THE IMPACT OF PROFESSIONAL WORK EXPERIENCE ON INDUSTRIAL INJURIES RATE

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ABSTRACT

There is a hypothesis that professional experience has a significant impact on the safety and with its increase professional competence and mastery of employees grow, and hence the risk of an accident reduces. The objective of the author is to investigate the impact of professional work experience on the industrial injuries on the example of the track maintenance section of Kuibyshev Railway. The findings, presented in the paper, are based on statistical analysis and calculation of the degree of correlation between the average length of service and the number of victims of accidents. Variables, measured in the interval scale, and Pearson correlation coefficients were taken into account.

The author drew an unpredictable conclusion that the number of victims of accidents at work in no way depends on their professional work experience. To support her statement, the author provided certain explanations.

Editorial note: the authors' technique could be applied to larger sample to verify the correctness of those conclusions.

Keywords: work safety, industrial injuries, track facilities, maintenance section, professional work experience, correlation.

Background. *Track facilities include a railway track with all its facilities and arrangement, enterprises and units with the objects of industrial, service and technical, sanitary, and domestic purposes, including maintenance and repairs of the roadbed, the production of sleepers, welded rails, materials for ballasting etc. Track facilities operate more than half of the capital stock of railway transport, quarter of operating costs, one fifth of the personnel of the industry [1].*

Production of works on multi-track hauls with vigorous speed train traffic, continuous location of employees in the danger zone, operation of moving, rotating machinery, displacement of track superstructure materials, built-up structures and their elements make to consider the conditions of track facilities as an area of high occupational hazard.

So, according to the statistics [2] in the period from 2004 to 2013 on maintenance section facilities 103 accidents occurred, which affected 125 people, representing one-third of the total number of injured workers of Kuibyshev Railway.

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Objective. *The objective of the author is to investigate the impact of professional work experience on the industrial injuries at the example of the maintenance section of Kuibyshev Railway.*

Methods. *The author uses statistical analysis derived from real business units' data, comparative method, scientific description.*

Results. *To verify this, or, on the contrary, to refute such speculation multivariate statistical analysis of data on the injured workers of maintenance section was carried out. Data on length of service on a position were taken from the Acts of Form H-1 of an accident at work, based on the results of the investigation of circumstances and causes of injury at the track maintenance section of Kuibyshev Railway. Processed statistics is shown in Table 1.*

Table 1

Distribution of victims of accidents depending on work experience

Professional work experience	2004–2013 years		
	General injury rate	Including fatal outcome	Including serious outcome
less than 1 year	25	3	10
from 1 to 3 years	32	5	11
from 3 to 5 years	17	1	5
from 5 to 10 years	18	4	4
over 10 years	33	3	13
Total	125	16	43

Table 2

The calculation of the frequency coefficient of industrial injuries on the distance section with distribution by work experience

Professional work experience	2004–2013 years		
	General injury rate	Including with fatal outcome	Including with serious outcome
Less than 1 year	1,84	0,22	0,74
from 1 to 3 years	2,36	0,37	0,81
from 3 to 5 years	1,25	0,07	0,37
from 5 to 10 years	1,33	0,30	0,30
over 10 years	2,44	0,22	0,96
Average number of employees	13551		

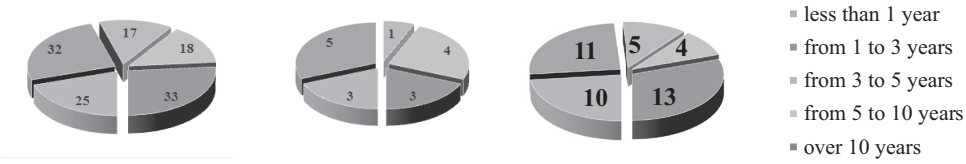

Diagram 1. Distribution of injured workers of the track maintenance section depending on work experience during 2004–2013. a) Total number of injuried; b) Injury rate with fatal outcome; c) Injury rate with serious outcome.

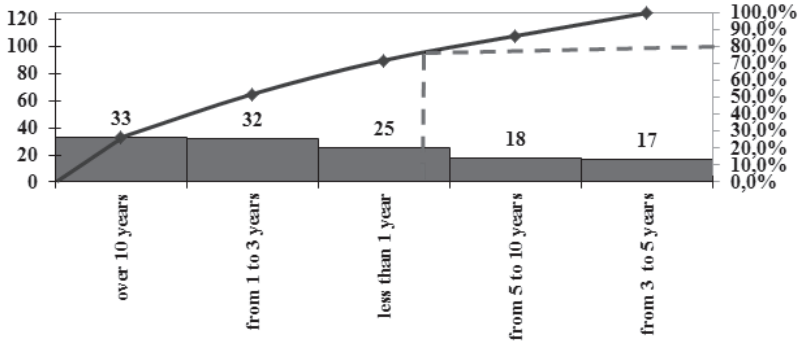

Diagram 2. Pareto chart – the distribution of track injured of maintenance section depending on the length of service for the period 2004–2013.

For clarity, presentation and comparison of quantitative indicators on the basis of the table data a «triad» of the diagram 1 is built.

From the presented information it follows that the vast majority of people were injured at work, having a work experience of more than 10 years – 33 employees, or 26,4% of the total number of injured, including 3 cases (3,8%) with fatal outcome and 13 cases (16,3%) – with serious, disability outcome.

There is also a significant category of injured with work experience from 1 to 3 years – 32 people, or 25,6% of the total number of injured, including 5 cases (6,3%) with fatal outcome and 11 (13,8%) – with serious, disability outcome.

In the category of workers with job experience of less than 1 year there are 25 injured, or 20% (3 cases (3,8%) – with fatal and 10 (12,5%) – with serious outcomes).

The number of victims of accidents at work with work experience from 3 to 5 and from 5 to 10 years is 17 and 18 people respectively, or 13,6 and 14,4%.

For a more accurate assessment of the dynamics of industrial injuries in view of its dependence on professional work experience it is necessary to take into account the frequency coefficient of injuries C_F [3], i. e. the number of injured (dead) on the 1,000 payroll employees during the reporting period. Coefficient is determined by:

$$Cf = \frac{Ninj \bullet 1000}{Ntot}, \qquad (1)$$

where N_{inj} is a total number of injured workers of the maintenance section during the reporting period; N_{tot} is an average number of employees of the maintenance section.

The data for calculating the frequency rate of industrial injuries on maintenance sections with the distribution by work experience is confirmed by quantitative indicators, illustrated by a Pareto diagram.

Diagram of the Italian economist and sociologist Vilfredo Pareto is a tool that allows to analyze, identify and rank the most important factors affecting the performance of industrial injuries by dividing them into a few important and numerous non-essential. The Pareto Principle says that, as a rule, about 20% of the most important factors bring a 80% contribution to the change of characteristics, so the purpose of the application of the chart in this case is to choose such a category of injured, to which it is necessary to pay attention and to concentrate efforts by taking appropriate preventive measures [4].

On the basis of statistical analysis we will construct the chart, where the left y-axis represents the number of injured workers over the considered period, and the right y-axis represents the scale with intervals from 0 to 100%, where 100% corresponds to the total amount of injured workers. On the x-axis each column corresponds to the number of injured workers with a certain professional experience.

To mark the cumulative curve (Pareto curve) on the graph we put the points of accumulated amounts which on the right y-axis will be equal to the quantitative value of accumulated cumulative percentage for each factor, and join them together by straight line segments.

Next we draw a horizontal line beginning at a point of 80% and ending at the point of intersection with the Pareto curve and from this point we drop the perpendicular to the x-axis. This perpendicular divides factors into significant located to the left and insignificant factors, located to the right.

In Diagram 2 it is clear that the main categories of workers affected by industrial accidents are workers of the maintenance section, the professional work experience of whom is over 10 years, from 1 to 3 years and employees, work experience of whom at the time of the accident was less than 1 year.

It should be noted that the category of injured employees affected by accidents at work with professional work experience from 3 to 10 years, does not differ significantly in the amount.

Table 3

Computation data for calculating the coefficient of correlation

Number of surveys in years	Average professional work experience, *xi*, years	Number of injured at work, y, people.	$x_i - \bar{x}$	$y_i - \bar{y}$	$(x_i - \bar{x})^2$	$(y_i - \bar{y})^2$	$(x_i - \bar{x}) \times (y_i - \bar{y})$
2004	7,9	21	0,69	8,60	0,4761	73,9600	5,9340
2005	6,1	9	–1,11	–3,40	1,2321	11,5600	3,7740
2006	7,7	13	0,49	0,60	0,2401	0,3600	0,2940
2007	6,1	14	–1,11	1,60	1,2321	2,5600	–1,7760
2008	7,8	24	0,59	11,60	0,3481	134,5600	6,8440
2009	6,4	18	–0,81	5,60	0,6561	31,3600	–4,5360
2010	10,2	7	2,99	–5,40	8,9401	29,1600	–16,1460
2011	5,5	11	–1,71	–1,40	2,9241	1,9600	2,3940
2012	5,8	4	–1,41	–8,40	1,9881	70,5600	11,8440
2013	8,6	3	1,39	–9,40	1,9321	88,3600	–13,066

The first thing to determine is whether there is a scientific rationale of these facts, that is, how close and consistent are statistical relationships between indicators of the impact of professional experience, and indicators of industrial injuries. And it is necessary to determine not only the presence or absence of connection, but also its extent to which the values of two variables will approximate to each other.

Since indicators of work experience and the number of injured are random variables, the degree of their relationship is characterized by the correlation statistical dependence, a mathematical measure of which is the Pearson correlation coefficient [5].

*The correlation dependence suggests that the pair of variables considered are professional work experience and the number of injured at work, as for track maintenance section of Kuibyshev railway in the years 2004–2013, measured on the interval scale, where **x** is an input variable and an independent random value, **y** is an output variable and dependent random variable. To assess the degree of dependence between them, it is necessary to know both the value of correlation and its significance. For the calculation of the correlation coefficient we will use the data shown in Table 1, diagrams 1, 2 and converted in Table 3.*

The obtained values are substituted into the formula to calculate the Pearson correlation coefficient:

$$r_{xy} = \frac{\sum (x_i - \bar{x}) \times (y_i - \bar{y})}{\sqrt{\sum (x_i - \bar{x})^2 \times \sum (y_i - \bar{y})^2}}, \qquad (2)$$

where x_i are values, taken by the variable x;

y_i are values, taken by the variable y;

$\bar{x}$ is average on x = 7,21;

$\bar{y}$ is average on y = 12,4.

*The calculations imply that the correlation coefficient is $rxy = 0$. This value indicates the absolute absence of impact of behavior of the input variable **x** on the behavior of the output variable **y**.*

Conclusions. *Hence we conclude that the number of victims of accidents at work in no way depends on their professional work experience.*

This very unpredictable conclusion can be explained as follows:

1. Workers professionals with many years of experience residing in the vicinity of the moving rolling stock and performing operations of high risk, have adapted to potential threats to the accident and the existing risks. As a result, the employee loses labor awareness, begins to show carelessness, is too relaxed, does not focus his mind on preventive measures, ignores safe work practices. This is in most cases becomes the primary cause of injuries and tragic consequences.

2. Employees with a small, little work experience and low knowledge of rules and regulations on labor protection do not sufficiently possess the skills of safe production, which often leads to an accident.

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