed methodology, companies can conduct a
15 systematic analysis of occupational safety and health expenses, identify
16 problematic areas, and take targeted measures to improve working conditions and
17 ensure employee safety. This contributes to enhancing production efficiency,
18 reducing the risk of accidents, and improving the company's image in the eyes of
19 employees and the public. By prioritizing the safety and well-being of their
20 workforce, companies can create a positive and responsible image, which can lead
21 to increased productivity and overall success.

22 Indeed, the developed methodology for analyzing occupational safety and
23 health expenses is a valuable tool for evaluating the effectiveness of the
24 occupational safety and health system in organizations. It contributes to achieving
25 a high level of safety and health for employees, which, in turn, positively impacts
26 overall productivity and the success of the company. By using this methodology,
27 companies can make informed decisions, allocate resources more efficiently, and
28 implement targeted measures to improve workplace safety. This proactive
29 approach to ensuring the well-being of employees not only enhances their working
30 conditions but also fosters a positive work environment and promotes the
31 company's overall success. Ultimately, prioritizing the safety and health of the
32 workforce is a critical aspect of responsible and sustainable business management..
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