UDC: 331.45(497.11)
DOI:10.7562/SE2022.12.01.03
Research paper
www.safety.ni.ac.rs

**JELENA MALENOVIĆ NIKOLIĆ[1]**
**DEJAN KRSTIĆ[2]**
**LIDIJA MILOŠEVIĆ[3]**
**IVANA ILIĆ KRSTIĆ [4]**
**MILAN LUKIĆ[5]**
[1]University of Niš,
Faculty of Occupational Safety

*[1]jelena.malenovic@ znrfak.ni.ac.rs*
*[2]dekikrs@gmail.com*
*[3]lidija.milosevic@znrfak.ni.ac.rs*
*[4]ivana.ilic@znrfak.ni.ac.rs*
*[5]milan lukic18031@ gmail.com*

# SAFETY SYSTEM MANAGEMENT BY ANALYSING OCCUPATIONAL INJURIES AND USING INDICATORS OF STATE

**Abstract:** *The occupational safety and health management system requires constant upgrades and analyses of the current state. Work environment indicators need to be monitored in order to ensure safe work conditions. Previous analysis has shown that problems are more prominent in specific administrative districts in Serbia. This paper discusses the number of total, minor, and major occupational injuries at the national level, the number of occupational injuries in the Nišava District, and the relation between the number of reported injuries and closed injury cases by the public attorney's office in Niš.*

**Key words:** management system, indicators, occupational injuries, Heinrich pyramid, preventive engineering

## INTRODUCTION

Preventive engineering, based on the analysis of preventive safety measures needs to include both conventional prevention activities and identification of safety risks. Timely elimination of causes of occupational injury depends on the system for reporting risk situations that occurred (Berry, 2004) but did not result in a risk event. The Heinrich pyramid is used in different economic branches to investigate the causes of disrupting the safety system (Dujman, 2017), even though it was originally intended for use in industrial production. Application of such statistical analyses suggests that an emergency or a risk event is preceded by hundreds of situations (Milovanović, 2011) in which undesired effects were avoided. The purpose of these analyses is to emphasise the need for monitoring the number of situations with compromised safety.

## ANALYSIS OF THE NUMBER OF OCCUPATIONAL INJURIES

The data on the number of injuries published in Labour Reports are classified into multiple categories. The available data include incidence of occupational injuries, types of injuries, severity of injuries, and share of injuries by economic activity, city, and administrative district. The number of injuries in administrative districts is dependent on the functioning of the occupational safety system management to a lesser extent and on economic development to a greater extent.

### Analysis of the total number of occupational injuries

The analysis of the total number of occupational injuries shows that there are serious deficiencies in the functioning of the occupational safety system in Serbia. The number of injuries also depends on economic development, so it is understandable that statistical data changed significantly in the period when the number of new factories, small companies, and artisanal businesses considerably increased. The situation is similar in the surrounding countries, but much better in developed EU countries. Figure 1 shows the total number of occupational injuries at the national level for a period of eight consecutive years.


**Figure 1.** *Number of occupational injuries in Serbia*

The growing trend of the total number of occupational injuries peaked in 2019; however, the Labour Report for 2019 does not state any reason for such a high number.

### Analysis of occupational injury severity

Minor occupational injuries by far outnumber major injuries either at work or during the commute. Figure 2 shows the number of minor injuries from 2015 through 2022.


**Figure 2.** *Number of minor injuries*

When comparing Figure 1 with Figure 2, it is apparent that the curves for the total number of occupational injuries and minor injuries are similarly shaped. Again, the upsurge in minor injuries occurred in 2019, which influenced the similarity between the two curves. Major and fatal injuries are presented together in the Labour

Reports and given as a single number, which is not in keeping with EU standards.

Figure 3 shows the number of major commuting injuries, while Figure 4 shows the number of major injuries at work.

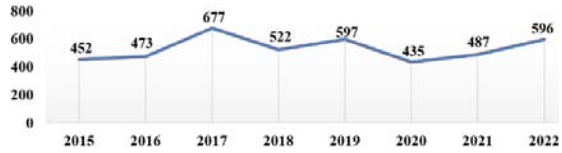


**Figure 3.** *Number of major injuries while commuting*

The data indicate that most major commuting injuries occurred in 2017 and the fewest in 2020. The reduction of these injuries in 2020 and 2021 also influenced the similarity between the curves in Figure 1 and Figure 2, but it needs to be stressed that this fact suggests a lower degree of occupational safety during that period.

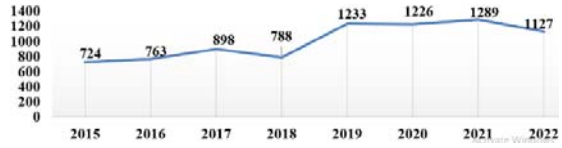


**Figure 4.** *Number of major injuries at work*

The growing trend of major occupational injuries warrants the proper implementation of preventive and corrective safety measures. The official data do not provide enough elements to correct the management system, because separate data on the number of fatal injuries are not available. The data only directly confirms that the situation has sharply deteriorated since 2019. The average number of major injuries over the first four-year period (2015-2018) was 794, only to increase over the subsequent period (2019-2022) by as much as 50% and reach 1,219 injuries.

## ANALYSIS OF THE NUMBER OF OCCUPATIONAL INJURIES IN THE NIŠAVA DISTRICT

The analysis of the total number of occupational injuries shows that there are significant differences in safety management between specific Serbian administrative districts (Malenović-Nikolić, 2023). The data presented in the Labour Report for 2022 reveal the three most prominent administrative districts according to the total number of injuries – the City of Belgrade (5,720), the South Bačka District (3,202), and the Nišava District (1,576).

Table 1 shows the number of criminal charges filed with the public attorney's offices throughout Serbia for failure to implement occupational safety and health measures.

**Table 1.** *Number of filed criminal charges and number of closed cases*

| | *filed* | *filed* | *closed* | *closed* |
|---|---|---|---|---|
| City | 2020 | 2021 | 2020 | 2021 |
| Aranđelovac | 10 | 24 | 15 | 18 |
| Bačka Palanka | 11 | 19 | 21 | 19 |
| Beograd | 83 | 144 | 106 | 93 |
| Bečej | 10 | 5 | 4 | 7 |
| Valjevo | 36 | 49 | 21 | 37 |
| Vranje | 19 | 19 | 7 | 24 |
| Vršac | 3 | 1 | 6 | 4 |
| Gornji Milanovac | 0 | 8 | 2 | 3 |
| Zaječar | 7 | 15 | 9 | 5 |
| Zrenjanin | 12 | 27 | 11 | 17 |
| Jagodina | 17 | 15 | 16 | 8 |
| Kikinda | 10 | 5 | 6 | 12 |
| Kragujevac | 24 | 21 | 23 | 32 |
| Kraljevo | 65 | 40 | 65 | 49 |
| Kruševac | 73 | 78 | 77 | 57 |
| Lazarevac | 1 | 1 | 1 | 2 |
| Leskovac | 23 | 17 | 28 | 17 |
| Loznica | 29 | 21 | 32 | 17 |
| Mladenovac | 7 | 1 | 6 | 2 |
| Negotin | 2 | 1 | 3 | 2 |
| **Niš** | **29** | **25** | **53** | **35** |
| Novi Pazar | 22 | 34 | 31 | 21 |
| Novi Sad | 87 | 93 | 40 | 92 |
| Obrenovac | 5 | 5 | 2 | 4 |
| Pančevo | 2 | 8 | 4 | 6 |
| Paraćin | 3 | 4 | 6 | 5 |
| Pirot | 39 | 41 | 45 | 19 |
| Požarevac | 15 | 22 | 20 | 16 |
| Požega | 1 | 5 | 4 | 1 |
| Preševo | 1 | 0 | 0 | 0 |
| Prijepolje | 2 | 7 | 2 | 5 |
| Prokuplje | 4 | 10 | 8 | 5 |
| Raška | 7 | 1 | 11 | 12 |
| Ruma | 6 | 10 | 9 | 11 |
| Senta | 9 | 12 | 11 | 11 |
| Sjenica | 2 | 0 | 0 | 0 |
| Smederevo | 7 | 5 | 6 | 7 |
| Sombor | 4 | 3 | 15 | 4 |
| Srem. Mitrovica | 7 | 3 | 4 | 5 |
| Subotica | 54 | 67 | 80 | 46 |
| Trstenik | 12 | 5 | 16 | 2 |
| Užice | 14 | 28 | 19 | 18 |
| Čačak | 16 | 28 | 23 | 32 |
| Šabac | 25 | 13 | 29 | 31 |
| Total | 815 | 940 | 897 | 940 |

The Nišava District is the focus of this paper because of the conspicuously lower activity of inspectorates and attorneys' offices compared with some smaller cities (shaded fields in Table 1). The Labour Reports present these data as sourced from the Serbian National Health

Insurance Fund, the Public Attorney's Office, and the Ministry of Justice.

Table 1 shows the number of closed cases by the public attorney's offices throughout Serbia regarding the failure to implement occupational safety and health measures.

The data show that the inspectorates and public attorney's offices in Subotica and Kruševac had the most closed cases.

## Analysis of work results of inspectorates

The analysis of the number of criminal charges filed with public attorney's offices in Serbia for failure to implement occupational safety and health measures resulting in fatal, major, and collective occupational injuries and of the outcomes of proceedings following the charges paints a clearer picture of how occupational safety preventive measures are implemented.

Figure 5 shows a comparison of data taken from the Labour Reports for the Nišava District concerning (I) the number of filed criminal charges, (II) the number of closed cases, and (III) the number of cases closed in a different manner pursuant to the Law on Misdemeanours (warning notices, request denials, dismissals, and release from responsibility of the accused).

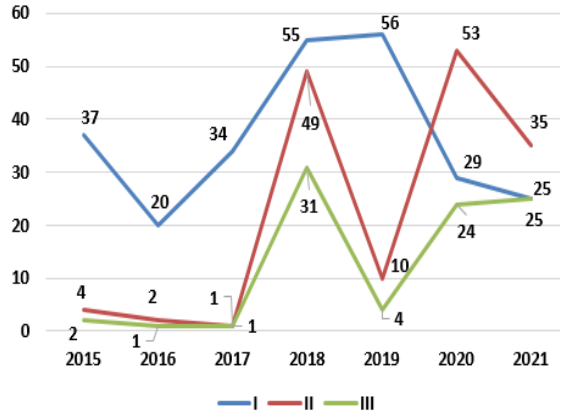


**Figure 5.** *Work results of inspectorates*

The analysis of data in Figure 5 shows that a significant number of cases were closed in 2018 and 2020 and that the period from 2015 through 2017 was characterized by a surprisingly small number of closed cases, fewer than three on average. Another cause for concern is the number of criminal charges filed with the public attorney's office in Niš, where the maximum number is 56, even though the Nišava District has the third-highest number of major occupational injuries. The results of the analysis indicate that more work is required on preventive safety measures, and even more work on repressive measures, in order to establish an adequate worker safety management system. The data show that the inspectorates and public attorney's offices in Subotica and Kruševac had the most closed cases.

## ANALYSIS OF OCCUPATIONAL SAFETY SYSTEM MANAGEMENT

Occupational safety system management using the principles of preventive engineering involves the analysis of risk events that did not result in occupational injuries. Heinrich pyramid is a suitable basis for the analysis of real problems, as it can be adjusted to present the number of (I) fatal injuries, (II) major injuries, (III) minor injuries, (IV) and avoided injuries during risk events (near misses). Its application facilitates the identification of potentially hazardous events and the proper record keeping for the number, causes, and effects of recorded problems in the work environment. The safety system will function properly and more easily with orderly statistical records of risk situations. Detailed records of risk situations create conditions to clearly identify the causes of occupational injuries, eliminate the elements that endanger workers' health, and reduce the level of risk.

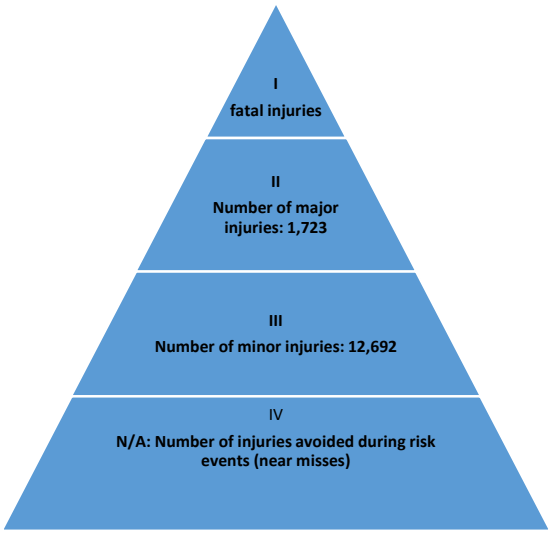


**Figure 6.** *Heinrich pyramid of occupational injuries*

Injuries may be directly or indirectly caused by oversights in the functioning of the occupational safety system and failures to implement preventive safety measures. Direct causes of injuries include absence or non-performance of preventive maintenance, disregard of maintenance, or malfunctions due to ignored warnings, whereas indirect causes include maintenance errors. The problems that can produce the highest level of risk and most likely cause fatal injuries should take priority.

## CONCLUSION

The use of indicators of the state of the work environment is an important step towards improving the management system. The exact ratio of the number of major and minor injuries is impossible to determine because data on major injuries are presented together with fatal injuries. In addition, the presentation of

unified data on the number of major and fatal injuries is not in keeping with European standards. Another issue to be tackled is the definition of the number of risk situations in which an occupational injury was avoided. Orderly record keeping and inputs in the Heinrich pyramid segments are prerequisites for improving the occupational safety system. Regular preventive inspection (daily, weekly, monthly, quarterly, biannually, and yearly) and registration of individual data on the number of fatal injuries and near misses can help present a clearer picture of how to preserve workers' health and increase their safety.

## REFERENCES


[1] Berry T., Campbell S., Riedy C., White S, A New Distributed Infrastructure and Services Market, Institute for Sustainable Futures, UTS, 2004.

[2] Labour Report for 2015, Ministry of Labour, Employment, Veteran and Social Affairs, Occupational Safety and Health Administration, Republic of Serbia, Belgrade, 2016.

[3] Labour Report for 2016, Ministry of Labour, Employment, Veteran and Social Affairs, Occupational Safety and Health Administration, Republic of Serbia, Belgrade, 2017.

[4] Labour Report for 2017, Ministry of Labour, Employment, Veteran and Social Affairs, Occupational Safety and Health Administration, Republic of Serbia, Belgrade 2018.

[5] Labour Report for 2019, Ministry of Labour, Employment, Veteran and Social Affairs, Occupational Safety and Health Administration, Republic of Serbia, Belgrade, 2020

[6] Labour Report for 2020, Ministry of Labour, Employment, Veteran and Social Affairs, Occupational Safety and Health Administration, Republic of Serbia, Belgrade, 2021

[7] Labour Report for 2021, Ministry of Labour, Employment, Veteran and Social Affairs, Occupational Safety and Health Administration, Republic of Serbia, Belgrade, 2022

[8] Labour Report for 2022, Ministry of Labour, Employment, Veteran and Social Affairs, Occupational Safety and Health Administration, Republic of Serbia, Belgrade, 2023

[9] Dujman, J. (2017). Upotreba neparametarske statistike u inženjerskim problemima. Sveučilište u Zagrebu. Fakultet strojarstva i brodogradnje, Zagreb), 2017 https://zir.nsk.hr /islandora /object/fsb%3A3729

[10] Malenovic-Nikolic, J., Krstić, D., Jovanović, U., Ilić-Krstić, I., Milošević, L. (2023). Analysis of the number of injuries at work as a key element in the management of the system of safety and the energy sector. First international EUROSA conference 2023, Kopaonik.

[11] Milovanović, R. (2011). Quality as a Vision of the Future, 7th Research/Expert Conference with International Participation "QUALITY 2011", 2011, Neum, 153-158.


## ACKNOWLEDGEMENTS

This paper was supported by the Ministry of Science, Technological Development and Innovation of the Republic of Serbia, grant no. 451-03-47/2023-01/200148.

## BIOGRAPHY

**Jelena Malenović-Nikolić** was born in Knjaževac, Serbia, in 1974. She received a diploma in environmental protection engineering and the Magister of technical sciences degree from the University of Nis, Faculty of Occupational Safety.
She obtained a Ph.D. in Mining Engineering, Special Scientific field: Occupational Safety and Environmental Protection, from the University of Belgrade, Faculty of Mining and Geology, Special Scientific field: Occupational Safety and Environmental Protection. Her main areas of research include environmental protection, energy, environmental management, environmental security, etc. She is currently working as an assistant professor at the Faculty of Occupational Safety, University of Niš.

# UPRVLJNJE SISTEMOM ZAŠTITE BAZIRNO NA ANALIZI POVREDA NA RADU I PRIMENI INDIKATORA STANJA

***Jelena Malenović-Nikolić, Dejan Krstić, Lidija Milošević, Ivana Ilić-Krstić, Milan Lukić***

**Rezime:** *Sistem upravljnja bezbenošću i zdravljem na radu zahteva konstantno unapređivanje i analizu postojećeg stanja. Praćenje indiktora kvaliteta radne sredine treba vršiti s ciljem da se stvore uslovi bezbedni uslovi rada. Anlizom je utvrđeno da su problemi izraženiji u pojedinim uprvnim okruzima Srbije. U radu se razmatra broj ukupnih, lakih i teških povreda na radu, na nacionlnom nivou, broj povreda na radu u Niškom okrugu i odnos broja prijavljenih povreda i rešenih predmeta niškog tužilaštva.*

**Ključne reči:** sistem upravljanja, indikatori, povrede na radu, Hajnrihova pirmida, preventivno inženjerstvo