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CLASSIFYING OCCUPATIONAL THREATS POSED TO KNOWLEDGE WORKERS AS A RESPONSE TO ONE OF THE SOCIAL ASPECTS OF SUSTAINABLE DEVELOPMENT CONCERNING OCCUPATIONAL HEALTH AND SAFETY

Abstract

The goal of this study was to discover, weather using different multidimensional exploratory techniques in self-assessing occupational threats by knowledge workers brings logical classification of variables and if obtained classifications are similar.

In a theoretical part of the study, on a basis of literature studies peculiarity of knowledge-based work and specific occupational threats were identified. Then, in the empirical part of the study, they were examined as observable variables with the use of a questionnaire method on a sample of 500 knowledge workers. Variables were classified using two multidimensional exploratory techniques: factor analysis and cluster analysis. The obtained results were compared. It turned out, that the results achieved with the use of the two techniques are similar, yet they differ in detail.

The implications are of both cognitive and utilitarian character. In first case – the analysis revealed and explained the structure of perception of knowledge workers' occupational threats, in second – the classification of variables allows to measure perception of occupational threats and use the results e. g. when designing trainings on occupational health and safety and to better fit them to this group of employees.

The paper's contribution are novel ways of quantifying and measuring occupational threats posed to knowledge workers as well as a comparison of the proposed methods.

JEL Classification Code: **C38, I15, J28**.

Keywords: knowledge workers, occupational threats, assessment, multidimensional exploratory techniques, factor analysis, cluster analysis.

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Introduction

Knowledge is the source of competences, improvement of efficiency and effectiveness of management and productivity (Drucker 2007, Handy 1996, Skrzypek 2002, Sońta 2010). Knowledge workers deal with creating, processing, applying and disseminating knowledge and information. They constitute a group educated in a formal way, however they understand the wide context of work, creative thinking, creativity, openness to changes and challenges as well as exercise treatment of work. They are responsible for creation and implementation of new ideas thanks to which organizations can better adapt to the rapid changes taking place in the surrounding environment. In contemporary economy, this particular group is becoming even more numerous. Specification of work based on knowledge triggers new occupational threats. Advantage of psycho-sociological threats over physical threats is a characteristic phenomenon (Lotko 2012).

Proper relations in the human-technique-environment system constitute a necessary condition to provide safety and well-being of a worker in the working process. Still, performance of every work is strictly connected with the occurrence of various type of threats. Occupational threats constitute potential events which by virtue of their appearance, i.e. occurrence in practice, exert a negative impact on the working environment or psychophysical condition of the workers. Such events may cause accidents at work or occupational diseases. Every factor and/or situation which may cause such accident or disease constitutes a threat in the working environment.

Today, at the microeconomic level, the realization of the demands of sustainable development is achieved by the enterprises by means of application of the rule of Corporate Social Responsibility (CSR). The aim of the social responsibility of an organization should be the contribution to the practical realization of the idea of sustainable development. One of the key elements of the sense of social responsibility is the occupational safety and health. Safety of the labour force is one of the aspects used in the measurement of general progress of the companies in this field (Segal *et al*. 2003). Managing occupational health and safety is a challenge here.

The goal of this study was to discover, weather using different methods of classifying variables in self-assessing occupational threats by knowledge workers brings logical classification of variables and if obtained classifications are similar. Such a classification of perception of occupational threats could help managing occupational health and safety in a more conscious way.

From such defined a goal, the following research hypotheses were drawn:

H1: latent variables measuring self-assessing of occupational threats by knowledge workers can be grouped into few logical items.

H2: applying different data classification methods to self-assessing occupational threats by knowledge workers leads to similar results.

To verify hypotheses two multidimensional exploratory techniques were used:
1. Factor analysis.
2. Cluster analysis.

The obtained results were compared.

1. The state of the art

Professions and knowledge workers

Issues concerning knowledge workers are mainly discussed by the following foreign authors: T. Davenport (2007), P. Drucker (1995), W. Cortada (1998), D. Jemielniak (2012), J. Patalas-Maliszewska (2013), J. Evetts (2003), M. Roell (2004), M. Granitzer and S. Linsteadt (2010), D. Kleinmann and S. Vallas (2001), and in Poland: E. Skrzypek (2002; 2009), M. Morawski (2003; 2009), G. Filipowicz (2008), T. Kawka (2009), D. Makowski (2008), D. Jemielniak (2008), M. Staniewski (2008) and K. Łysik (2011). Authors conducting research in this topic define the term of knowledge workers (W. Cortada, D. Jemielniak, D. Makowski, T. Kawka), they also present the results of research concerning their creativity (E. Skrzypek), productivity (M. Granitzer and S. Linsteadt (2010); E. Matson and L. Prusak (2010)) and effectiveness (G. Filipowicz), as well as group work (K. Lewis (2004)), motivation (D. Jemielniak (2012)), communicating (D. Straub and E. Karahanna (1998)) acquisition (B. Mikuła (2004)) and sharing knowledge (M. Roell (2004), K. Czop and D. Mietlicka (2011)), specification of work based on knowledge (D. Jemielniak (2008)) as well as methods of managing knowledge workers (T. Davenport, J. Patalas-Maliszewska, M. Morawski, M. Staniewski), management models (J. Patalas-Maliszewska) and challenges (K. Łysik) in this area. However there are no analyses available concerning self-awareness and self-assessment of work's character conducted by particular knowledge workers. Consequently we can observe a research gap which we tried to eliminate at least partly by means of this study.

Complexity of the management of knowledge in organizations and the lack of applicable definition of the knowledge worker result in the establishment of a number of various classification schedules connected with the processing of knowledge. Thus Ch. Handy divides workers into three categories (Handy 1996):
- routine workers – employed in order to operate shop cash desks or to enter data on floppy disks,
- suppliers of external services,
- analytics who work with numbers, ideas and words – journalists, financial analytics, consultants, architects, managers, etc.

M. Morawski claims that a knowledge worker is perceived in the context of formal education often exceeding the average level, He combines knowledge with different disciplines and at the same time he possesses deepened specialist knowledge and particular solid and practical skills based on the specialist knowledge, which are

very often beyond the access of others (Morawski 2002). Whereas T. Davenport acknowledges that knowledge workers are distinct from office workers as they not only process data by means of process of thinking but they also analyse them, understand them and create new knowledge in terms of its quality (Davenport 2007, s. 25). At the same time „they do not like to receive instructions, the mode of their work is difficult to be organized and foreseen, the best results are achieved when working with others in the contact nets".

A good example of knowledge workers constitute representatives of independent professions such as: doctors, attorneys, chartered accountants or architects (Łysik 2011). E. Skrzypek maintains that knowledge workers are professionals processing symbols, paid for the effectiveness (Skrzypek 2009). They have professional skills, interpersonal competences and unique competences the use of which creates an added value included in modern products and technologies; they create, keep, apply and disseminate knowledge. According to C. Sikorski (Sikorski 1997) the most important workers existing in modern economy, are psychologically ready for frequent changes at work, are not afraid of these changes, are flexible and they eagerly take risk, are not focused on a long-lasting career in one organization and are oriented towards the result – they have a strong need for achievements supported by a pursuit of continuous learning and a will to exert impact on the environment being subject to a minimized control.

An interesting and wide review of definitions and features of knowledge workers are among other discussed by: T. Davenport (2007), P. Drucker (2007,), A. Kidd (1994), D. Kleinmann and S. Vallas (2001), M. Strojny (2004), T. Kowalski (2011), A. Fazlagić (2001) or J. Szaban (2001).

Role of managing occupational health and safety in sustainable development

Sustainable development is a process aiming to satisfy development aspirations of current generation in a way enabling realization of the same pursuits by the generations to come (Brundtland 1987). The above definition, nowadays commonly applied, was formulated in the Report of the World Commission on Environment and Development of 1987. The vision of development included in this definition takes into account the human population, the world of animals and plants, ecosystems, natural resources of the Earth. It also considers the most important challenges of the contemporary world such as the battle with poverty, equality between sexes, human rights and safety, commonly accessible education, health and intercultural dialogue in an integrated way (UNESCO 2014).

Comprehensive attitude towards sustainable development considers various impacts and interactions such as (Kołodko 2008):

– economic policy,
– rules of the game of the functioning of economy,

– culture of organization,
– confessed values,
– social relations, applied techniques and technologies,
– risk of undertakings,
– environment reactions,
– ways of management.

At present, the term of sustainable development is beginning to be perceived in the world as the type of development balanced by common social, economic and environmental interests. Thus sustainable development may be defined as the development satisfying fundamental needs of all people with simultaneous care for protection, preservation and renewal of health as well as the integrity of ecological systems without the risk that the needs of future generations could not be satisfied and the limits of endurance of the planet would be exceeded (Żuchowski 2009). The balance of the functioning of an organization in the conditions of sustainable development is connected with the process of effective production of goods and services with the simultaneous restriction of the use of the resources of the nature and natural environment, ensuring the satisfaction of stakeholders both external (contractors, clients, members of local society) and internal (employees).

At the microeconomic level, the realization of the demands of sustainable development is achieved by the enterprises by means of application of the rule of Corporate Social Responsibility (CSR). The aim of the social responsibility of an organization should be the contribution to the practical realization of the idea of sustainable development. Corporate social responsibility is defined as a concept of voluntary inclusion of social and environmental aspects by the enterprises as well as contacts with external stakeholders in the economic activity. Social responsibility means going beyond legal requirements by way of increased investment in the human capital, environment protection and relations with contractors. Its integral part is among others the assurance of safe working conditions and care for a good state of health and morale of the employees which are covered by the corporate social responsibilities (EABiZwP 2006).

With the use of CSR, the enterprises integrate social and environmental aspects in their day-to-day business activity as well as in the mutual relations with external clients on a voluntary basis (Żemigała 2007). It should be noted that this is not merely about the observance of legal provisions or applicable rules, but about the investing in the assurance of appropriate working conditions for the employees and restriction of interference into the natural environment. An organization should engage in the CSR depending on its competences, resources, contractors, cultural traditions, social and ecological situation of the area of its functioning. There are three aspects of social dimension of CSR (Żemigała 2007):

– internal – management of human resources, ethics, occupational safety and health, adjustment to the changes, management of the impacts on natural environment and resources,

– local external – local societies, trade partners, local non-governmental organizations,
– global external – suppliers and consumers, investors, human rights, global problems within the scope of the environment protection, global non-governmental organizations.

Corporate social responsibility does not have to constitute an additional cost factor in the organization, but becoming an organization management strategy it should at the same time be an effective mechanism creating an added value by stimulating innovativeness and constructing a competition advantage (Odpowiedzialna Firma 2014). It should contribute to the harmonious development of the entire economy with the consideration of the relations between business and ethics, natural environment and respect for the community of human units.

One of the key elements of the sense of social responsibility is the occupational safety and health. Safety of the labour force is one of the aspects used in the measurement of general progress of the companies in this field (Segal *et al*. 2003). These aspects include:
– safety and health of the labour force and a healthy product,
– work norms and working conditions, human rights,
– equal possibilities and access to employment.

Occupational safety and health means the state of conditions and organization of work assuring the required level of protection of health and life from threats existing in the work environment (Borysiewicz 2001). Management of occupational safety and health covers conscious activities oriented towards the reduction of the risk of the loss of life or health in the work environment to the acceptable borderline level and subsequently towards the maintenance of the said level at the same or lower level (Krzemień 2003). Occupational safety and health is considered to be one of the key elements of company's ethics strictly connected with the feeling of social responsibility as it introduces ethic values in business into the CSR activity program (Fisscher 2003). However, a good combination of occupational safety and health with social responsibility requires the fulfilment of certain conditions. Above all, this responsibility should be considered to be a positive feature. Fair and open behaviour towards workers and external clients is extremely important, as it enables the development of moral competences on the basis of dialogue with the employees (Fisscher 2003).

Threats posed to knowledge workers in terms of sustainable development

Contemporary environmental and professional threats require a wider and deeper study (Greenberg 2007, Frumkin 1999, Brown 2002). The World health Organization (WHO) promotes the strategy of health and safety at work (WHO 1994), and the International Labour Organization (ILO) promotes the safety of work in the „green economy" of sustained development, which brings new and unknown threats to the workers (ILO 2012). Attention is also paid to the specific nature of occupation-

al threats in the information society (Lotko 2014). A threat is a potential source of a damage i.e. of an injury or other kind of deterioration of health (PN-EN-ISO 12100-1:2005). A dangerous situation is a situation in which a given person is exposed to at least one danger. Such exposure may cause damage immediately or after some time.

The interest of the empirical part of this study is the assessment of occupational threats of the knowledge workers. The author discussed this issue in her previous works (Lotko 2011, Lotko 2012, Lotko and Żuchowski 2014). The awareness within the scope of occupational threats is particularly significant as the most frequent cause of accidents at work constitute the consequences of improper conduct of a worker (CIOP 2007). On the other hand studies in the way the workers perceive their organization, concentrate on three different aspects of its functioning and culture: as the environment to solve problems and as the environment of self-;development (Cox 1990). Within the first of the aspects mentioned above, one of the stress-causing factors constitutes the role served by a worker in a given organization. This threat mainly relates to the problems connected with the conflict of the roles in organization and responsibility for other people as well as to the possibility to receive support from the management and co-workers (Landy 1992). Uncertainty connected with the development of the professional career of a knowledge worker and uncertainty regarding the employment are both perceived as a serious threat. Threats resulting from the work itself include working environment, project of the task, pace of work and work schedule. Monotonous repeatability of tasks, insufficient use of worker's skills, incompatibility of duties and capabilities of a worker and a high level of uncertainty, these are the kind of stress-causing threats connected with a particular type of work performed by a knowledge worker. Significant threats resulting from the work itself include work schedule and pace of work leading to overwork (Hiyama, Yoshikara 2008, Dembe, Ericsson, Delbos, Banks 2005). Threats listed above have a psychological background.

Another group of threats are threats resulting from improper organization of work. Factors limiting occupational threats of organizational character include breaks during work, possibility to perform various tasks, freedom of decisions concerning the manner of performance of the entrusted work, attainable deadlines for the performance of duties (CIOP 2007).

When considering technical threats we should take into account the peculiarity of a given workplace. Workers perform the majority of their duties using office electronic equipment. Work stations should have an access to the day light and electric light. Work with a computer monitor, minimisation of personal computers including the monitors results in sight disorders. Moderate temperature and quietness are important elements for conceptual work. On the other hand non-ergonomic position at work results in disorders of musculoskeletal system and spine injuries. Seemingly not dangerous, but the effect of such disorders and injuries is cumulating for years what causes chronic illnesses which very often require a long-term treatment (Lotko 2011).

The last group of threats to the working environment of knowledge workers includes safety threats concerning the „material" of which the knowledge is made of, i.e. data and information processed in an organization, especially in the environment of computer networks. Basic attributes defining safety of information are confidentiality, integrity and accessibility (PN-ISO/EIC 27001:2007). Threats to these attributes are of psycho-sociological and stress-causing character.

2. Remarks on research methodology

Sampling was purposive – among working students of the University of Technology and Humanities in Radom 500 persons were selected, who specified the nature of their work as a „knowledge worker". The adopted methodology provided the veracity of one of the qualification criteria of the knowledge workers concerning the possession of formally documented specialist knowledge – they had at least a bachelor or engineer title.

A questionnaire method was applied to collect statistical material whereas the author designed a special tool, i.e. a questionnaire form. Examined knowledge workers filled in the questionnaire composed of 28 questions. The first five questions were in the form of a certificate, the next 7 questions evaluated the self-awareness of the knowledge workers and the last 16 concerned the assessment of occupational threats (placed in Table no. 3). Observable variables concerning the self-assessment of worker's knowledge and the assessment of occupational threats was described on the five-point Likert scales which measure the compatibility degree of a given respondent with a particular statement. The aim was to determine the set of the features (factors) which are used by the knowledge workers in the process of perception of occupational threats and consequently to build a factor model. For the purpose of the study of statistical material, a questionnaire method was used, whereas the author designed a special tool in the form of a questionnaire. Because of the assumed scales, where each item is described by a positive statement, low value of a variable means perceiving threat as a weak one, as high value of a variable means perceiving threat as a strong one. Such an approach allowed to treat occupational threats as „hidden" ones, not expressed in an explicit manner, hence not dictated to the surveyed employees.

In the paper we compared two multidimensional exploratory techniques: factor analysis and cluster analysis.

The concept of factor analysis was established and developed in the Anglo-Saxon psychology. For the first time it was described in 1994 by C. Spearman. However theoretical basics and possibilities of practical solutions were elaborated by L. Thurstone (Thurstone 1947, Mynarski 1992). The factor analysis was formulated as a formal statistical model by D. Lawley and A. Maxwell (1963) and as a model of confirmative factor analysis by K. Jöreskog (1971). It constitutes a set of statistical methods and procedures which allow for the reduction of a great number of examined variables

to a smaller number of mutually independent (uncorrelated) factors. Its basic scope of application includes the reduction of the number of variables and detection of the structure in the relations between the variables (Kaczmarczyk 2002). Selected factors reach a deeper level of studied reality (e.g. attitudes, values) and are the causes underlying observable variables. The most significant and classic works within the scope of the procedures of factor analysis include the following studies: J. Stevens (Stevens 2009), W. Cooley and P. Lohnes (1971), D. Lawley and A. Maxwell (1963), and within the scope of its application in psychometry: J. Nunnally (1978). However the factor analysis has much broader applications, from the measurement of satisfaction and loyalty of the clients (Sagan 2003) to the estimation of the value of a given real estate (Jasińska 2008).

Cluster analysis was used during this study. The term cluster analysis was introduced by R. Tryon (1939) and then developed by R. Cattell (1944). The use of cluster methods has increased dramatically in the last 30 years (Gore 2000). Cluster analysis encompasses a number of different algorithms and methods for grouping objects of similar kind into respective categories. The objective of cluster analysis is to group objects into clusters such that objects within one cluster share more in common with one another than they do with the objects of other clusters. Thus, the purpose of the analysis is to arrange objects into relatively homogeneous groups based on multivariate observations. Cluster methods are used to group people (or other objects) together based on their scores across a set of variables (Gore 2000). A concise and relevant review of the development, applications, methods and problems of cluster analysis is provided by P. Gore (2000). Interesting and classical examples of cluster analysis applications are discussed by T. Hastie, R. Tibshirani and J. Friedman (2009) as well as P. Guidici and S. Figini (2009). Also, an excellent summary of the many published studies reporting the results of cluster analyses is provided by J. Hartigan (1975).

In this study, as it comes to cluster analysis, grouping variables by columns was performed. It is an example of hierarchical methods, which lead to creating a hierarchical tree-like structure of the elements of the analyzed set, which in its horizontal version is called a tree plot, and in its vertical version - an icicle plot. So, the effects of the algorithm can be presented as a tree, which shows the next steps of the performed analyses (Migut 2009). This way a final segmentation can be obtained, which means an orderly combination of a breakdown into segments. Different methods can be used here. Owing to the efficiency of reproducing the real data structure, the Ward method is recommendable. It uses the rule of minimizing variation (Migut 2009). This method do not require an earlier assumption on the number of clusters – a plot can be „cut off" on a proper height in the end of an analysis and then interpreted.

Finally, the results of the use of both methods were compared. In general, cluster analysis and factor analysis have different objectives. The usual objective of factor analysis is to explain correlation in a set of data and relate variables to each other, while the objective of cluster analysis is to address heterogeneity in each set of data.

Still, it can also be used as a method of data reduction. In spirit, cluster analysis is a form of categorization, whereas factor analysis is a form of simplification. Even though the solutions to both factor analysis and cluster analysis problems are subjective to some degree, factor analysis allows a researcher to yield a „best" solution, in the sense that the researcher can optimize a certain aspect of the solution. This is not so for cluster analysis, since all algorithms that could possibly yield a best cluster analysis solution are computationally inefficient.

Factor analysis and cluster analysis also differ in how they are applied to real data. Because factor analysis has the ability to reduce a unwieldy set of variables to a much smaller set of factors, it is suitable for simplifying complex models. Factor analysis also has a confirmatory use, in which the researcher can develop a set of hypotheses regarding how variables in the data are related, which is not for cluster analysis. The researcher can then run factor analysis on the data set to confirm or deny these hypotheses. Cluster analysis, on the other hand, is suitable for classifying objects according to certain criteria (http://www.ehow.com).

Interesting studies comparing those two methods on a practical basis are available (Krebs, Berger, Ferligoj 2000). The authors claim, that comparing factor analysis with cluster analysis means to approach a data set from two complementary perspectives. The underlying logic of both procedures is classification. Classification in either approach is based on homogeneity. Homogeneity with respect to cluster analysis means that research units, located in the rows of the data matrix, either individuals or groups of individuals, are classified into clusters with respect to their similarity on variables. Clusters are ideally characterized by within homogeneity of objects and between heterogeneity of objects. Factor analysis, in contrast, concentrates on the homogeneity of variables resulting from the similarity of values assigned to variables by respondents. Which of the two approaches better fits the data is an empirical question to which an answer can be: one of them, both or none (Bacher 1996).

3. Discussion of the results

Factor analysis

On the basis of the results of the study, we firstly managed to construct a factor model using a multidimensional scale. It was constructed with the use of one of the methods of multi-criteria exploratory analysis – factor analysis, in particular an analysis of principal components which consists in the use of linear model of orthogonal set transformation of initial n variables into a new set of mutually uncorrelated m variables. This is a typical variables classification (data reduction) method. An advantage of a factor analysis is the possibility to discover an optimal number of latent variables which explain mutual connections between observable variables.

The results of factor analysis for the solution with two factors are presented in Table 1 (Eigenvalues) and Table 2 (factor loadings).

Table 1. Eigenvalues matrix for dimensions of occupational threats – solution with five factors

Factor	Eigenvalue	% Variance	Cumulated Eigenvalue	% Cumulated
1	3,549410	22,18381	3,549410	22,18381
2	2,164391	13,52744	5,713801	35,71125
3	1,345420	8,40887	7,059221	44,12013
4	1,224078	7,65048	8,283298	51,77061
5	1,089146	6,80716	9,372444	58,57778

Source: authors' own study

A 5-factor solution was adopted, which explains 58,57% of the whole of the variations. The first factor has a high Eigenvalue – 3,55 and explains 22,18% of total variations. The second factor has the Eigenvalue amounting to 2,16 and explains 13,52% of variations, whereas the consecutive factors have the Eigenvalue greater than 1 - 1,35, 1,22 and 1,09 respectively and consecutively explain 8,41%, 7,65% and 6,81% of the whole of the variations. The next factor has the Eigenvalue lower 1 and consequently it is rejected.

Table 2 presents loadings of the highest correlations – being the components of the subscale of a given factor.

Table 2. Factor loadings matrix – four factor solution

Value number	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5
1	0,516332	0,134074	0,228619	0,098782	-0,169477
2	-0,019698	0,060606	0,745174	-0,156155	0,144498
3	0,205091	0,073781	0,817375	-0,027467	-0,074390
4	0,241242	0,116043	0,657900	0,207601	0,178619
5	-0,140193	-0,020452	0,121311	0,648489	-0,239987
6	0,344730	-0,046594	0,399303	-0,307456	0,123663
7	0,009237	0,164109	0,275083	-0,061339	0,756729
8	0,199916	0,037913	-0,001188	0,137762	0,679458
9	0,671149	0,256030	0,079729	-0,006920	0,119955
10	0,800203	0,102523	0,054665	-0,051432	0,096914
11	0,698717	-0,006983	0,120474	-0,109721	0,193540
12	0,071741	0,111194	-0,059046	0,768187	0,148138
13	-0,027805	0,146618	-0,127329	0,708774	0,157668
14	0,087991	0,853327	0,082417	0,049307	0,049235
15	0,130758	0,851623	0,077159	0,112159	-0,020804
16	0,143455	0,682120	0,041566	0,085922	0,171058

Source: authors' own study.

The analysis of Table 2 suggests that variables no. 1 and 6 should be rejected as none of them has the factor loading at the level or above the level equal to 0,6. The analysis of observable variables loading each of the factors indicates the possibility of a reasonable interpretation of relations.

Since the scale includes the variables of the highest correlation with a given factor, table 2 presents that:

- the first factor is loaded by 3 variables of the following numbers 9, 10, 11,
- the second factor is loaded by 3 variables of the following numbers 14, 15, 16,
- the third factor is loaded by 3 variables of the following numbers 2, 3, 4,
- the fourth factor is loaded by 3 variables of the following numbers 5, 12, 13,
- the fifth factor is loaded by 2 variables of the following numbers 7 and 8.

Therefore we obtained a set of data reduced to the factors loaded by observable variables. Naming of the dimensions of occupational threats results from the following interpretation of factors:

- „physical conditions" (F) at work station including lighting, temperature and possibility to concentrate at a given work station,
- „data security" (D) covering the criteria of confidentiality, integrity and accessibility of data used during the performance of work,
- „psycho-sociology" (S) covering optimism and high self-estimate, resulting in comfortable and certain mood satisfaction of work, optimistic evaluation of future career and application of skills,
- „physiology" (P) covering the time pressure and physical ailments of an organism caused by the performance of work,
- „autonomy" (A) covering the possibility to choose the manner of the performance of work and diversity of tasks.

Subsequently the reliability of scales was examined. One of the most frequently applied techniques of scale reliability measurement is the α-Cronbach coefficient. It assumes values from the range <0,1>, while it is assumed that the minimum reliability of scale means coefficient value greater than 0,6 (Sagan 2003). The analysis of reliability scale was carried out separately for each distinguished dimension.

Finally it turned out that the deletion of variable no. 5 contributes to the increase of Cronbach's α to 0,66, i.e. it is worth to delete this variable in order to achieve a significant increase of the factor „physiology" subscale reliability. Other subscales are reliable. Only for the factor „autonomy", the Cronbach's α value of 0,41 is assumed. Therefore only in this one case, we may have some reservations about the reliability of the measurement.

So the final specification of the model covers 5 factors loaded by 13 variables. Mapping of values to factors is given in Table 3, placed further in the text.

Cluster analysis

Then cluster analysis was used. Grouping variables by columns was performed. It is an example of hierarchical methods, which lead to creating a hierarchical tree-like structure of the elements of the analyzed set. The aim was to examine whether occupational threats posed to knowledge workers can be grouped into few logical items. A vertical tree graph (icicle plot) drawn in Figure 1 shows clusters for occupational threats obtained in another steps.

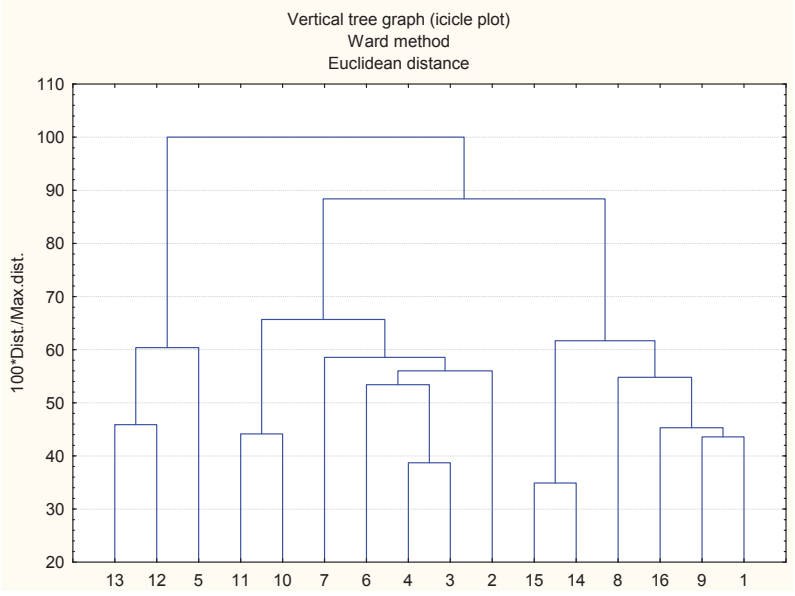

Figure 1. Icicle plot for occupational threats cluster analysis

Source: authors' own study.

From Figure 1 it can be seen that cutting a plot off at a standardized linkage distance e. g. 62, 4 clusters are obtained at the distinct increase in linkage distance appear in 7th and 14th of 15 steps of analysis. Interpretation of the obtained clusters is as follows (the order of linking variables was preserved, hence they are not sorted) (Lotko and Lotko 2015):

1. Cluster 1 – „physiology" (P), links variables 13, 12, 5, linking mainly physiological threats (threats to sight and musculoskeletal system) and the pressure of time.
2. Cluster 2 – „physical conditions" (F), links variables 11, 10, linking physical conditions at a workplace (temperature, noise, ability to concentrate).
3. Cluster 3 – „psycho-sociology" (S), links variables 7, 6, 4, 3, 2, linking psycho-sociological threats – ability to decide about the way of performing work, ability to relax, proper use of worker's abilities, estimation of the future and salary satisfaction.

4. Cluster 4 – „data and autonomy" (D), links 15, 14, 8, 16, 9, 1, linking threats posed to data security (confidentiality, integrity, availability), illumination of a workplace, diversity of tasks at work and support in performing them.

Analysis shows, that it is hard to logically interpret joining variables to clusters in 2 cases: variable 5 (pressure of time) to the cluster 1 and variable 9 (illumination of a workplace) to the cluster 4. Mapping variables describing occupational threats to clusters is given in Table 3.

Comparison of the results

Factor analysis and cluster analysis are two statistical exploratory methods of data analysis. These two forms of analysis are heavily used in the natural and behavior sciences. Both factor analysis and cluster analysis allow to group parts of the data into „factors" or „clusters", depending on the type of analysis.

Putting together results of the use of the two techniques, mapping variables to factors and clusters was done, shown in Table 3.

Table 3. Mapping variables (a) to factors (b) to clusters (shadow indicates a difference in mapping)

Var. no.	Statement	Mapping to a factor	Mapping to a cluster
1	I can count for the support in solving problems encountered at work.	-	D
2	I am satisfied with the remuneration that I receive.	S	S
3	I perceive the future of my career optimistically.	S	S
4	My skills are properly used in organization.	S	S
5	I work under time pressure.	-	P
6	Breaks at work allow me to relax.	-	S
7	I make the decisions concerning the manner in which I perform the work by myself.	A	S
8	Performed tasks are diversified.	A	D
9	My work station has appropriate lighting.	F	D
10	At my work station, the temperature is at a comfortable level.	F	F
11	Surrounding of my work station allows for concentration.	F	F
12	During the work my eyesight can rest.	P	P
13	During the work I have comfortable and ergonomic position.	P	P
14	Data and information used at work are at the disposal of authorised persons only.	D	D
15	Data and information used at work are protected from unauthorised modification.	D	D
16	Data and information used at work are available when necessary.	D	D

Source: authors' own study.

From Table 3 it can be concluded, that the results obtained using the both methods are quite similar. Although when using factor analysis 5 factors were discovered and when using cluster analysis 4 clusters where identified, in general they are similar, and of easy to interpretation character. The only differences implying from comparison of the two methods are visible in Table 3 and are as follows:

1. First variable, describing an ability of receiving support in solving problems at work, in factor approach was rejected as not having factor loading high enough for any of the factors, while in cluster approach it is joined to cluster „data and autonomy" (D),
2. Fifth variable, describing pressure of time, in factor approach was rejected as the variable lowering the reliability of factor „physiology" subscale (P), while in cluster approach it is joined to cluster „physiology" (P).
3. Sixth variable, describing an ability of relaxing in a workplace, in factor approach was also rejected as not having factor loading high enough for any of the factors, while in cluster approach it is joined to cluster „psycho-sociology" (S).
4. Seventh variable, describing ability to decide about the way of performing work, in factor approach loads factor „autonomy" (A), while in cluster approach it is joined to cluster „psycho-sociology" (S). Both situations seem possible to be logically interpreted.
5. Eighth variable, describing the diversity of tasks at work, in factor approach loads factor „autonomy" (A), while in cluster approach it is joined to cluster „data and autonomy" (D). Here also both situations seem possible to be logically interpreted.
6. At last, ninth variable, describing illumination at a workplace, in factor approach loads factor „physical conditions" (F) at a work station, while in cluster approach it is joined to cluster „data and autonomy" (D). The second situation is rather illogical and hard to interpret.

In table 4 similarities between factors and clusters are given. They are calculated as the number of common variables divided by the total number of unique variables for the two items. The value belongs to the range from 0 (no similarity) to 1 (identity).

Table 4. Similarities between factors and clusters

		Factors				
		Physical conditions (F)	Data security (D)	Psycho-sociology (S)	Physiology (P)	Autonomy (A)
Clusters	Physiology (P)	0,00	0,00	0,00	**0,67**	0,00
	Physical conditions (F)	**0,67**	0,00	0,00	0,00	0,00
	Psycho-sociology (S)	0,00	0,00	**0,40**	0,00	**0,17**
	Data and autonomy (D)	**0,13**	**0,50**	0,00	0,00	**0,14**

Source: authors' own study.

Data in table 4 confirms that similarities between factors and clusters are logical. The only illogical values seems the ones between factor „physical conditions" (F) and cluster „data and autonomy" (D) (value too high) and between factor „autonomy" (A) and cluster „data and autonomy" (D) (value too low).

Summing up, both of the obtained results are sensible, logical and easy to be interpreted. Also the revealed differences can be easily explained on a basis of logic.

At least, the comparison of results of assessment of occupational threats by the knowledge workers, grouped with the use of the two methods is presented. Firstly, there come results obtained with the use of factor analysis. The profile of occupational threats assessment is shown in Figure 2. Because of the assumed scales, where each item is described by a positive statement, low value of a variable means perceiving threat as a weak one, as high value of a variable means perceiving threat as a strong one.

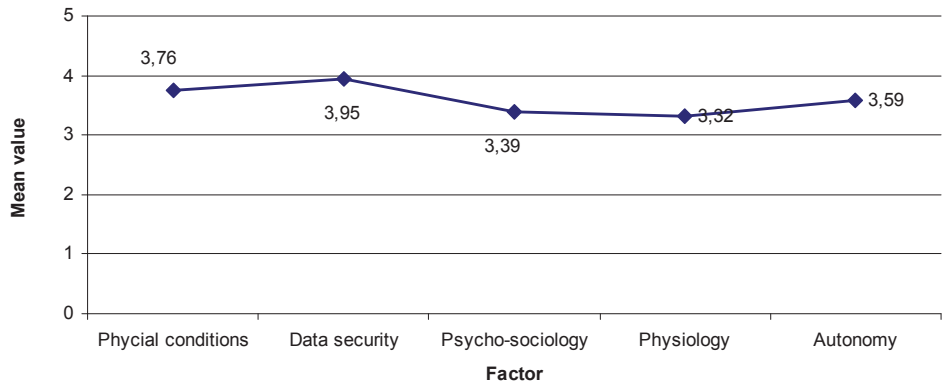

Figure 2. Assessment of occupational threats factors (mean values)

Source: authors' own study.

From figure 2 it can be read that knowledge workers' perception covers mostly psycho-sociological and physiological factors, as well as from the lack of autonomy (which is also of psycho-sociological character) – here are were low values of positive statements. Examined employees perceive threats to data security and implying from physical conditions at a workplace as relatively weak (here there are high values of positive statements).

Secondly, there comes results obtained with the use of cluster analysis. The profile of occupational threats assessment is shown in Figure 3.

From Figure 3 it can be read that knowledge workers' perception covers mostly threats coming from physiology and psycho-sociology (there are low values of positive statements). Threats concerning physical conditions and threats to data security and lack of autonomy are perceived as relatively weak.

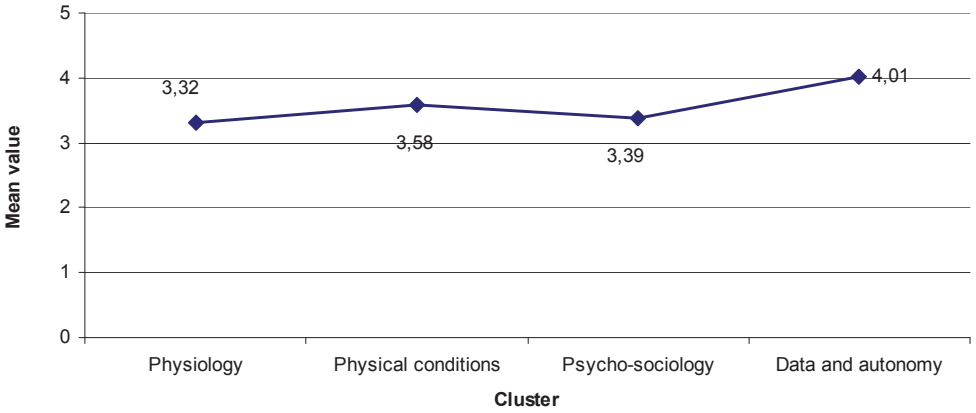

Figure 3. Assessment of occupational threats clusters (mean values)
Source: authors' own study.

Conclusions discovered from the comparison are as follows:

1. In both cases it was assessed that knowledge workers' perception covers mostly threats coming from psycho-sociological and physiological factors (3,39 and 3,32 accordingly; the results are identical for both methods).
2. Factor analysis explains threats concerning physical conditions on a workplace as a bit weaker than cluster analysis (3,76 vs. 3,58).
3. It is hard to compare threats to data security and autonomy, as for factor analysis there are two different factors (assessed 3,95 and 3,59 accordingly), while for cluster analysis there is one cluster assessed 4,01. Drawing mean value from the two factors gives 3,77, which is lower than in case of using cluster analysis. This allows to claim in some degree, that factor analysis explains this group of threats as stronger (lower mean value of a positive statement) than cluster analysis.

Conclusion

Conduct of empirical studies of the self-assessment of occupational threats ant the character of work by the knowledge workers by means of observable variables and application of two of multidimensional exploratory techniques, factor analysis and cluster analysis, allowed to establish the following:

1. Specification of the factor model of occupational threats perceived by knowledge workers covers 5 factors loaded by 13 variables. The revealed factors are: „physical conditions", „data security" , „psycho-sociology", „physiology" and „autonomy".
2. Threats perceived by knowledge workers can be grouped into 4 clusters: „physiology", „physical conditions", „psycho-sociology" and „data and autonomy".

3. Mapping variables to clusters and factors revealed, that the results obtained with the use of the two techniques are similar, yet they differ in details. Among minor differences in ascribing variables to items (factors or clusters), the main difference is that in factor analysis approach „data security" and „autonomy" are different factors, while in cluster analysis approach they form one cluster. Hence the first (factor) approach seems more sensible. Still it should be remembered, that three variables were removed from this model as not having enough factor loadings values (2 cases) or lowering the reliability of a factor subscale (1 case).
4. Concerning results of empirical measurement, in both cases it was assessed, that surveyed workers' perception covers mostly threats coming from psycho-sociological and physiological factors (the results are identical for both methods). Factor analysis explains threats concerning physical conditions on a workplace as a bit weaker than cluster analysis. It is hard to compare threats to data security and autonomy, as for factor analysis there are two different factors, while for cluster analysis there is one cluster. However, calculating a mean value from the two factors allows to claim in some degree, that factor analysis explains this group of threats as stronger (lower mean value of a positive statement) than cluster analysis.

The conclusions are of both cognitive and utilitarian character. In first case – the analysis revealed and explained the structure of perception of knowledge workers' occupational threats and the character of knowledge-based work, in second – the classification of variables allows to measure perception of occupational threats and use the results e. g. when designing trainings on occupational health and safety and to better fit them to this group of employees. It turned out, that the results achieved with the use of the two techniques are similar, yet they differ in detail.

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