REVISTA ESPACIOS

Assessment of risk factors and work-related stress among it developers

Evaluación de factores de riesgo y estrés laboral entre sus desarrolladores

HESHIMOVA, Albina C. 1; PRASOLOV, Valeriy I. 2; BURLAKOV, Vyacheslav V. 3 & SEMENOVA, Larisa V. 4

Contents

ABSTRACT:
Work-related stress concerns are given much attention by an increasing number of papers. This work discusses findings relative to stress among IT developers in a qualitative analysis of 684 studies conducted over the past 20 years. A flexible logical-heuristic method helps identify the key risk factors for stress development. Among four groups of thereof (work environment, working conditions, process organization, and personal qualities), the most significant factors are heavy workload, job stability, work schedule, vision problems and emotional intelligence. The study discusses methods and strategies to assess the risk of developing stress and reduce its negative effects.
Keywords: stress, risk factors, information and communication technologies, IT developers, working conditions, psychosocial health, meta-analysis

RESUMEN:
Las preocupaciones relacionadas con el estrés laboral reciben mucha atención por parte de un número creciente de artículos. Este trabajo analiza los hallazgos relativos al estrés entre los desarrolladores de TI en un análisis cualitativo de 684 estudios realizados en los últimos 20 años. Un método lógico-heurístico flexible ayuda a identificar los factores de riesgo clave para el desarrollo del estrés. Entre cuatro grupos de ellos (ambiente de trabajo, condiciones de trabajo, organización de procesos y cualidades personales), los factores más importantes son la gran carga de trabajo, la estabilidad laboral, el horario de trabajo, los problemas de visión y la inteligencia emocional. El estudio analiza métodos y estrategias para evaluar el riesgo de desarrollar estrés y reducir sus efectos negativos.
Palabras clave: estrés, factores de riesgo, tecnologías de información y comunicación, desarrolladores de TI, condiciones de trabajo, salud psicosocial, metaanálisis.

1. Introduction

The most difficult issues related to occupational safety and health are psychosocial risks and workplace stress. They significantly affect the health of people, organizations and the national economy. According to the EU-OSHA European Opinion Survey (Psychosocial risks and stress at work, 2019), about half of the workers believe that workplace stress is a common thing in their lives. Psychosocial risks are the result of poor social context of work, improper work planning, organization and management. They can lead to negative psychological, physical and social consequences, such as workplace stress, burnout or depression. As a rule, the examples of working conditions leading to psychosocial risks include: excessive workload, contradictory

requirements and changes to duties, insufficient involvement in decision-making processes affecting the employee, inability to influence the work flow; workplace unreliability and the likelihood of a workplace change; ineffective communication; lack of support from management or colleagues; psychological and sexual misconduct, violence (Kawakami &Haratani, 1999; Singh et al., 2012). In addition to mental health problems, the workers suffering from prolonged stress can develop serious physical health problems such as cardiovascular disease or musculoskeletal system problems (Belkic et al., 2004; Sharan et al., 2011).

The global reach of information and communication technologies (ICTs) makes people constantly interact with these technologies in order to get the work done. According to academic literature, popular press and anecdotal evidence, ICTs are responsible for high levels of stress in people. However, despite the large number of publications on the issue, it is not clear what characteristics of ICTs provoke stress (Belkic et al., 2004; Sharan et al., 2011). It is said that it is necessary to focus on people and provide incentives to make developers happy in order to increase their productivity and software quality (Ayyagari et al., 2011).

Research works (Belkic et al., 2004; Steptoe et al., 2007; Ahmed et al., 2017) show that the relationship between stress and the onset and development of many basic mental and physical disorders is well documented (Sharan et al., 2011; Chirico, 2016; Park & Jang, 2019). At a conservative estimate, stress-related disorders and injuries cost billions of dollars, including direct medical, legal and insurance expenses, as well as the expenses associated with accidents, absence from the workplace, a small number of staff and decreased productivity. Therefore, the development of effective programs to prevent and eliminate the predisposition to stress is an important task for both employers and the health care system as a whole.

As it is noted in (Graziotin et al., 2014), high-tech companies such as Google and Facebook are well-known for their perks for the employees: entertainment, sports, good food in the office during working hours. The key assumption is "happy software developers work better than the unhappy ones." In scientific articles, it has long been argued that the best way to improve the productivity of software developers is to focus on people (Chilton et al., 2005) and to keep people ahead of the process (Major et al., 2007). Software development is a complex and purely intellectual work. Software developers are creative people and they need appropriate working conditions (Darshan et al., 2013; Martikainen et al., 2014). Comprehension processes are affected by the emotions and moods of individuals. Therefore, some cognitive processes are associated with the effectiveness of problem solving (Graziotin et al., 2014; 2014b).

Workplace stress is a common problem faced by all specialists, regardless of the type of their work. However, this phenomenon is more common in situations where there are hard deadlines (Rashidi & Jalbani, 2009). The work of software specialists is associated with tight deadlines; it is customer-oriented and requires significant knowledge of technology. The combination of these tendencies and many other factors (including technology change, customer interaction, fear of obsolescence, the need for family support, long hours, excessive working hours, etc.) contribute to stress (Rashidi & Jalbani, 2009).

The analysis of the publications shows that there is very little research on the feelings of software developers and possible consequences. High workplace stress positively correlates with a decreased quality of life, detrimental effects on employee health, increased number of absenteeism cases and decreased labor productivity. Workers are exposed to workplace stress by the perception of psychosocial risks. Thus, a comprehensive analysis of the production risk problem for IT workers is required.

Our research is based on the fact that workplace stress is a serious problem which significantly affects IT workers. IT workers who overwork themselves burn out and give up their work. There is a need for a systematic identification of the relationship between risk factors and the consequences of workplace stress, as well as the stress-reduction techniques.

The purpose of our research is to summarize existing studies on the analysis of the work-related risks for IT developers. In our research, we discuss different approaches to assessing stress factors, compare the results of individual studies and summarize the results of the studies conducted over the past 20 years, taking into account duplication.

The following questions are included into our research:

1) What factors influence the exposure to workplace stress and its negative consequences for the health of IT developers?

2) What are the effective measures to reduce stress and its consequences among IT teams?

In the course of our research, we also considered the following aspects: 1) threats and risks faced by IT developers; 2) the effect of stress on health, psychological and physiological processes; 3) factors to reduce the work-related stressors and the conditions for increasing the efficiency of IT teams.

2. Materials and methods

The literature search was carried out in seven databases; the studies written in English and published over the past 20 years were selected.

In order to analyze publications devoted to psychosocial stress in the workplace and its negative consequences for health and performance, we considered the articles published over the past 20 years. The following databases were used: 1) Scopus (2019) – a multidisciplinary abstract scientometric database; 2) WebofScience (Clarivate Analytics, 2019) – an internationally recognized database of scientific citation in natural, social, humanitarian sciences and arts; 3) PubMed (2019) – a database of scientific publications, mainly on medicine and biology; 4) JSTOR (2019) – an extensive database of articles, journals and scientific papers on a wide variety of topics; 5) ERIC (2019) – a database with articles and scientific publications on psychology in English. In addition, we analyzed the publications available on Research Gate (2019), a free social network for scientific collaboration and exchange of publications, and arXiv.org (2019), the largest free archive of electronic scientific articles and their preprints on physics, mathematics, astronomy, computer science and biology.

The selection of risk factors is made through the use of the flexible general methodological approach based on the heuristic algorithm. The possibility to use logical-heuristic methods for different subject areas, types of users, as well as various types of tasks makes them universal. In order to analyze the relationship between workplace stress and mental and physical health, as well as the impact of measures to relieve workplace stress on the effectiveness of IT development processes and the formation of project teams, the selection of factors is carried out in several stages.

 1. Selection criteria development.

To identify the main factors affecting workplace stress and the effectiveness of IT development processes, there have been developed four main criteria for the selection of factors through the careful analysis: 1) frequencies of mention; 2) assessment complexity; 3) narrow specialization; 4) impact on the effectiveness of the IT team.

 1. Vetting for the compliance with criteria requirements.

Based on the extensive review, the factors that were singled out by the authors of the articles as the most significant are identified. All the factors identified at the first stage are evaluated according to the selected criteria on the binary scale. Based on the qualitative analysis, the factors and their assessments according to the given criteria are included into the table.

 1. Selection of indicators from the initial sampling.

Based on the qualitative analysis, we selected the factors that: are highlighted by the majority of authors; are common in terms of nationality, geography and activity types of the company; can be easily identified; significantly affect not only the employee, but also the effectiveness of the team as a whole. The most important factors include all factors that: 1) are often used, 2) can be easily evaluated, 3) do not have a highly specialized nature, 4) are valuable for the results of the IT team as a whole.

3. Results and discussion

In order to assess the relationship between workplace stress and mental and physical health, as well as the impact of measures to relieve workplace stress on the effectiveness of IT development processes and the formation of project teams, a qualitative analysis of 684 publications was carried out (arXiv.org, 2019; Clarivate Analytics, 2019; ERIC, 2019; JSTOR, 2019; PubMed, 2019; ResearchGate, 2019; Scopus, 2019). At the first stage, we identified duplicate articles; there were 178 duplicates in total. After that, the remaining 506 publications were reviewed. For further analysis, we selected 238 articles within the scope of the research topic. Most of the 268 articles rejected for further analysis did not meet the selection criteria: focus on psychosocial stress among IT developers; clear research methods; consideration of the IT sphere specifics; consideration of the mutual influence of workplace stress and health status. The full text of 17

publications was not available. Thus, 238 publications were selected for further qualitative analysis.

According to the initial analysis of publications, their findings are based on the surveys and statistical methods for processing the results. In addition, most works are devoted to the study of IT stressors in India and the USA. There is no sharp geographical predominance in the other studies. A thorough analysis of relevant publications allowed us to identify risk factors for workplace stress among IT workers. They were grouped and analyzed for the compliance with criteria requirements. There were identified 36 factors; the main of them are presented in Table 1. The secondary analysis of the selected factors allowed us to combine the results based on the qualitative analysis of the research descriptions, as well as to identify the groups of factors. Based on the logical-heuristic analysis, we singled out four groups of factors significantly affecting psycho-emotional health, stress development and, as a result, the efficiency of the IT team.

Table 1
Workplace stress factors

No.	Factor	criterion			
		frequencies of mention (+)	assessment complexity (-)	narrow specialization (-)	impact on the effectiveness of the IT team (+)
1	2	3	4	5	6
	Work environment	-	-	-	+
	Air quality	-	-	-	-
	Lighting	+	-	-	-
	Access to daylight	-	-	-	-
	View from the window	-	-	-	-
	Temperature	-	-	-	-
	Office acoustics	-	+	-	+
	Gym	+	-	-	+
	Yoga and meditation	-	+	+	+
	Vision problems	+	-	-	+
	musculoskeletal system problems	+	-	-	+
	Working conditions	+	+	-	+
	Workplace personalization	-	+	-	-
	Work schedule	+	-	+	+
	Career growth	+	-	-	+
	Remuneration conditions	+	-	-	+

Stability	+	-	-	+
Process organization	+	+	-	+
Changes to duties	+	+	-	+
Heavy workload	+	-	-	+
IT project complexity	-	-	-	+
Motivation	-	-	-	+
Leadership	+	-	-	+
Development	+	-	-	+
Personal qualities	-	+	-	+
Personal growth	-	+	-	+
Emotional intelligence	+	+	-	+
Family relationship	+	-	-	-

The first group of factors consists of the indicators related to the quality of the work environment, i.e. the factors characterizing the workplace, the office space and infrastructure. These factors include: air quality, lighting, access to daylight, view from the window, temperature, office acoustics, gym, yoga and meditation, vision problems, as well as musculoskeletal system problems (Table 1).

The second group consists of the factors related to the working conditions: workplace personalization, work schedule, career growth, remuneration conditions, stability, etc.

The third group includes the factors that are associated with the organization of work, teamwork and the allocation of responsibilities in the team: changes to duties, heavy workload (including due to the lack of specialists), the complexity of IT projects (large-scale projects, the need for a high level of professional knowledge, responsibility), motivation (work should give pleasure), leadership (the key role of having a leader in the team, leadership qualities), development (continuous education, project dynamics and work assignments).

All factors that are associated with personal characteristics of the employee: personal growth (internal self-actualization and self-education, spiritual practices, etc.), emotional intelligence (the ability to cope with stressful situations), family relationship (communication with the family, family support, etc.) fall into the fourth group. It should be noted that the first three groups consist of the factors directly affecting the employer while the fourth group includes the factors that characterize each employee individually. The factors of the first three groups describe the working from different perspective. The factors of the first group (air quality, lighting, humidity, etc.) have the greatest impact on health; deterioration in health always leads to stress. At the same time, the groups of factors describe the negative impact on the employee and, in fact, characterize the risks for the workplace stress development. The fourth group, on the contrary, describes the factors that have a positive effect and help to cope with stress.

The analysis of the publications shows that most employees are productive in a healthy work environment. Air quality is the most positive factor affecting general physical state. Comfortable lighting can be regarded as the second most important factor related to health. The ability to control the workflow and the ability to personalize workplace can also contribute to the creation of a favorable work environment. Workplace temperature is an important factor that has been highlighted in many studies. Employees are distracted by poor office acoustics. It is confirmed that the work environment that supports and improves health and well-being of the employees has a positive effect on their overall psychoemotional background. It is important to should be noted that such factors as air quality and access to daylight are often neglected by researchers.

However, they have a significant impact on health, employee's productivity and overall performance.

Musculoskeletal system problems associated with work are common among IT specialists. Their work style can be one of the risk factors for musculoskeletal discomfort. Based on the results of the study (Sharan et al., 2011), it can be concluded that to prevent musculoskeletal system problems, it is necessary to focus on psychosocial factors of work, such as an unfavorable work style, in addition to biomechanical risk factors.

Vision problems are the most common health problems among computer users, and particularly among IT developers (Ostrovsky et al., 2012). The combination of symptoms associated with eye strain, eye irritation, burning sensation, redness, blurred vision and double vision was recently called "computer vision syndrome." The study (Ostrovsky et al., 2012) confirms that workplace stress and, as a consequence, burnout of employees, significantly contribute to the development of asthenopia among IT specialists.

Thus, it can be concluded that in most cases the disorders affecting IT workers are not the cause, but the consequence of their psychoemotional state.

Stress management is not only a moral obligation and a good investment for employers. This is a legal obligation included in the Framework Directive 89/391/EEC (1989). Although employers are legally responsible for ensuring proper evaluation and monitoring of workplace risks, employees should also participate in this process. The right approach will make it possible to prevent and successfully overcome psychosocial risks and stress at work regardless of the business size or type. They can be addressed as logically and systematically as other risks associated with safety and health in the workplace.

Most researchers believe that it is necessary to focus on people in order to increase the productivity of IT developers. Affective states (emotions, mood and feelings) influence work-related behavior, cognitive processing and people's productivity. IT companies operate in a competitive environment, tight deadlines, changing requirements and budgets. This can lead to workplace stress. Emotional intelligence is an effective method that can be used to reduce workplace stress. The key components of emotional intelligence are self-awareness, self-government, social awareness and relationship management.

Most professions, not only related to IT, are currently associated with a certain degree of stress. Everyone has to deal with deadlines, last-minute change of requirements and communication with people. In addition, working at a computer for more than eight hours provides additional stressors. The solution to this problem can be careful monitoring of the quality of the work environment, employee motivation and the development of emotional intelligence as the most important factor in reducing the risks associated with workplace stress among IT developers and other IT professionals.

The authors of (Ayyagari et al., 2011) confirm that it is necessary to focus on people and provide incentives to make software developers happy in order to increase their productivity and software quality. This important statement is rarely confirmed in the studies on software development. Software development is an intellectual activity, but human aspects are not considered in the studies devoted to it. In addition to a number of skills required for software development, developers should have high analytical problem-solving skills and a creative approach to their work. According to psychological studies, affective states (emotions and mood) have a profound impact on the cognitive processing abilities and productivity of employees, including the creative approach and solution of analytical tasks. Nevertheless, the analysis showed that little research is devoted to studying the relationship between affective states, creativity and analytical problem-solving ability of developers. For example, in (Ayyagari et al., 2011) it is confirmed that happy developers are better at solving problems in terms of their analytical skills.

In many studies, for example (Rashidi & Jalbani, 2009; Singh et al., 2012; Graziotin et al., 2014; Rezvani & Khosravi, 2019), the nature of stress among IT developers and specialists, as well as the attempts to identify key factors are examined. The authors argue that the management is responsible for provoking stress among staff. This limits the functionality of work and overall productivity. Most studies on this issue are based on surveys that are focused on specific stress factors. The analysis of the publications showed that the number of specialists participating in the survey can vary from several dozens to several thousands of people. The results of the meta-analysis summarize the stress factors identified in individual studies. They allow us to conclude that the problem should be solved through the conditions created by the employer and the development of emotional intelligence of the developers. The issues related to emotional

intelligence have not been sufficiently addressed in the studies devoted to the problems of work organization of IT developers and require further research.

4. Conclusions

In our research, we carried out a thorough analysis of scientific publications on the impact of stress on software development processes and the psychoemotional state of IT developers. Our review is a meta-analysis of independent scientific value. According to the results obtained, it goes far beyond the scope of the review and can be used for further research. The topic being addressed has its own unique feature: the working conditions of an IT specialist are fairly comfortable and according to the analysis, working conditions provoke stress. The quality of the work environment, including air, lighting, temperature, etc., is important for the health of IT workers. The analysis showed that health disorders affecting IT specialists are always associated with the organization of the workplace and the work process. Poor health condition exacerbates stressors.

Based on the flexible logical-heuristic method, the key risk factors for the development of stress among IT workers have been identified. Four groups of factors determining the degree of workplace risk have been singled out: work environment, working conditions, process organization and personal qualities. The most significant factors are: heavy workload, stability, work schedule, vision problems and emotional intelligence.

The results of our research are useful for many interested parties in the local context, including IT specialists and project managers.

5. Bibliographic references

Ahmed, H. U., Hossain, M. D., Aftab, A., Soron, T. R., Alam, M. T., Chowdhury, M. W. A., & Uddin, A. (2017). Suicide and depression in the World Health Organization South-East Asia region: A systematic review. *WHO South-East Asia journal of public health, 6*(1), 60.

arXiv.org (2019). Cornell University. Retrieved from https://arxiv.org

Ayyagari, R., Grover, V., & Purvis, R. (2011). Technostress: technological antecedents and implications. *MIS quarterly, 35*(4), 831-858.

Belkic, K. L., Landsbergis, P. A., Schnall, P. L., & Baker, D. (2004). Is job strain a major source of cardiovascular disease risk? *Scandinavian journal of work, environment & health, 30*(2), 85-128.

Chilton, M. A., Hardgrave, B. C., & Armstrong, D. J. (2005). Person-job cognitive style fit for software developers: The effect on strain and performance. *Journal of Management Information Systems, 22*(2), 193-226.

Chirico, F. (2016). Job stress models for predicting burnout syndrome: a review. *Annali dell'Istituto superiore di sanita*, *52*(3), 443-456.

Clarivate Analytics (2019). Retrieved from https://clarivate.com/

Darshan, M. S., Raman, R., Rao, T. S., Ram, D., & Annigeri, B. (2013). A study on professional stress, depression and alcohol use among Indian IT professionals. *Indian journal of psychiatry, 55*(1), 63.

Directive 89/391/EEC - OSH "Framework Directive" (1989). Retrieved from https://osha.europa.eu/en/legislation/directives/the-osh-framework-directive/1

ERIC (2019). Institute of Education Science. Retrieved from https://eric.ed.gov/

Graziotin, D., Wang, X., & Abrahamsson, P. (2014). Software developers, moods, emotions, and performance Studies show that software developers' happiness pays off when it comes to productivity *IEEE Software, 31*(4), 24-27, 2014

Graziotin, D., Wang, X., & Abrahamsson, P. (2014b). Happy software developers solve problems better: psychological measurements in empirical software engineering. *PeerJ*, *2*, e289.

JSTOR (2019). Retrieved from https://www.jstor.org/

Kawakami, N., & Haratani, T. (1999). Epidemiology of job stress and health in Japan: review of current evidence and future direction. *Industrial health, 37*(2), 174-186.

Major, D. A., Davis, D. D., Germano, L. M., Fletcher, T. D., Sanchez-Hucles, J., & Mann, J. (2007). Managing human resources in information technology: Best practices of high performing supervisors. *Human Resource Management: Published in Cooperation with the School of Business*

Administration, The University of Michigan and in alliance with the Society of Human Resources Management, 46(3), 411-427.

Martikainen, S., Korpela, M., & Tiihonen, T. (2014). User participation in healthcare IT development: A developers' viewpoint in Finland. *International Journal of Medical Informatics, 83*(3), 189-200.

Ostrovsky, A., Ribak, J., Pereg, A., & Gaton, D. (2012). Effects of job-related stress and burnout on asthenopia among high-tech workers. *Ergonomics, 55*(8), 854-862.

Park, S., & Jang, M. K. (2019). Associations Between Workplace Exercise Interventions and Job Stress Reduction: A Systematic Review. Workplace health & safety, 2165079919864979. Retrieved from https://journals.sagepub.com/doi/abs/10.1177/2165079919864979

Psychosocial risks and stress at work (2019). Retrieved from https://osha.europa.eu/en/themes/psychosocial-risks-and-stress

PubMed (2019). US National Library of Medicine National Institute of Health. Retrieved from https://www.ncbi.nlm.nih.gov/pubmed

Rashidi, Z., & Jalbani, A. A. (2009). Job stress among software professionals in Pakistan: A Factor analytic study. *J Independent Stud Res (MSSE), 7*, 1-12.

ResearchGate (2019). Retrieved from https://www.researchgate.net

Rezvani, A., & Khosravi, P. (2019). Emotional intelligence: The key to mitigating stress and fostering trust among software developers working on information system projects. *International Journal of Information Management, 48*, 139-150.

Scopus (2019). Retrieved from https://www.scopus.com

Sharan, D., Parijat, P., Sasidharan, A. P., Ranganathan, R., Mohandoss, M., & Jose, J. (2011). Workstyle risk factors for work related musculoskeletal symptoms among computer professionals in India. *Journal of occupational rehabilitation, 21*(4), 520-525.

Singh, P., Suar, D., & Leiter, M. P. (2012). Antecedents, work-related consequences, and buffers of job burnout among Indian software developers. *Journal of Leadership & Organizational Studies, 19*(1), 83-104.

Steptoe, A., Hamer, M., & Chida, Y. (2007). The effects of acute psychological stress on circulating inflammatory factors in humans: a review and meta-analysis. *Brain, behavior, and immunity, 21*(7), 901-912.

1. Department of Common discipline, Zagatala branch of Azerbaijan State University of Economics (UNEC), Zagatala, Azerbaijan

2. Department of Risk Analysis and Economic Security, Financial University under the Government of the Russian Federation, Moscow, Russian Federation; valeriyprasolov@yahoo.com

3. Department of Economics and Organization, Moscow Polytechnic University, Moscow, Russian Federation

4. Department of Philosophy, Bashkir State Medical University of the Ministry of Health of the Russian Federation, Ufa, Russian Federation

[Index]

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