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ECONOMETRIC ANALYSIS OF DYNAMICS OF OCCUPATIONAL INJURY IN UKRAINE

Substantiation of the influence of supervision activity indicators on the level of occupational injuries in Ukraine. The justification of the possibility of influencing the level of occupational injuries in Ukraine and reducing the number of injured workers, including those with fatal coincidences, by increasing the number of planned inspections of supervised entities and increasing the number of violations detected on occupational and industrial safety issues at 1 actual state Labor Protection Inspectorate of the State Labor Service of Ukraine. As part of the study, the econometric analysis of the linear chronological trends of occupational injuries in Ukraine according to the reporting forms of the State Labor Service 3-ND and 4-ZT 2008-2017 was carried out in order to determine the influence on the amount of state supervision measures implementation on one actual state inspector and the level of occupational injuries in supervised entities. Basing on practical meaning forecast, it is possible to adjust the supervising activity promptly in case of unacceptable expected indicators of occupational injuries. The indicators on the number of violations detected on occupational and industrial safety issues were analyzed on 1 verified facility and 1 actual state inspector of the State Labor Organization. The reduction of these indicators is shown as a positive shift in compliance with legislative and regulatory acts of occupational and industrial safety at the level of supervised entities.

Key words: state supervision, level of occupational traumatism, correlation-regression factor analysis, correlation coefficients and regression coefficients.

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ЕКОНОМЕТРИЧНИЙ АНАЛІЗ ДИНАМІКИ ВИРОБНИЧОГО ТРАВМАТИЗМУ В УКРАЇНІ

Стаття присвячена аналізу динаміки і рівня виробничого травматизму в галузях економіки України в залежності від ефективності державного нагляду з питань охорони праці інспекторського складу Державної служби України з питань праці.

Автором проведено економетричний аналіз лінійних тимчасових трендів виробничого травматизму в Україні за даними форм звітності Держпраці 3-НД та 4-ЗТ 2008–2017 рр. з метою визначення впливу наглядової діяльності на рівень виробничого травматизму в ризиконебезпечних галузях економіки України залежно від загальної кількості перевірених піднаглядних суб'єктів господарювання, кількості перевірок виробничих об'єктів і кількості здійснення заходів державного нагляду на одного фактичного державного інспектора, а також від кількості виявлених порушень з питань охорони праці та промислової безпеки на один перевірений виробничий об'єкт.

Ключові слова: державний нагляд, рівень виробничого травматизму, факторний кореляційно-регресійний аналіз, коефіцієнти кореляції та регресії.

Introduction. Practice shows that the need for continuous improvement of supervisory activity on the issues of labor protection and industrial safety of economic entities is difficult to overestimate. After all, the increase in the number of hazards in the workplaces of economic entities and the number of violations of the relevant legislative and regulatory acts on labor protection, which are not detected by officials of the supervisory bodies and not removed by employers, inevitably leads to an increase in the level of occupational injuries, especially in the subjects management of risky sectors of the economy of Ukraine. This not only negatively affects the efficiency of economic activity of enterprises and the well-being of workers due to the emergence of forced man-days of disability, but also endangers health and, in the worst case, even takes lives of victims in the production of workers [1].

Formulation of the problem. As part of the study, the econometric analysis of the linear time trends of occupational injuries in Ukraine according to the data of the 3-ND and 4-ZT 2008–2017 forms was carried out in order to determine the impact on the change in the number of implementation of state supervision measures on one actual state inspector and the level of occupational injuries on subordinate subjects of management, the results of which are given in Table 1.

Table 1

Dynamics of occupational injuries in Ukraine according to data Report on injuries 4-ZT

Index	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Total number of victims	16302	12370	11698	10657	9816	8568	6318	4260	4428	4313
The number of injured	15297	11695	11054	9972	9193	8030	5770	3885	4028	3947
Number of deaths	1005	675	644	685	623	538	548	375	400	366
Part of the injured from all victims,%	93,8	94,5	94,5	93,6	93,7	93,7	91,3	91,2	91,0	91,5
Part of deaths from all victims,%	6,2	5,5	5,5	6,4	6,3	6,3	8,7	8,8	9,0	8,5
Number of man-days of disability	425 863	340 846	305 796	318 455	259 317	223 415	151 028	104 579	114 515	146 437

On the basis of monitoring, the number of man-days of disability can be confirmed with a high reliability of 0.91, which is a positive annual reduction of this figure by 34202 man-days [7]. The data is shown in Fig. 1.

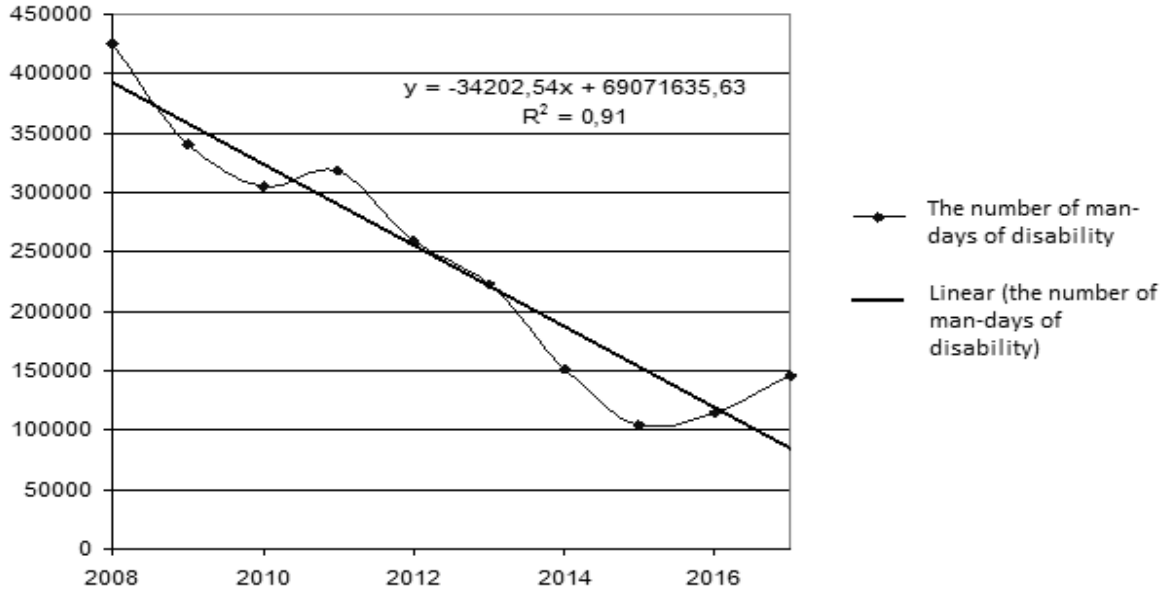

Fig. 1. Time trend of the number of man-days disability

The purpose of the work. The main purpose of the paper is to substantiate the impact on the level of occupational injuries in Ukraine and to reduce the number of injuries in the work, including those with a fatal outcome, with an increase in the number of planned inspections of supervised economic entities and an increase in the number of violations detected on occupational safety and industrial safety issues 1 actual State Labor Protection Inspectorate of the State Service of Ukraine on Labor (hereinafter – State Labor Organization).

Determination of the dependence and level of influence of the main relative indicators of the supervisory activity of the State Labor Inspectorate on the number of industrial accidents, as well as the state of safety in production and the motivation of employers to create safe and healthy working conditions at risky enterprises in Ukraine.

Similar positive trends for the period under review were also established for the total number of victims, injured and fatal cases. Namely, in Fig. 2 shows that with a high probability of 0.95 there is an annual reduction of the total number of victims by 1302 persons [2].

The number of injured persons with an authenticity of 0.95 annually decreases by an average of 1245, according to Fig. 3, while the number of fatal cases is reduced with an authenticity of 0.83 for 57 people, according to Fig. 4.

At the same time, in a relative measure, the situation does not look equally soothing. Thus, the linear time trends of the structure of victims of occupational injuries testify to an increase in the weight of injuries with lethal consequences. Namely, according to Fig. 5, part of the injured of all victims with an accuracy of 0.77 is annually

reduced by 0.42%, while the relative weight of fatalities increases annually by 0.42 %, according to Fig. 6.

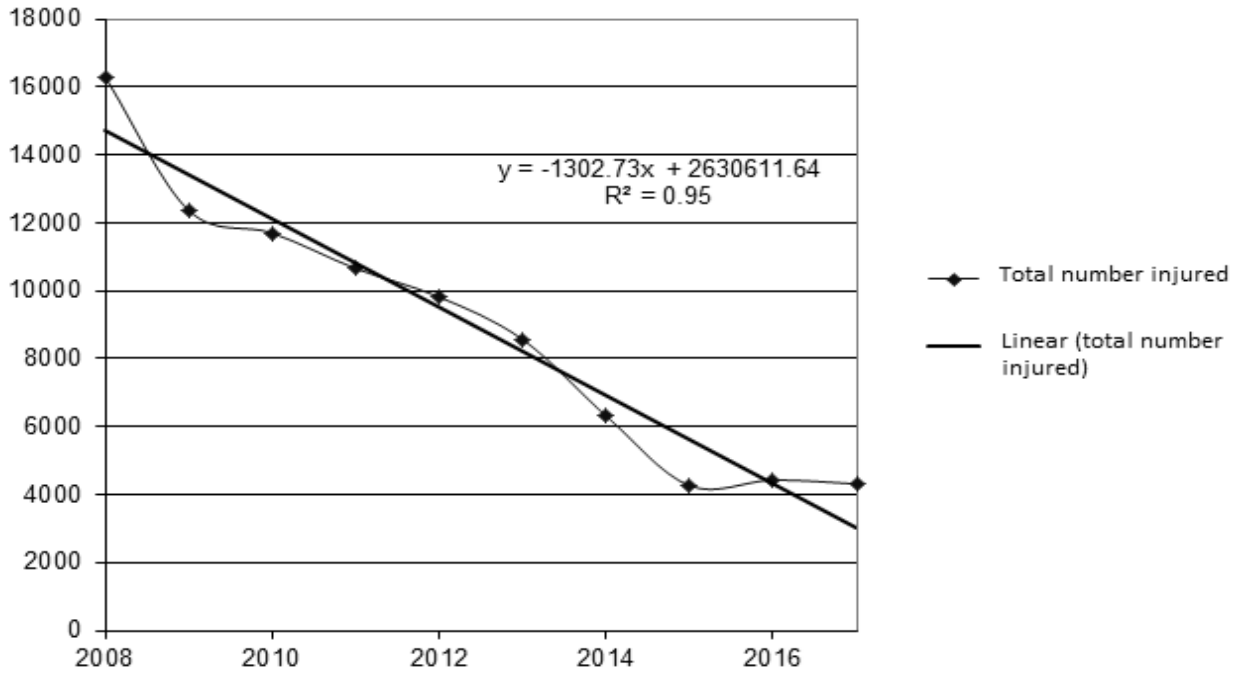

Fig. 2. Time trend of the total number of victims

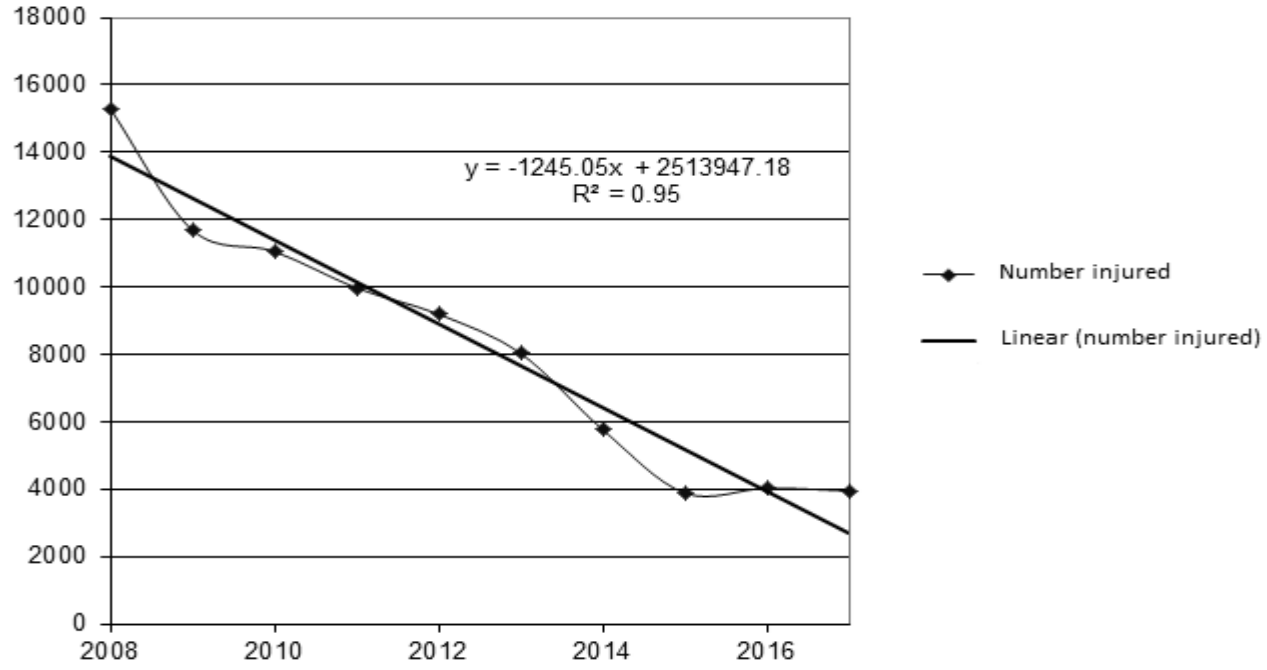

Fig. 3. Time trend of the number of injured

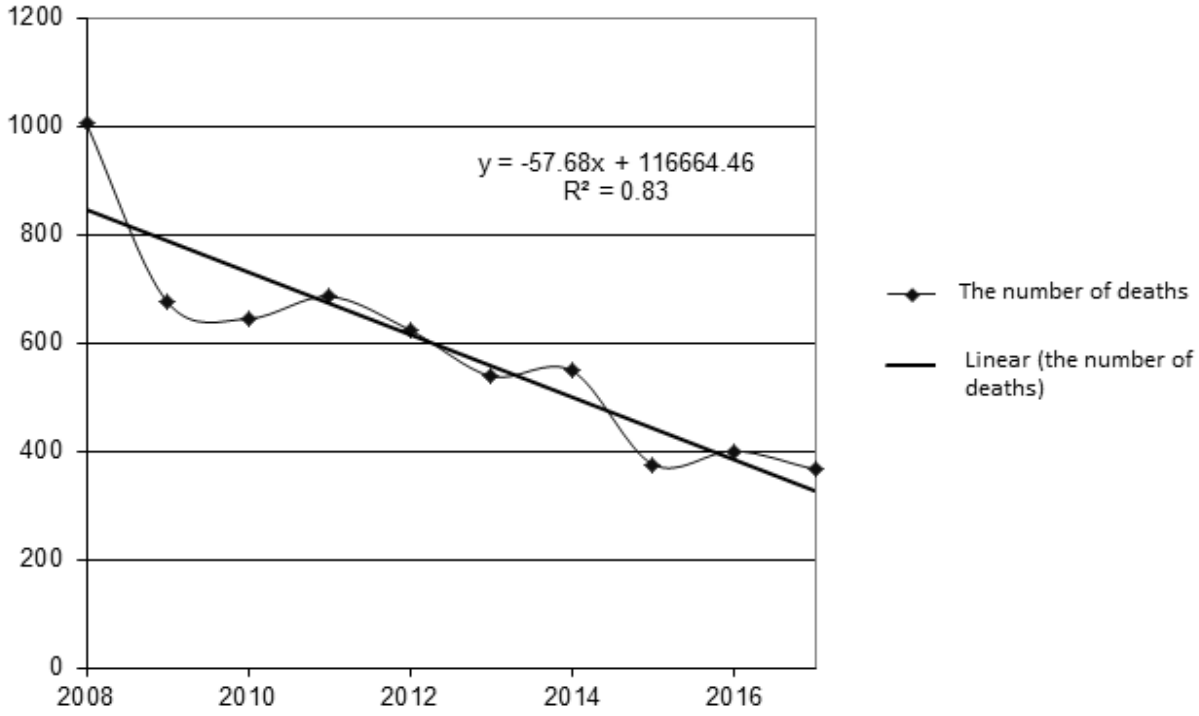

Fig. 4. Time trend of the number of deaths

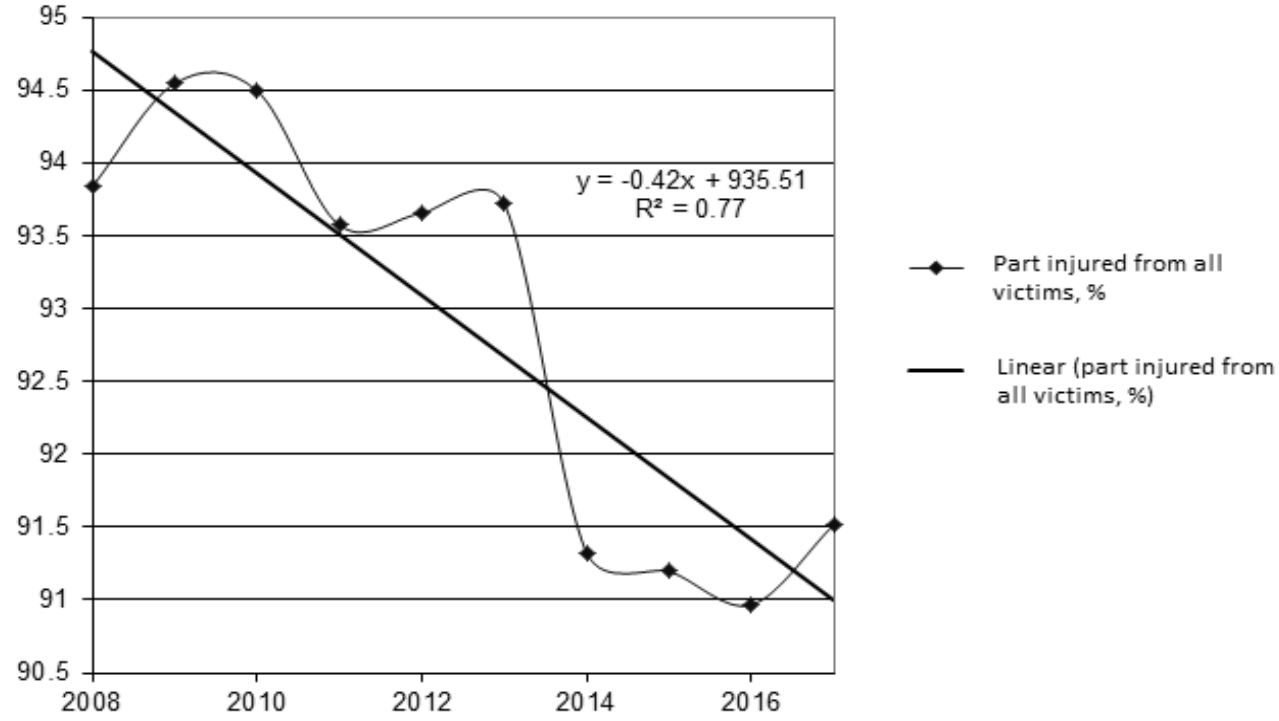

Fig. 5. Time trend of the part injured from all victims

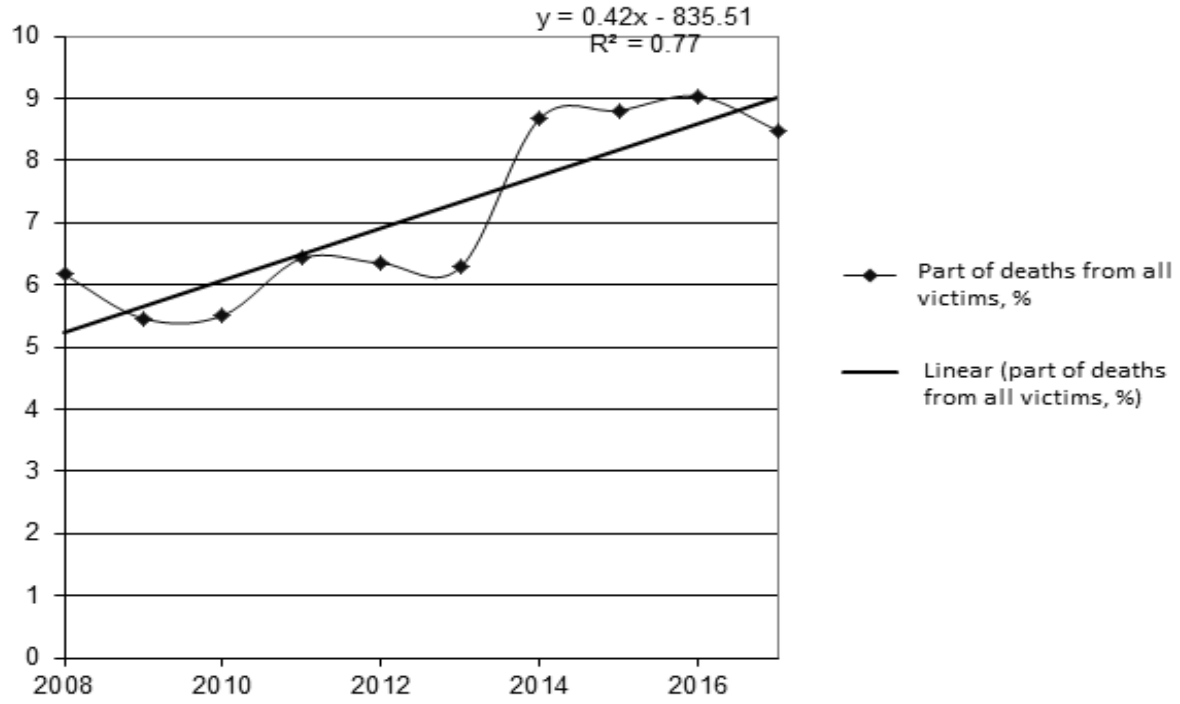

Fig. 6. Time trend of a part of deaths from all victims

The established negative tendency of complication of occupational injuries in some way is explained by insufficiently perfect supervisory activity on occupational safety and industrial safety by subjects of the economy of traditionally most dangerous areas of production [6].

In support of the reduction of occupational injuries in the study, a factor correlation-regression analysis of the most influential factors of supervisory activity on occupational safety and industrial safety was conducted. Quantitative dependencies are obtained in the form of linear equations:

$$Y = a_0 + a_1 \cdot X_1 + a_2 \cdot X_2 + a_3 \cdot X_3 , \quad (1)$$

where a_0, a_1, a_2, a_3 – numerical regression coefficients;

X_1, X_2, X_3 – influential factors of supervisory activity;

Y – the result of occupational injuries.

According to the 3-ND and 4-ZT forms, the most important indicators of occupational injuries (Y), for which further correlation-regression analysis is carried out, are

- total number of victims;
- the number of deaths;
- Number of man-days of disability.

Their values for the period 2008–2017 are given in Table. 1

The most influential explanatory factors of annual oversight activities include:

1) part of audited subordinate economic entities, % (X_1) as an indicator of the volume of implementation of the control function;

2) the number of inspections of production facilities by 1 inspector (X_2) as indicator of the load of inspector;

3) the number of detected violations in occupational safety and industrial safety on 1 verified production facility (X_3) as a characteristic of the environment of occupational injury.

The values of the listed factors for the period of 2008–2017 years contains the table. 2. Table data. 2 indicate a positive tendency for the growth of part of the audited subordinate economic entities to increase, indicating an increase in the scope of supervisory activity. The indicator of the number of inspections of production facilities by 1 inspector for 2008–2017, in general, tended to decrease, indicating an improvement in the management of inspections and concentration on high-risk industrial sites as a potential source of occupational injuries. Similarly, the number of detected violations in terms of occupational safety and industrial safety decreased by 1 verified production facility, which can be interpreted as a positive shift in compliance with legislative and regulatory acts on occupational safety and industrial safety at the level of supervised economic entities. Effective incentives should include increased penalties and effective preventive and explanatory work.

Table 2

Dynamics of supervisory activity in accordance with the report on the supervisory activity of the State Labor Organization in the form of 3-ND

Index	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Part of inspected business entities,%	0,27	0,42	0,98	0,36	0,79	1,06	0,73	0,20	1,11	3,09
The number of inspections of production facilities by 1 inspector	125	131	132	145	111	107	109	35	57	61
Number of detected violations per 1 verified production facility	10,2	9,8	9,5	9,8	10,3	10,3	8,2	4,6	7,8	7,7

Supervisory activities for 2014–2015 are characterized by insignificant indicators in connection with the negative impact on the safety of the production of a moratorium on

state supervision measures (Article 31 of the Law of Ukraine "On the State Budget of Ukraine for 2014" (as amended by the Law on the Budget of 31.07.2017 No. 1622-VII)).

The results of the factor analysis of the dependence of occupational injuries on the aggregate of the most important factors of supervisory activity were obtained by the toolkit of Microsoft Excel spreadsheets and reflected in the table. 3–5.

Table 3

Correlation and regression characteristics of the influence of supervisory activity on the total number of victims

Index	Correlation coefficient	Regression coefficient	Factor elasticity
Constant	–	-1945	–
Part of inspected business entities,%	-0,48	-1429	-0,15
The number of inspections of production facilities by 1 inspector	0,82	41	0,46
Number of detected violations per 1 verified production facility	0,75	903	0,90

Described in Table 3 regression dependence of the indicator of occupational injuries from observation factors was obtained with a higher than average determination coefficient of 0.75 and a high level of F-significance of 0.03. Correlation coefficients (-0.48) and regression (-1429) indicate that the proportion of verified business entities produces an inverse proportional effect on the total number of victims. Namely, an increase in the number of audited business entities, even by 0.01 %, will reduce the number of victims of industrial injuries to 14 people. Or according to the factor elasticity (-0.15), 1 point (percentage point), the growth of the indicator of a part of the audited business entities will result in a reduction of 0.15 % in the reduction of injuries from injuries.

Correlation coefficients (0.82) and regression (41) reflect that the number of inspections of production facilities by one inspector has a direct proportional effect on the total number of victims. This indicates the expediency of increasing the state. Namely, reducing the number of inspections of production facilities by 1 inspector even for one measure will reduce the number of injuries from occupational injuries to 41 people. Or, according to factor elasticity (0.46), a 1 % reduction in the number of inspections of production facilities by one inspector will result in a decrease in the number of injuries from occupational injuries by 0.46 %.

Correlation coefficients (0.75) and regression (903) show that the number of detected violations per 1 verified production facility produces a direct proportional effect on the total number of victims. This should be understood as the own reserve of supervised economic entities for the strict observance of legislative and regulatory acts on occupational safety and industrial safety in order to withstand diligent inspections

without comments and violations detected by the inspectors. Namely, the reduction of the number of detected violations per 1 verified production facility on the average even by 0.1 will lead to a reduction in the number of victims of occupational injuries to 90 people. Or, according to factor elasticity (0.90), a 1 % reduction in the number of violations detected on one verified production facility will result in a reduction in the number of injuries from occupational injuries by 0.90 % [4].

Table 4

Correlation and regression characteristics of the influence of surveillance activity on the number of deaths

Indexes	Correlation coefficient	Regression coefficient	Factor elasticity
Constant	–	132	–
Part of audited business entities,%	-0,51	-81	-0,12
The number of inspections of production facilities by 1 inspector	0,77	2	0,28
Number of detected violations per 1 verified production facility	0,69	41	0,62

Described in Table 4 regression dependence of the indicator of occupational injuries on observation factors was obtained with a higher average level of the determination coefficient of 0.70 and a high level of F-significance of 0.06. Correlation coefficients (-0.51) and regression (-81) indicate that the proportion of verified business entities has an inverse proportional effect on the number of deaths. In particular, an increase in part of the audited business entities even by 0.1 % will prevent 8 fatal consequences. Or according to the factor elasticity (-0.12), 1 point (percentage point), the growth of the indicator of a part of the audited business entities will result in a decrease in the number of fatal accidents involving occupational injuries by 0.12 %.

Correlation coefficients (0.77) and regression (2) reflect that the number of inspections of production facilities by one inspector has a direct proportional effect on the number of fatal consequences of occupational injuries. As in the previous case, this indicates the expediency of increasing the state. In particular, reducing the number of inspections of production facilities by 1 inspector for 1 event will save 2 people. Or, according to factor elasticity (0.28), a 1% reduction in the number of inspections of production facilities by one inspector will result in a decrease in the number of fatalities by 0.28 %.

Correlation coefficients (0.69) and regression (41) show that the number of detected violations per 1 verified production facility produces a direct proportional effect on the number of fatal consequences of occupational injuries. As in the previous case, this should be understood as the own reserve of supervised economic entities in the steady observance of legislative and regulatory acts on occupational safety and industrial safety in order to withstand thorough checks without comments and violations detected

by the inspectors. In particular, reducing the number of detected violations per 1 verified production facility on average by even 0.1 will prevent 4 fatal consequences. Or, according to factor elasticity (0.62), a 1 % reduction in the number of detected violations per 1 proven production facility will reduce the deaths by 0.62 %.

Table 5

Correlation and regression characteristics of the influence of supervisory activity on the number of man-days of disability

Indexes	Correlation coefficient	Regression coefficient	Factor elasticity
Constant	–	-60418	–
Part of audited business entities,%	-0,40	-24282	-0,09
The number of inspections of production facilities by 1 inspector	0,84	1426	0,61
Number of detected violations per 1 verified production facility	0,77	19983	0,74

Described in Table 5 the regressive dependence of the indicator of occupational injuries on observation factors was obtained with a higher than average determination coefficient of 0.74 and a high level of F-significance of 0.04. Correlation coefficients (-0.40) and regression (-24282) indicate that the part of the checked business entities has a proportional impact on the number of man-days of disability. Thus, an increase in the part of the audited business entities, even by 0.1%, will prevent 2428 man-days of disability during the year. Or according to the factor elasticity (-0,09), 1 point (percentage point), the growth of the indicator of a part of the audited business entities will result in a reduction of 0.09 % of man-days of disability.

Correlation coefficients (0.84) and regression (1426) indicate that the number of inspections of production facilities by one inspector has a direct proportional effect on the number of man-days of disability. As noted earlier, this indicates an expediency to increase the state. Thus, reducing the number of inspections of production facilities by 1 inspector per 1 event will exceed 1426 man-days of disability. Or, according to factor elasticity (0.61), a 1 % reduction in the number of inspections of production facilities by one inspector will result in a decrease of 0.61 % of man-days of disability.

The coefficients of correlation (0.77) and regression (19983) show that the number of detected violations per 1 verified production facility produces a direct proportional effect on the number of man-days of disability. As noted earlier, this should be understood as the own reserve of supervised economic entities for the strict observance of legislative and regulatory acts on labor protection and industrial safety in order to withstand thorough checks without comments and violations detected by the inspectors. In particular, the reduction of the number of violations detected on 1 verified production facility by an average of even 0.1 will prevent the 1998 man-days of disability. Or,

according to factor elasticity (0.74), a 1 % reduction in the number of violations detected on one verified production facility will lead to a decrease in man-days of disability by 0.74 %.

Conclusions and suggestions. In general, the practical value of the regressions obtained for the dependence of occupational injuries on the factors of supervisory activity in the form of formula (1) with the coefficients given in Table. 3–5, is the possibility of forecasting the total number of victims, the number of fatalities and the number of man-days of incapacity for current or planned indicators of the part of the audited subordinate economic entities, the number of inspections of production facilities per inspector, and the number of detected violations of the protection labor and industrial safety on 1 verified production facility. On the basis of the forecast, it is possible to adjust the supervisory activity promptly in case of unacceptable expected indicators of occupational injuries.

The main practical recommendation based on the results of the conducted factor analysis and the calculation of total elasticity is to substantiate the possibility of reducing by 1.51 % of the total number of victims, by 1.02 % – the number of deaths and by 1.44 % - the number of man-days of incapacity with simultaneous increase by 1 % of the part of the audited business entities and a 1% decrease in the number of inspections of production facilities and an increase in the number of detected violations of industrial safety issues for one actual state Labor Inspector of Labor Protection. That, in turn, will allow to influence the level of occupational injuries through eliminating the risks of accidents at work and motivating employers to create safe and healthy working conditions at enterprises of risky sectors of Ukraine.

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ЭКОНОМЕТРИЧЕСКИЙ АНАЛИЗ ДИНАМИКИ ПРОИЗВОДСТВЕННОГО ТРАВМАТИЗМА В УКРАИНЕ

Статья посвящена анализу динамики и уровня производственного травматизма в отраслях экономики Украины в зависимости от эффективности государственного надзора по вопросам охраны труда инспекторского состава Государственной службы Украины по вопросам труда.

Автором проведен эконометрический анализ линейных временных трендов производственного травматизма в Украине по данным форм отчетности Гоструда 3-НД и 4-ЗТ 2008–2017 гг., с целью определения влияния надзорной деятельности на уровень производственного травматизма в рискоопасных отраслях экономики Украины в зависимости от общего количества проверенных поднадзорных субъектов хозяйствования, количества проверок производственных объектов и количества осуществленных мероприятий государственного надзора на одного фактического государственного инспектора, а также от количества выявленных нарушений по вопросам охраны труда и промышленной безопасности на один проверенный производственный объект.

Ключевые слова: государственный надзор, уровень производственного травматизма, факторный корреляционно-регрессионный анализ, коэффициенты корреляции и регрессии.

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