ENHANCING OCCUPATIONAL HEALTH AND SAFETY LEGAL FRAMEWORK REGARDING INCREASED AMBIENT TEMPERATURES, NANOTECHNOLOGIES AND DESIGN FOR SAFETY IN BUILDINGS – MACEDONIAN CASE

ARTAN ORTAM SICAKLIĞI, NANOTEKNOLOJİLER VE BİNA GÜVENLİĞİ İÇİN TASARIMLA İLGİLİ İŞ SAĞLIĞI VE GÜVENLİĞİNİN GELİŞTİRİLMESİ – MAKEDONYA ÖRNEĞİ

**Daniela Mladenovska**

Adjunct Docent/Mother Teresa University Skopje, dmladenovska@gmail.com

https://orcid.org/0000-0001-5368-4846

**Inci Derebey**

Docent/University American College Skopje, inci.derebey@gmail.com

https://orcid.org/0000-0001-7456-4026

Abstract

The necessity to comply the national legislation in Macedonia with the EU Directives is continuously addressed by the European Commission. The field of Occupational Health and Safety is not an exemption. Moreover, in a circumstance where the country is lacking behind with OHS legislation transposition and implementation, an additional burden on working environment conditions create new challenges, in particularly three areas, such as climate change consequences, emerging of new technologies (such as nanotechnology) and changes in built environment. Contending with the main issues regarding the above-mentioned challenges and to foster the policy makers to enhance the relevant OHS legislation, this paper proposes a review and comparison of the national, EU and non-EU countries legislation as well as relevant research papers. The referred three areas are important for Macedonia considering that construction and agriculture are significant economic activities where outdoor workers are extremely vulnerable to high ambient temperatures, nanotechnology is already present in several factories (foreign direct investments) and there is ongoing process of mass and rapid construction of new buildings.

In general, the monitoring and reporting of the work-related injuries and fatalities should be improved and more specific data on the accident causes should be included. In addition, it is required to improve the monitoring of the workers’ health condition as well as to adopt new methods for risk assessment in the workplace (in particularly for the workers handling with nanoparticles). The safe design regarding buildings refer not only to construction workers but also the buildings residents during the expected lifetime. The main focus regarding the buildings safe design requirements should be in using safe materials regarding mechanical injuries (in particularly safety glass), as well as taking in consideration the indoor air quality. The suggested enhancement in the national OHS legislation concerning increased ambient air temperatures, nanotechnologies and safe design in construction sector, will result in improved prevention and control activities, lower incidence of occupational diseases, avoiding work related injuries and fatalities as well as maintaining optimal work capacity and productivity enabling economic growth and income. The benefits of this kind of improvement will not only affect the companies but enable the well-being of the entire society.

Key words: Occupational health and safety, legal framework, climate change, nanotechnology, design for safety in buildings.

INTRODUCTION

Although the occupational health and safety (OHS) in Macedonia is regulated by Law (new OHS Law is still in process of preparation), correspondent by-laws and strategic documents (Strategy for OHS 2021 – 2025), the level of its implementation could not be denoted as satisfactory. The knowledge of employers and employees of their respective rights and obligations is limited and this backwardness induces additional burden to the economy. Namely, the majority of OHS activities in the Macedonian companies are pro forma implemented, only because they are required by the Law. On the other side, there is a significant lack of preventive activities (especially in terms of education and training), risk analyses and safety improvements (investigation of the causes for the accidents and/or "near miss" situations), etc. [(Mladenovska & Dubravac, 2021)](#Mladenovska) Moreover, the flexibility and agility of the responsible authorities in terms of legislation changes and amendments that will encompass climate change consequences, as well as new technologies arising challenges, are constantly lacking behind. The country is ranked as 43 (out of 182) in terms of climate change vulnerability, but 67th in terms of readiness (country’s ability to leverage investments and convert them to adaptation actions) [(ND – GAIN Index, 2020).](#NDGAIN) Having in mind that both indoor and outdoor workers are affected, there is a need for more coordinated activities in this field including climate change related OHS legislation. North Macedonia has a significant share of agriculture and construction in GDP (outdoor workers mainly), and a number of new factories (foreign direct investments) that have implemented certain types of new technologies, such as nanotechnology. The top exports of North Macedonia in 2020 are reaction initiators, reaction accelerators and catalytic preparations, resulting in annual value of USD 1,4 billion [(OEC, 2020)](#OEC). In terms of safe design, the global changes in the built environment brought a variety of new materials and increased energy efficiency demand resulting insignificant buildings envelope airtightness. Such circumstances require revision of the air pollutants exposure in the buildings, as well as the built-in materials quality in terms of mechanical injuries prevention.

This paper refers to the comparison among the national OHS legislation and the relevant EU legislation (not excluding the other examples of good practices), and addresses the necessity for national legislation enhancement. This issue is gaining importance due to the fact that in general in Macedonia the reporting in terms of the causes for work injuries and fatalities is not transparent in terms of the accident cause identification. [(Macedonian OHS Association, 2021)](#MOHSA) The majority of the work accidents are taking place in the construction sector and manufacturing industry. As per the seasonal variation, it could be concluded that the period April – October (in line with the construction season) has slightly higher number of accidents compared to the rest of the year. Moreover, the number of work related injuries and fatalities in construction sector in North Macedonia have a trend of increasing. Namely, in 2016 there were 16 injuries and 6 fatalities, while in 2021 these numbers are 30 and 9 respectively. [(Mitrevska et al., 2022).](#Mitrevska) However, more profound analyses both in terms of the seasonal variation of the accident frequencies as well as type of industry, will contribute towards identification of the main problems in terms of injuries and fatalities prevention. The awareness raising is also important. Additional efforts must be focused on workers training and education related to OHS, as well as the visibility of these issues among the general public. The role of media in enabling environment for adoption of the correspondent legislation could also be very significant.

METHOD

This paper encompassed three important aspects of the OHS legal framework that should be upgraded and adopted on a national level. Namely, the trend of increasing of average global temperatures due to climate changes, emerging new technologies (in particularly nanotechnology) as well as increased rate of urbanization and significant development of the construction sector, required updated legal framework for workers protection. In order to locate the main areas for policy action, foster the policy makers and raise the awareness among the stakeholders, and comparison between the current EU legislation and the national legislation regarding this field is performed. The main sources of data and information at the national level are: OHS Law, correspondent by-laws, publications of the national Institute for Public Health, Annual reports on work related accidents, as well as published scientific and professional papers concerning the Macedonian case. Regarding the EU and other countries, the main sources of data and information are: EU and European Commission Directives, Occupational Health and Safety Administration (OSHA), Eurostat, European Trade Union Confederation (ETUC), as well as scientific and professional paper from researchers in EU and non EU countries.

FINDINGS AND DISCUSSION

*Increased ambient air temperatures*

The phenomenon of climate change, contributes in constant increasing of the average ambient air temperatures. Such circumstances more than ever urge the need for preparation of correspondent bylaws that will stipulate the prevention measures and the manner of work’s organization under the conditions of high temperatures (both indoor and outdoor), in order to prevent injuries and/or heat-related illnesses. The situation becomes even more complicated, since there are several workers who have second jobs or live in homes that lack efficient cooling or have high humidity. It is implied that heat stress and the risk to heat-related illnesses may be even higher, and may be further complicated by the urban heat island effect (i.e., built-up areas releasing heat absorbed during the day and night). [(Lundgren et al., 2013)](#Lundgren) According to the World Health Organization (WHO), usually people work best at a temperature between 16°C and 24°C. Higher temperatures are related with increased risks of accidents. When temperatures rise above 30°C, the risk of workplace accidents increases by 5-7% and, when temperatures exceed 38°C, accidents are between 10% and 15%. [(ETUC, 2022)](#ETUC)  In the last two decades, in Macedonia there is significant increasing of the number of days with air temperatures above 30°C and above 35°C, as well as the number of nights with the temperatures above 20°C (tropical nights). Recently, the frequency of the heat waves occurrence is increased. In accordance to the World Meteorological Organization (WMO), the heat waves are defined via Heat Wave Duration Index (HWDI). It is an interval of at least 6 consecutive days where the maximum air temperature is 5°С higher than the average maximum temperature for the period 1961 – 1990. [(IPH, 2018)](#IPH1)  Unfortunately, in Macedonia, there are no data on heat - related work accidents and professional illnesses, having in prospect the manner (the low quality) of the reporting. Moreover, excess heat reduces work capacity and productivity in heat-exposed jobs, and may result in the loss of income, leading to adverse mental health and economic effects. [(Kjellstrom, 2009)](#Kjellstorm) There is no correspondent legal framework that regulates the working process under the conditions of high temperatures, although there are specific standards that are applied only on a voluntary basis.

Even though the correspondent EU Directive (Directive on maximum working temperatures) is yet to be prepared and adopted, several countries (bot EU and non EU members) already have legislation to keep workers safe during heatwaves, with a wide variation in limits ranging from 28 to 36 degrees. In Belgium there is a limitation of the indoor temperatures to 29°C for light physical workload, 26°C for a moderately heavy physical workload, 22°C at heavy physical workload and 18°C at very heavy physical workload. Latvia has limmited the maximum working temperature for indoor work at 28°C. In Montenegro, the maximum working temperature for outdoor work of 36°C, while in Slovenia the air temperature in indoor work areas must not exceed 28 °C. [(ETUC, 2022)](#ETUC)

The Institute of Public Health of Republic of North Macedonia (IPH), has continuously prepare publications in order to raise the awareness among the stakeholders as well as to recommend measures for workers protection, in correlation with the working specific conditions, type of the performed working operations, general health condition of the workers, working places risk assessment, etc. [(IPH, 2018)](#IPH1) As per the recommendations, there is a brochure prepared by the IPH, based on a combined effect of the high air temperature and air humidity values, embedded into the Humidex Index (HI). It is measured by using thermal hygrometers. In accordance with the measured value of HI, the correspondent measures should be applied for specific are temperature range. Another indicator regarding the workers exposition on high outdoor air temperatures, is Wet Bulb Globus Temperature (WBGT), based on ISO 7243. It is calculated based on the air temperature values, relative humidity, air velocity as well as solar irradiation values, measured by means of the commercially available instruments. The recommendations in accordance with WBGT, takes in to account the type of the performed working operations categorized into aforementioned four groups. [(CCOHS, 2022)](#CCOHS)

Having in mind the previous statements, Macedonia should stipulate the maximum working temperatures in terms of both indoor and outdoor conditions, by means of comprehensive consultations with the stakeholders and implementation of the already proven best practices in other countries. Improvement of the work accidents reporting system (including reporting on the accident causes) is a precondition for preparation of a legislation that will adequately correspond the specific demands. The already prepared publications and brochures from the national IPH and other relevant institutions (State labor Inspectorate), could serve as useful start point for this process.

*Nanotechnologies*

Nanotechnology is being hailed as the “next industrial revolution”. It refers to the design, production and application of structures, devices or systems at the incredibly small scale of atoms and molecules – the “nanoscale”. “Nanoscience” is the study of phenomena and the manipulation of materials at this scale, generally understood to be 100 nanometers (nm) or less. [(The Royal Society and Royal Academy of Engineering, 2004)](#RoyalSociety) The toxicity of nanomaterials is often linked to their extremely small size. Smaller particles have a greater reactive surface area than larger particles, are more chemically reactive and produce greater numbers of reactive oxygen species that include free radicals. This is one of the primary mechanisms of nanoparticle toxicity; it may result in oxidative stress, inflammation, and consequent damage to proteins, membranes and DNA. [(Nel et al., 2006)](#Nel) Occupational exposure to nanomaterials is of particular concern as workers may be exposed at much higher levels than the general public and on a more consistent basis. Workers may experience nanoexposure in the production, manufacture, packaging or transport of products that contain nanomaterials, or in cleaning or maintenance work. [(Institute of Occupational Medicine, 2004)](#IOM)

Even globally, there is still a vast gap between technological progress and research into health and safety in this field. Studies on the effects of the nanotechnologies on health and analysis of the risks of exposure to nanomaterials are still in their initial stages. Workers may be exposed to nanoscale materials during manufacturing or synthesis of nanoscale materials, during formulation or end-use, disposal or recycling of products containing these materials. Because the concentrations and amounts of nanoscale materials and the frequencies and exposures are likely to be higher in workplace settings, occupational exposure calls for particular attention. [(EPA, 2007)](#EPA)

Having in prospect the emerging progress of the nanotechnology, the European Commission in 2013 prepared and adopted a Guidance to assist employers, health and safety practitioners and workers in fulfilling their regulatory obligations, namely those under the provisions of Framework Directive 89/391/EEC and the Chemical Agents Directive 98/24/EEC (CAD)[[1]](#footnote-1), whenever exposure to nanomaterials or use of nanotechnology in a professional capacity is known or likely to take place, with the ultimate aim of ensuring adequate protection of workers’ health and safety. [(European Commission, 2013)](#EuropeanCommission)

In Macedonia nanotechnology is already present in a number of production companies that are established as foreign direct investments. Thus, besides the need for preparation and adoption of the correspondent legal framework, it is necessary to improve the workers’ health condition monitoring, as well as to adopt new methods for risk assessment in the workplace. Moreover, the existing Rulebook for the minimal requirements regarding OHS in terms of the chemical substances workers exposure[[2]](#footnote-2), was adopted 12 years ago and didn’t foreseen the presence and the potential risk arising from nanotechnology and nanomaterials, although it refers to the aforementioned Framework Directive 89/391/EEC and 98/24/EEC. In the environment where there are weak capacities of the responsible institutions such as the environmental and labor inspectorates, while examples of good practices in OHS on a voluntary basis are almost non existing, upgrading of the Rulebook for chemical substances referring to the EC latest recommendations and guidance will bring significant positive change. Moreover, the lack of knowledge in terms of the potential nanotechnology related OHS risks, is not a problem only among the OHS responsible officers and the workers themselves on a national level, but there is a lack of capacity in the responsible institution that issues the environmental permits to the facilities. Recently, the Helsinki committee for human rights in Macedonia, highlighted among other issues the importance of chemical agents’ exposure legislation. Namely, to further harmonise with the EU standards in the area of OHS, they noted that it is necessary to be taken into account the directives of the European Occupational Safety and Health Agency (EU-OSHA). In addition, special attention should be paid to higher prevention and safety of workers from occupational diseases, their exposition to electro-magnetic radiations, chemical agents and generally, the negative impact of the technology on their health, as well as the strengthening of micro and small-size enterprises for more qualitative assessment of occupational hazard. [(Najcevska et al., 2019)](#Najcevska)

To appropriately safeguard workers, research is needed to: better understand where it is reasonable to apply existing knowledge and safety standards in emerging industries; identify previously unrecognized hazards associated with new technologies and assess the need for new hazardous substance exposure limits. Rapid growth in emerging industries also provides an opportunity to encourage the incorporation of Prevention through Design (PtD) principles to design out worker hazards in facility construction and technology development. [(Schulte et al., 2008)](#Schulte)

*Architecture /changes in built environment (design for safety)*

Minimizing hazards and risks early upstream in the design process is an increasingly popular approach to preventing injuries, illnesses, and fatalities in construction. Safe design or designing for safety is recognized internationally as a feasible method to reduce not only construction workers’ risk, but also to provide safe conditions for the buildings occupants latter. [(Choundhry et al., 2009)](#Choundhry) Among other issues, glazing quality referring to window or door installation in the buildings and its safety characteristics triggered many concerns for the designers considering the health and safety issues.

On 1 January 1993 the Workplace (Health, Safety and Welfare) Regulations 1992 came into force to implement the EC Workplace Directive. Regulation 14 includes requirements for glazing which make explicit those that are implicit in the Health and Safety at Work Act. This regulation covers the segments of wall openings, safety of the transparent material and marking procedure to make it apparent. Additionally, the regulations apply to all workplaces including factories, offices, shops, schools, hospitals, hotels and places of entertainment, without covering the domestic premises used for work, or to construction sites[[3]](#footnote-3).

Additional issue in this matter is the indoor air quality which could be jeopardized from the pollutants emitted from the construction materials and furniture. Vapors given off by the materials employed (e.g. volatile organic compounds, formaldehyde) may impair the quality of the air, particularly in new buildings and in consequence of redecoration work[[4]](#footnote-4). In addition, for the purpose of reducing energy consumption, the modern buildings often reach the limit values (preventing almost any air infiltration) regarding the envelope airtightness, thus preventing the natural exchange of air. In order to retain high indoor air quality, many experts re­commend that ventilation equipment be installed in all such buildings. This also enables exposure to damp and the ensuing mold build - up to be prevented4. Although certain EU countries have developed a legislation on limitation of certain pollutants in the indoor air, yet on EU level, IAQ remains largely unregulated. On 25 March 2021, the European Parliament adopted a resolution on the implementation of the Ambient Air Quality (AAQ) Directives, in which it calls on the European Commission to regulate Indoor Air Quality (IAQ) as well. The resolution is not binding on the Commission but is nevertheless a significant milestone in the efforts to enshrine IAQ into legislation. The adoption of IAQ legislation, is particularly important in the context of the review of the Energy Performance of Buildings Directive (EPBD). [(EUROVENT, 2021)](#EUROVENT)

Having in prospect the situation in Macedonia, it should be highlighted that in general there are numerous weaknesses and gaps regarding legislation relevant not only for Prevention through Design principles, but in general concerning construction sites and their protection. In terms of the specific protection of workers working in the sectors where higher number of violations and death cases has been noted, such as construction and industry, the Republic of

North Macedonia has not ratified the Safety and Health in Construction Convention No. 167 of 1988. This Convention shall envisage the construction standards relating to the safety of scaffolds, ladders, machinery and the use of construction materials, work at height, tunnel constructions, working over water, demolishing, explosives, workers’ health hazards, safety in the event of fire, protective clothing and equipment, and other standards that are mandatory for full safety of workers. [(Najcevska, 2019)](#Najcevska) There isn’t any requirement for glazing in the educational, commercial and business buildings. Namely, installation of any type of safety glass (tempered, laminated or similar) is not required, thus creating environment for severe mechanical injuries in cases of accidents.

Regarding IAQ, the improvements in design of the heating, ventilation, and air conditioning

(HVAC) systems are necessary including more strict control of the performed works on site. Although the measurements on the microclimatic conditions are mandatory for the employers, their realization is often pro forma and without proper analyses of the obtained results in terms of the purposes allocation. Hence, the urgent actions should be focused in firstly ratification of the Safety and Health in Construction Convention No. 167 of 1988, transposition of the Regulation 14, as well improving of HVAC design and installation processes. In addition, there shouldn’t be any delay in transposing IAQ Directive, once it is adopted.

Hence, the above noted and elaborated requirements for enhancement in the national OHS legislation concerning increased ambient air temperatures (climate change consequences), nanotechnologies and safe design in construction sector, will result in improved prevention monitoring and control activities, lower incidence of professional illnesses in correlation with the targeted areas, avoiding work related injuries and fatalities as well as maintaining optimal work capacity and productivity, resulting in increased economic growth and income.

ABBREVIATIONS AND ACRONYMS

EU European Union

OHS Occupational Health and Safety

GDP Gross Domestic Product

OEC Observatory of Economic Complexity

OSHA Occupational Safety and Health Agency

ETUC European Trade Union Confederation

WHO World Health Organization

WMO World Meteorological Organization

HWDI Heat Wave Duration Index

IPH Institute of Public Health

HI Humidex Index

WBGT Wet Bulb Globus Temperature

CCOHS Canadian Center for Occupational Health and Safety

DNA Deoxyribonucleic acid

EPA Environmental Protection Agency

CAD Chemical Agents Directive

PtD Prevention trough Design

IAQ Indoor Air Quality

AAQ Ambient Air Quality

EPBD Energy Performance of Buildings Directive

HVAC Heating, Ventilating and Air-conditioning

REFERENCES:

Mladenovska, D., & Dubravac, I. (2021). Weaknesses regarding occupational health and safety in Macedonian companies. *Safety Engineering 11* (1), 31-36. DOI: 10.5937/SE2101031M

University of Notre Dame. (2020). Notre Dame Global Adaptation Initiative, ND-Gain Country Index. Retrieved from <https://gain.nd.edu/our-work/country-index/rankings/>

The Observatory of Economic Complexity (OEC). (2020). North Macedonia country profile. Retrieved from <https://oec.world/en/profile/country/mkd>.

Macedonian Occupational Health and Safety Association. (2021). Annual report for accidents at work place 2020, Skopje.

Lundgren, K., K. Kuklane, C. Gao, & I. Holmér. (2013). Effects of heat stress on working populations when facing climate change. *Industrial Health 51* (1), 3–15.

European Trade Union Confederation (ETUC). (2022). Climate crisis requires EU law on maximum working temperatures. Press release. Retrieved from <https://www.etuc.org/en/pressrelease/climate-crisis-requires-eu-law-maximum-working-temperatures>

Institute for Public Health of the Republic of Macedonia. (2018). Work in open spaces and under the conditions of high and low ambient temperatures, Skopje.

Kjellstrom, T. (2009). Climate change, direct heat exposure, health and well-being in low and middle-income countries. *Global Health Action 2* (1), 1–3.

Canadian Center for Occupational Health and Safety (CCOHS). (2022). Temperature as physical hazard. Retrieved from <https://www.ccohs.ca/topics/hazards/physical/temperature/>

The Royal Society and Royal Academy of Engineering. (2004). Nanoscience and Nanotechnologies: Opportunities and Uncertainties. The Royal Society, London. Retrieved from <http://www.nanotec.org.uk/finalReport.htm>

Nel, A., Xia, T., & Li, N. (2006). Toxic Potential of Materials at the Nanolevel. *Science* 311(5761), 622-627. [DOI: 10.1126/science.1114397](https://doi.org/10.1126/science.1114397)

Institute of Occupational Medicine (IOM) for the Health and Safety Executive. (2004). Nanoparticles: An occupational hygiene review. Retrieved from http://www.hse.gov.mk

Environmental Protection Agency (EPA). (2007). Nanotechnology white paper. Environmental Protection Agency, Washington, DC.

European Commission. (2013). Guidance on the protection of the health and safety of workers from the potential risks related to nanomaterials at work, Brussels.

Najcevska, M., Cekic, A., Blazeva, A., Shishovski, J. & Stojadinovic, S. (2019). Analysis of workers’ rights standards and their application in the Republic of North Macedonia, Helsinki committee for human rights of the Republic of Macedonia, Skopje.

Schulte, P. A., Rinehart, R., Okun, A., Geraci, C. L. & Heidel, D. S. (2008). National Prevention through Design (PtD) Initiative. *Journal of Safety Reearch 39* (2), 115–121.

Choudhry, R., [Lingard](https://researchrepository.rmit.edu.au/esploro/search/outputs?query=creator,exact,Lingard%20Helen,AND&page=1&sort=date_d&mode=advanced&institution=61RMIT_INST), H. & [Blismas](https://researchrepository.rmit.edu.au/esploro/search/outputs?query=creator,exact,Blismas%20Nick,AND&page=1&sort=date_d&mode=advanced&institution=61RMIT_INST), N. (2009). Designing for safety: Perspectives from European Union, United Kingdom, Australia and United States pertaining to safety and health in construction. *Proceedings of the CIB W99 International Conference: Working Together: Planning, Designing and Building a Healthy and Safe Construction Industry,* 18-27, Melbourne, Australia.

EUROVENT, European Industry Association. (2021). Air quality in buildings on radar of European legislators (GEN – 1227.00). Retrieved from <https://eurovent.eu/?q=articles/air-quality-buildings-radar-european-legislators-gen-122700>.

Mitrevska, C., Bureska, L., Gruevska, N. & Mitrevski, V. (2022). Statistical analyses for accidents at work in construction sector in North Macedonia. *8th International Professional and Scientific Conference Occupational Safety and Health*, 21-24 September 2022 Zadar, Croatia.

1. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A01998L0024-20190726 [↑](#footnote-ref-1)
2. Official Gazette of the Republic of Macedonia 64/2010 from 7th of April 2010. [↑](#footnote-ref-2)
3. Regulation 14 – Glass safety legislation (https://solarshield.co.uk/glass-safety-legislation) [↑](#footnote-ref-3)
4. https://oshwiki.eu/wiki/Indoor\_air\_quality\_(IAQ) [↑](#footnote-ref-4)