

THE IMPACT OF PSYCHOPHYSICAL FACTORS ON THE LEVEL OF OCCUPATIONAL RISK IN SMALL-SIZED ENTERPRISES WITH PARTICULAR EMPHASIS ON THE MANUFACTURING SECTOR

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Abstract:

In this paper, the authors focused on the analysis and evaluation of factors affecting the level of occupational risk in "small" enterprises, with a particular emphasis on psychophysical factors in the manufacturing sector. The study was conducted using a self-administered questionnaire. The results were verified using the strucla interview method with elements of observation. The purpose of the paper was to draw attention to – often overlooked in the assessment of occupational risks by employers – psychophysical hazards with particular emphasis on psychosocial hazards. Respondents – employees of enterprises with a particular focus on the manufacturing sector – point to psycho-physical hazards as those that, right after hazardous (accident) hazards, significantly affect the level of occupational risk. However, the assessment of factors determining the level of occupational risk changes with the age of respondents. Older workers, more often than younger ones, perceive the factors that affect the level of occupational risk. Their experience and ability to reliably identify risks can be very useful in creating awareness of safe behavior among the youngest workers, who are most vulnerable to occupational accidents. The article also presents analyses and assessments of the symptoms of occupational stress, which is one of the factors shaping psycho-physical risk that is so often underestimated by many workers and employers.

Key words: occupational risk, psychophysical risk, occupational health and safety, management, occupational stress, production enterprises, small-sized enterprises

INTRODUCTION

Small-sized enterprises, that is, micro and small, are the backbone of the Polish economy. They are considered a key element among all economic entities, primarily driving economic growth by strongly shaping GDP, but also employment growth and social inclusion [1]. Most of the Polish workers are employed by "small-sized" enterprises [2]. Effective management of occupational risk in micro and small enterprises is therefore necessary, because reliable identification of threats and assessment of occupational risk is very important in terms of maintaining an appropriate level of safety in an enterprise [3]. Unfortunately, the results of publicly available reports in Poland indicate a low level of occupational health and safety in "small-sized" enterprises [4]. Occupational health and safety management in "small-sized" enterprises continues to be a challenge for employers and employees. There is a belief among employers of the smallest business entities that spending on safety and health protection at work is only a cost. They see no tangible benefits from occupational safety actions [5]. There are

many barriers that cause entrepreneurs to think in this way. These are primarily the high costs of maintaining the company in the market, the enormous amount of work put into acquiring customers, maintaining them and being competitive in a very dynamic and changing environment [6, 7]. In order for the company to present a satisfactory level of work safety, it must ensure the quality of initial, periodic and instructional training. Reliable identification of threats in the enterprise and the assessment of occupational risks are equally important. In "small-sized" enterprises, both training and the risk assessment constitute an area that requires a lot of work and commitment by both the employer and employees [8, 9]. This identification of threats is a challenge for many "small-sized" companies. It is rarely carried out by the employer in cooperation with employees. The most often it is outsourced to external companies that comprehensively deal with the implementation of training in the fields of health and safety and occupational risk assessment. Unfortunately, such orders are very rarely reliably carried out by enterprises [10, 11]. Many studies and

reports, including those of the National Labor Inspectorate, indicate that in the assessment of occupational risk, psychophysical risks are often underestimated, and psychosocial risks are ignored at all [12]. At the same time, research indicates that these are threats that significantly affect the level of occupational risk in enterprises and, consequently, the health and life of employees [13, 14]. Physical and mental workload affect quality, efficiency, and, above all, safety at work [15]. Psychophysical dangers burden the human psychophysical sphere as a result of unfavorable working conditions, both in the physical and mental area. In the classification of psychophysical hazards, there are physical and mental factors [16]. The physical workload, in turn, can take the form of a static or dynamic load [17]. Work-related mental strain may result primarily from the physical elements of the work environment, from organizational factors, from the manner and conditions of receiving information, from decision-making conditions, as well as from the manner and conditions of performing activities. In Table 1 the elements of individual areas that affect the psychological burden of a person in the work environment were presented.

Table 1
Elements of individual areas influencing the psychological workload

The area influencing the psychological burden related to professional work related to professional work	Elements of the area
Organizational factors	<ul style="list-style-type: none"> • Management styles • Employment security • Interpersonal relationships in the organization
Manner and conditions of receiving information	<ul style="list-style-type: none"> • Features of the visual space • The quality of the information items • Lighting quality • Possible mistakes in receiving information and their consequences
Decision-making conditions	<ul style="list-style-type: none"> • The amount and complexity of the information preceding the decision • Number of selection paths • Consequences of wrong decisions
Manner and conditions of performing activities	<ul style="list-style-type: none"> • Features of the operating space • Quality of control components • Work rhythm dictated by the machine or technological process • Possibility of making mistakes and the resulting consequences
Physical element of the work environment	<ul style="list-style-type: none"> • Noise • Microclimate • Lighting • Oscillations and vibrations
Strengthening the influence of other factors leading to psychological workload and arousing fear cause by working conditions and their consequences	

Source: own study based on [18].

Reliable identification of psychophysical threats requires extensive knowledge and experience in this type of activities. The employee is the source of comprehensive knowledge about the risks in a given workplace. It is he who deals with all the risks on a daily basis while performing his employee tasks. An employee is the greatest potential and capital of any organization [19]. Therefore, both the International Labor Organization and the National Labor Inspectorate recommend employers to involve employees in the process of hazard identification and occupational risk assessment [20].

For several years in Poland, the causes of accidents at work have been the inappropriate behavior of employees (60.5%), among which the dominant ones [21]:

- insufficient concentration of attention on the performed activity (25.9%),
- being surprised by an unexpected event (22.8%),
- ignorance of the risk, inadequate pace of work and inexperience (6.5%).

Another important cause of accidents is improper general organization of work and work stations (9.6%). The youngest employees constitute the largest group of victims, both in terms of their work experience and age [22]. In the literature on the subject, the preparation of an employee for safe and accident-free work is primarily determined by the initial and instructional training that he must undergo in order to be able to perform employee tasks. In the opinion of employees, these, in turn, are tedious, too long and not adapted to the issues of a given industry [23]. The causes of accidents at work as well as work-related ailments are also seen in the lack of reliable identification of threats and occupational risk assessment at the workplace. This is an area where there is much space for improvement, especially in "small-sized" companies. There are more barriers to the effective and safe operation of the enterprises described. Also of great importance is the organizational culture and its autonomous part, which is the safety culture in the enterprise [24]. It is this culture that consists, among other things, of reliable identification of all risks, with particular attention to psychophysical and psychosocial risks [25]. In addition, psychophysical risks, which are underestimated by many employers and employees, begin to play an important role in shaping the level of occupational risk in the enterprise. And while both the level of training and the reliability of the performed occupational risk assessment are higher in larger business entities (medium and large), it is a challenge in "small-sized" enterprises. This paper is an attempt to draw attention to the fact that reliable identification of threats, especially psychophysical ones, is very important in relation to a reliable and effective assessment of occupational risk, and thus in relation to the number of potential accidents at work or mental health problems of employees.

RESEARCH AREA

The presented research results refer to the research carried out before the pandemic period. The questionnaire was sent to enterprises by e-mail. The research using the

authors' questionnaire was dedicated to small-sized enterprises, i.e., economic operators with up to 49 employees. 1600 enterprises took part in the survey and it had nationwide coverage. After verification of the collected questionnaires, 1006 of those completed were selected for the analysis. In terms of the age structure, the most numerous group of respondents was employees aged 35-44 – 37.9%. More than half of those questioned worked for longer than 6-10 years. Nearly ¼ of the employees declared that they performed a professional job of a physical or mixed nature (mental and physical). More than 60% of those questioned declared that they had secondary or higher education. In order to verify the research results, direct interviews were conducted with elements of observation in selected production companies of the Silesian Voivodeship. The Voivodeship selected for additional research was chosen on the basis of the following premises:

- the industry which most often responded to the question was production companies,
- the most complete questionnaires were obtained from the Silesian Voivodeship,
- availability and consent to direct penetration of the company (consent to discussions and observation of employees during work).

RESULTS AND DISCUSSION

The aim of the paper was to assess the impact of hazardous (accidental), physical, chemical, biological and psychophysical factors on the level of occupational risk in the opinion of employees of "small-sized" enterprises, with particular emphasis on the manufacturing sector. Based on the obtained results, an analysis of the above-mentioned factors was carried out in order to determine which of them has the greatest impact on the health and life of employees (occupational risk).

Table 2
Distribution of indications (by average) of threats to life and health (occupational risk) occurring the most often in the opinion of respondents by sector of activity, and the results of the significance test of differences between indications for the production and service sectors

Variable	Average assessment					Median	MW tests results	
	Production	Service	Commercial	Mixed	Total		Z	P
Hazardous (accidental) factors	3.734	3.888	3.194	2.993	3.702	4	-2.556	0.011
Physical factors	2.983	2.859	2.833	2.514	2.840	3	1.709	0.087
Chemical factors	2.589	2.565	2.389	2.157	2.508	2	-0.089	0.929
Biological factors	2.519	2.615	2.472	2.221	2.532	2	-1.878	0.060
Psychophysical factors	2.925	3.148	3.222	2.700	3.035	3	-2.979	0.003

Source: own study * - statistically significant values at the level of $\alpha = 0.05$.

Among threats to life and health, the highest score of indications (on average) was given to dangerous factors. Half of the respondents assessed that they are very important. They were considered the most dangerous in both the production and service enterprises sector, while in the latter the rating was significantly higher ($Z = -2.556$, $p = 0.011$). Another highly rated risk factors for health and life were, according to the respondents, psychophysical factors. Also in this case, the assessment of service sector employees (3.148) in relation to the manufacturing (2.925) was significantly higher ($Z = -2.979$, $p = 0.003$). The threat from physical and chemical factors was assessed as insignificant.

Table 3 presents the results concerning the distribution of indications of threats to life and health (occupational risk) that occur the most frequently in the opinion of the respondents, according to their age. As the age of employees increases, the significance of such life threatening factors as traumatic factors ($\tau = 0.087$, $p < 0.001$), physical factors ($\tau = 0.126$, $p < 0.001$), chemical factors ($\tau = 0.101$, $p < 0.001$) and biological factors increases. ($\tau = 0.086$, $p < 0.001$). The presented relationships are not high but statistically significant.

Table 3
Distribution of indications (according to average) threats to life and health (occupational risk) occurring the most often in the opinion of respondents according to their age and the value of the tau-Kendall correlation coefficient between age and types of threats to life

Variable	Age						Correlation		
	18-24	25-34	35-44	45-54	55-64	65+	Total	Tau	P
Hazardous (accidental) factors	3.034	3.282	3.715	3.795	4.061	3.000	3.702	0.087	0.000
Physical factors	2.522	2.443	2.835	2.980	2.879	2.250	2.840	0.126	0.000
Chemical factors	2.275	2.047	2.613	2.590	2.394	2.000	2.508	0.101	0.000
Biological factors	2.130	2.125	2.660	2.563	2.515	2.000	2.532	0.086	0.000
Psychophysical factors	2.957	2.639	3.165	2.853	3.424	4.500	3.035	0.000	0.991

Source: own study * - statistically significant values at the level of $\alpha = 0.05$.

Table 4 presents the differences in the assessments of threats to life and health (occupational risk), the most often occurring from the point of view of employees of micro and small enterprises.

Table 4
The difference in assessments of threats to life and health (occupational risk) occurring the most often from the point of view of micro and small enterprise employees (Mann-Whitney test results)

Variable	Micro enterprises		Small enterprises		MW tests results	
	Mean	SD	Mean	SD	Z	P
Hazardous (accidental) factors	3.6298	1.0422	3.7890	1.0831	-2.4665*	0.0136
Physical factors	2.8367	0.8142	2.8440	0.8744	0.1313	0.8955
Chemical factors	2.4918	0.7898	2.5275	0.8611	-1.0094	0.3128
Biological factors	2.4918	0.8213	2.5802	0.8345	-2.6071*	0.0091
Psychophysical factors	2.9927	0.9972	3.0857	0.9763	-1.5761	0.1150

Source: own study * - statistically significant values at the level of $\alpha = 0.05$.

Employees of small enterprises (10-49 employees) significantly more often indicated the importance of dangerous traumatic factors ($Z = -2.4665$; $p = 0.0136$), and in particular biological factors ($Z = -2.6071$; $p = 0.0091$), as threats to life and health in comparison with employees of micro enterprises (1-9 employees).

In the further part of the questionnaire, the respondents indicated the symptoms of stress that the most often occur in their lives and are identified with professional work. Table 5 presents the results concerning the distribution of stress symptoms indications, which the most often occur in the opinion of the respondents, according to their age. There is a positive weak relationship between age and stress symptoms such as: increased blood pressure ($\tau = 0.050$, $p = 0.018$), elevated cholesterol ($\tau = 0.146$, $p < 0.001$), anger ($\tau = 0.077$, $p < 0.001$) and smoking cigarettes ($\tau = 0.120$, $p < 0.001$). With age, the assessment of the significance of these stress symptoms increases. There was also a negative statistically significant correlation between age with the assessment of stress symptoms such as: depression ($\tau = -0.050$, $p = 0.017$), absenteeism ($\tau = -0.054$, $p = 0.011$) and willingness to change at work ($\tau = -0.190$, $p < 0.001$). These results seem to confirm the guesswork. Older employees are definitely less willing to change jobs and, to some extent, also because of the fear of losing it, they try to avoid abusing absenteeism. As for depression, even recent social campaigns indicate that its diagnosis is extremely difficult, often overlooked or underestimated by older generations.

Table 5
Distribution of indications (according to average) of stress symptoms occurring the most often in the opinion of respondents by age of respondents, and the value of the tau-Kendall correlation coefficient between age and symptoms of stress

Variable	Age						Correlaion		
	18-24	25-34	35-44	45-54	55-64	65+	Total	Tau	P
Increased blood pressure	2.377	2.153	2.380	2.474	2.576	3.00	2.429	0.050	0.018
Increased heart rate	2.406	2.231	2.432	2.491	2.636	3.00	2.478	0.024	0.248
Increased cholesterol levels	1.899	1.890	2.207	2.317	2.212	2.50	2.205	0.146	0.000
Anger	2.551	2.071	2.437	2.502	2.697	3.25	2.455	0.077	0.000
Medicines	2.145	1.827	2.089	2.061	2.152	2.50	2.084	0.012	0.559
Depression	1.971	1.851	2.037	1.997	1.939	2.00	2.031	-0.050	0.017
Smoking	2.362	2.349	2.647	2.802	2.879	3.50	2.687	0.120	0.000
Alcohol abuse	2.043	1.867	2.215	2.048	2.152	2.75	2.132	-0.015	0.464
Insomnia	2.188	2.051	2.241	2.263	2.424	2.75	2.270	0.028	0.187
Absence from work	2.043	1.831	2.073	2.020	1.970	2.00	2.053	-0.054	0.011
Tendency to make mistakes	2.275	1.882	2.113	2.205	2.121	2.500	2.157	0.024	0.259
Willingness to change jobs	2.507	2.235	2.387	2.191	2.242	2.500	2.367	-0.190	0.000

Source: own study * - statistically significant values at the level of $\alpha = 0.05$.

Table 6 presents the results concerning the distribution of stress symptoms indications which occur in the opinion of the respondents, according to the indications of the sector of activity. The surveyed employees perceive possible symptoms of stress only to a limited extent – as significant or moderately important. Nevertheless, there are significant differences in the assessment of these symptoms on the part of employees in the production and service sectors. In the service sector, the role of elevated cholesterol ($Z = -3.634$, $p < 0.001$), insomnia ($Z = -3.160$, $p = 0.002$), alcohol abuse ($Z = -2.859$, $p = 0.004$), smoking ($Z = -2.859$, $p = 0.004$) is rated significantly higher ($Z = -2.374$, $p = 0.018$) and depression ($Z = -2.197$, $p = 0.028$). In turn, in the manufacturing sector, symptoms of stress such as increased heart rate ($Z = 3.382$, $p = 0.001$) and increased blood pressure ($Z = 2.457$, $p = 0.014$) are more often noticed.

Table 6
Distribution of indications (according to average) of stress symptoms occurring the most often in the opinion of respondents by sector of activity, and the results of the test of significance of differences between indications for the production and service sectors

Variable	Average assessment					Median	MW tests results	
	Pro-duction	Service	Com-mercial	Mixed	Total		Z	P
Increased blood pressure	2.510	2.365	2.444	2.557	2.429	2	2.457	0.014
Increased heart rate	2.556	2.390	2.611	2.679	2.478	2	3.382	0.001
Increased cholesterol levels	2.137	2.248	2.222	2.136	2.205	2	-3.634	0.000
Anger	2.444	2.394	2.778	2.650	2.455	2	0.299	0.765
Medicines	2.066	2.061	2.417	2.129	2.084	2	-0.597	0.551
Depression	1.975	2.037	2.194	2.057	2.031	2	-2.197	0.028
Smoking	2.614	2.756	2.194	2.650	2.687	3	-2.374	0.018
Alcohol abuse	2.041	2.188	2.000	2.086	2.132	2	-2.859	0.004
Insomnia	2.187	2.324	2.389	2.157	2.270	2	-3.160	0.002
Absence from work	2.062	2.051	2.083	2.036	2.053	2	0.478	0.633
Tendency to make mistakes	2.170	2.129	2.528	2.157	2.157	2	1.141	0.254
Willingness to change jobs	2.386	2.312	2.889	2.429	2.429	2	0.417	0.677

Source: own study * - statistically significant values at the level of $\alpha = 0.05$.

The respondents also assessed the risk of losing health and life, indicating the factor that determines it in the most important way. Table 7 presents the results concerning the distribution of health and even life risk indications, the most frequently occurring in the opinion of the respondents, according to their age. In the opinion of the respondents, the risk of losing health due to bothersome factors ($\tau = 0.213$, $p < 0.001$), harmful ($\tau = 0.126$, $p < 0.001$) and hazardous (accidental) factors ($\tau = 0.071$,

$p = 0.001$) increases with age increase. The first of these relationships can be considered moderate, the others are weak but statistically significant.

Table 7
Distribution of indications (according to the average) of risk of losing health and even life, occurring the most often in the opinion of respondents, by age of respondents, and the value of the tau-Kendall correlation coefficient between age and types of risk

Variable	Age							Correlation	
	18-24	25-34	35-44	45-54	55-64	65+	To-tal	Tau	P
Bother-some factors	2.261	2.212	2.720	2.805	2.909	3.500	2.675	0.213	0.000
Harmful factors	2.217	2.125	2.576	2.614	2.788	3.250	2.535	0.126	0.000
Hazardous (accidental) factors	2.797	2.839	3.309	3.321	3.303	3.500	3.257	0.071	0.001

Source: own study * - statistically significant values at the level of $\alpha = 0.05$.

Table 8 presents the results concerning the distribution of health and even life risk indications, the most frequently occurring in the opinion of the respondents, according to the sector of activity. The respondents did not notice (in general) a high level of risk of losing health or life. More specifically, in the services sector, the risk of hazardous factors was perceived (3.411). On the other hand, the assessment of the significance of the risk of harmful factors on the part of workers in the manufacturing sector was (although generally low) higher than a similar assessment on the part of the service sector ($Z = 2.516$, $p = 0.012$).

Table 8
Distribution of indications (by average) of the risk of losing health or even life occurring most often in the opinion of respondents by sector of activity, and the results of the test of significance of differences between indications for the production and service sectors

Variable	Average assessment					Median	MW tests results	
	Pro-duction	Service	Com-mercial	Mixed	Total		Z	P
Bother-some factors	2.788	2.703	2.278	2.464	2.675	3	1.901	0.057
Harmful factors	2.705	2.562	2.361	2.171	2.535	3	2.516	0.012
Hazardous (accidental) factors	3.315	3.411	2.389	2.736	3.257	3	1.386	0.166

Source: own study * - statistically significant values at the level of $\alpha = 0.05$.

In order to refer to the results of the research conducted with the use of the questionnaire, in selected small enterprises, an open observation with elements of structured interview was additionally carried out. The enterprises selected for the research are micro and small production companies (45 economic entities). All entities are located

in the Śląskie Voivodeship. The production companies were selected from among those participating in the study by means of a questionnaire. The visits were arranged by phone in advance. The observation period with elements of the structured interview lasted about a year. The visits took place before the pandemic. Out of 45 economic entities, 32 belonged to micro-enterprises (up to 9 employees), and 13 – to small enterprises (with 10-49 employees). Only 5 companies out of 45 observed with elements of the structured interview had a functioning management system. The observation with elements of the structured interview, supported by selected questions from the author's questionnaire, concerned many thematic areas related to work safety. For the purposes of the paper, the area of psychophysical hazards (especially stress) was selected, which, apart from dangerous (accidental) hazards, significantly affects the level of occupational risk in "small-sized" enterprises, with particular emphasis on the manufacturing sector.

The observation with elements of the structured interview, carried out in the "small-sized" enterprises, in the aspect of psychophysical factors that may cause stress, allowed for the formulation of the following statements.

1. The most common factors causing stress in "small-sized" enterprises include:

- a) time and deadlines pressure,
- b) improper organization of work,
- c) communication problems between employees,
- d) problems with equipment and devices,
- e) conflicts between employees.

2. Stress in the "small-sized" companies is also caused by musculoskeletal ailments, which almost all employees of "small-sized" production companies complain about. The sources of these ailments should be seen primarily in the non-compliance with the acceptable standards for carrying, lifting and moving heavy loads. In each of the observed companies, the employees did not comply with the standards of permissible manual transport of loads, moreover – they did not have specific knowledge on this subject.

3. In micro enterprises, stress intensified anxiety about permanent work and orders from larger companies. This phenomenon has not been observed in small enterprises.

4. Loose and unofficial relations in micro-enterprises (up to 9 employees) between the manager (employer) and other employees had a positive effect on the well-being of all employees while performing their work. In small enterprises (10 to 49 employees), more rigid relationships were observed between employees and their superiors. However, this has not been observed to have a negative impact on the climate in the performance of their duties. With more employees, discipline and order are very important. It allows to avoid mistakes, near misses and eliminate threats that can also be a source of stress.

SUMMARY AND CONCLUSION

The need to shape employees' awareness of safe (accident-free) behavior should be a priority in every organization. An employee with such knowledge is a source of in-

formation, which in turn affects the effectiveness and reliability of the occupational risk assessment carried out in the enterprise. Knowledge about the risks that occur in the workplace gives the opportunity to formulate clear and precise instructions to minimize or completely eliminate potential threats. Thoroughly conducted initial, periodic and instructional training also significantly influences the level of work safety.

Knowledge of the risks that occur in the workplace gives the opportunity to formulate clear and precise instructions to minimize or completely eliminate potential threats. Thoroughly conducted initial, periodic and instructional training also significantly influences the level of work safety. The results of the conducted research indicate that there is a great need to draw the attention of employees and employers to psychophysical risks that significantly affect the level of occupational risk in the enterprise. It should also be noted that older employees more often pay attention to psychophysical factors as those that have a significant impact on occupational risk than younger employees. Their experience and knowledge may be useful in the enterprise to shape safe attitudes of other employees by indicating areas neglected or omitted in the identification of threats. The more so as it is the reliable identification of threats and occupational risk assessment that are the essence of effective work safety management in an enterprise. In times when we have very strongly developed enterprises in terms of technology and digitalization, the factors that have an equally strong impact on work safety and come from the area of psychophysical factors are forgotten. Having soft skills, especially in manufacturing companies, is very desirable. It turns out that "hard" skills and competences are not enough to safely perform own work. "Soft" skills more and more often play a significant role in shaping safe behavior among employees, and the psychophysical factors of the work environment are beginning to be perceived as important not only in large economic entities. The results of the research presented in this paper confirm the validity of reliable hazard identification especially in the area of psychophysical hazards with a special focus on psychosocial hazards present in the work environment.

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