

SESSION C:

PRODUCTION TECHNOLOGIES, CAE AND MANAGEMENT

Selection and analysis of key occupational safety and health indicators: A case study in the foundry industry

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ABSTRACT

Selection of key performance indicators (KPI) in the field of occupational safety and health requires precise definition of measurable parameters which allow efficient monitoring of the level of employee protection and evaluation of the success of implemented preventive measures. In the foundry industry, which is characterized by high temperatures, use of heavy equipment, complex technological processes and the presence of hazardous and harmful materials, continuous monitoring of situation in the field of employee health protection is a significant basis for improving working conditions, reducing professional risks and increasing the level of employee safety and health. This paper presents the identification and analysis of key indicators of occupational safety and health through a case study conducted in a foundry in Serbia. Special attention was paid to the LTIFR (Lost Time Injury Frequency Rate), SR (Severity Rate) and AFR (Accident Frequency Rate) indicators, with the analysis of their values in the period 2018-2024, which allowed the quantitative assessment of workplace injury frequency and severity. The results indicate an increased level of professional risk in the observed foundry from the case study. The analysis established that the highest risk workplaces are connected with machine molding, grinding and final treatment of castings, while arms and eyes are the most frequently injured body parts. The obtained results emphasize the importance of preventive measures, education of employees, improvement of risk assessment, more consistent use of personal protective equipment and modernization of technological processes for the purpose of improving occupational safety and health.

KEYWORDS

Occupational safety and health, Foundry industry, Workplace injuries, KPIs, LTIFR, AFR, Severity Rate, Risk assessment, Industrial safety, Occupational risk.

1. INTRODUCTION

Key performance indicators (KPI) are quantitative and qualitative indicators which serve for measuring, monitoring and managing of business results of an organization. They are instruments used by a company to monitor the degree of success in the accomplishment of its strategic goals, vision and business policy. At the same time, KPIs allow the assessment of business efficiency, identification of problematic areas and improvement of decision-making processes and, therefore, they occupy a significant place in modern management and professional practice. A large number of different indicators for measuring company performance have been developed in theory and practice. However, the main challenge of successful management relates to the selection of adequate indicators, i.e. determination of a limited number of key indicators among a great number of potential performance measures. The selected KPIs should cover those factors which can be directly influenced by the organization and which have a crucial importance for its long-term and sustainable development.

In order to assess and improve the existing business operations, it is necessary for the management to translate organizational goals into measurable categories. Various types of indicators are used in that process, where each of them measures a certain aspect of business operations and provides the management with relevant information for decision-making. KPIs allow comparison of the achieved results with the target values defined in advance, the results from previous periods, the established standards, as well as the performances of competitive organizations [1]. Since the performance indicators must be reliable, objective and informative, the selected KPIs should fulfill several basic criteria:

- to be based on relevant and verifiable data,
- to be sensitive to changes in the business environment,
- to be specific for the analyzed situation and goals of the organization,
- to be calculated based on the available data.

In addition to monitoring the efficiency of production, product quality and the level of exploitation of resources, key performance indicators in the foundry industry have a significant role in the field of occupational safety and health as well, because they allow the identification of risk factors and the analysis of frequency of workplace injuries for the purpose of improving the safety of the work environment. The foundry industry is one of the highest risk sectors from the aspect of occupational safety and health due to the complex action of technological processes and conditions of the work environment. Previous research has shown that the most frequent injuries in foundries are burns, mechanical injuries and musculoskeletal disorders, while the most serious incidents are connected with spilling of liquid metal, explosions and interventions on the equipment [2]. Besides occupational injuries, the impact of long-term exposure to harmful effects, such as silica dust, noise and heat stress, is also important, which is confirmed by the reports of Health, Safety and Environment - HSE and recent research in the field of public health [3].

Modern approaches to safety are based on monitoring key performance indicators (KPI), which enable systematic risk assessment and injury prevention. The selection of KPIs in the field of occupational safety and health is a complex process which implies precise definition of measurable parameters for monitoring the safety level in industrial systems. In the foundry industry, which is characterized by high temperatures, application of heavy industrial equipment and the presence of hazardous substances, systematic monitoring of safety indicators has a special importance for improving employee safety and reducing risks of workplace injuries. Therefore, the increasing importance is assigned to proactive indicators, such as the number of near-miss events (avoided incidents), level of compliance with maintenance procedures, exposure to harmful effects and indicators of employee behavior. Research shows that a large number of near-miss events are a reliable predictor of serious accidents, which is in accordance with classical models of industrial safety (e.g. Heinrich model, also known as the Domino Theory).

A particularly important factor is the maintenance of equipment. Papers from the field of risk assessment suggest that inadequate maintenance procedures or the non-obeyed ones are among the most frequent causes of severe and fatal injuries [1], which is confirmed by analyses of real accidents from the bases of the National Institute for Occupational Safety and Health (NIOSH) in the USA. Besides technical aspects, human factor has a key role because risk perception, the level of training and the respect of procedures directly influence the probability of injury occurrence [4].

Accordingly, efficient occupational safety and health management in foundries requires an integrated approach which combines reactive and proactive indicators. Monitoring of the injury rate, near-miss events, maintenance parameters, exposure to harmful effects and the indicators of safety behavior allows timely risk identification and directing preventive measures. Previous research indicates that such a systematic approach makes the basis for reducing the frequency and severity of injuries in the foundry industry.

This paper presents an example of identification and analysis of key occupational safety and health indicators through a case study in the foundry industry in Serbia. Special attention is dedicated to the LTIFR (Lost Time Injury Frequency Rate), SR (Severity Rate) and AF (Accident Frequency) indicators, with the presentation of their values in an eight-year period, which enables quantitative assessment of workplace injury frequency and severity. Also, the paper presents the analysis of the total number of injuries according to the degree of injury, causes of injury, then the analysis of injuries in relation to the workplace, body part which is injured, time of occurrence, and even the day of injury occurrence is analyzed.

The research methodology in the paper is based on the authors' independent interpretation of data from the foundry from the case study with the application of critical analysis, comparison and synthesis of data in the definition of findings, with the qualitative-descriptive approach in the presentation of results and derivation of conclusions. The key research question in the paper is: "Which key performance indicators most efficiently indicate the level of professional risk and the need for improving occupational safety and health measures in the foundry industry?"

Consequently, the aim of this paper is to assess the level of professional risk in the foundry industry through identification, analysis and application of KPIs in the field of occupational safety and health as well as to establish the possibilities of improving preventive measures for the purpose of reducing workplace injuries, improving working conditions and increasing the level of employee health protection.

2. KEY OCCUPATIONAL SAFETY AND HEALTH INDICATORS IN THE FOUNDRY INDUSTRY

The Fatal Incident Frequency Rate - FIFR and the Lost Time Incident Frequency Rate – LTIFR indicators stand out as the examples of reactive performance indicators, especially in the companies with pronounced risks regarding occupational safety and health. The FIFR indicator is defined as the number of fatalities per 100 million of hours worked, while the LTIFR is the number of lost-time workplace injuries per one million of hours worked. These indicators enable the assessment of the safety level in the organization and the identification of critical areas which require the improvement of occupational safety measures [5].

In this paper, special attention is dedicated to the analysis of key occupational safety and health indicators, i.e. LTIFR (Lost Time Injury Frequency Rate), SR (Severity Rate) and AFR (Accident Frequency Rate) indicators, with the presentation of their values in an eight-year period in the foundry from the case study. Quantitative assessment of both frequency and severity of workplace injuries is thus enabled, as well as comprehensive consideration of safety performances in the observed system. The analysis also includes the Fatal Accident Rate - FAR, i.e. the number of fatalities among employees and operators per 100 million working hours; however, as there were no fatalities in the observed period, this indicator was not further considered in the paper.

The Accident Frequency Rate - AFR indicator is defined as the ratio of the number of reported accidents resulting in more than one day of absence from work to the total number of hours worked [6], where the result is standardized to one million of working hours:

$$AFR = \frac{\text{Number of accidents (absence} > 1 \text{ day)} \times 1000000}{\text{Total number of hours worked}} \quad (1)$$

The LTIFR indicators is the frequency of lost-time injuries and it is expressed as the number of such injuries per one million of hours worked:

$$LTIFR = \frac{\text{Total number of lost-time injuries} \times 1000000}{\text{Total number of hours worked}} \quad (2)$$

The Severity Rate - SR indicator is defined as the ratio of the total number of workdays lost due to injuries to the total number of hours worked, where the value is also standardized:

$$SR = \frac{\text{Total number of lost workdays} \times 1000000}{\text{Total number of hours worked}} \quad (3)$$

The total number of working hours is the sum of all hours effectively worked by employees in the observed period and can be approximated using the following expression:

$$\text{Working hours} = \text{number of employees} \times \text{number of working days} \times 8h \quad (4)$$

The application of the abovementioned indicators allows standardized monitoring and comparison of safety levels between different time intervals and organizational units, regardless of the size of the system. Their complementarity is particularly important, taking into account that AFR and LTIFR indicate the frequency of injuries, while SR provides an insight into their consequences and seriousness. It is possible to use an integrated analysis of these indicators to identify critical points in the working process, define priorities in risk management and improve the occupational safety and health system.

3. ANALYSIS OF WORKPLACE INJURIES IN THE PERIOD 2018-2024

According to the reports of the International Labour Organization (ILO), heavy industry, including foundries, is characterized by an increased injury frequency in relation to the other industrial sectors. Similarly, the data obtained by the Bureau of Labor Statistics (BLS) indicate that the metal production sector records above-average workplace injury rates, especially regarding injuries which lead to the absence from work.

Modern approaches to safety management are based on the application of quantitative indicators, such as LTIFR (Lost Time Injury Frequency Rate), AFR (Accident Frequency Rate) and SR (Severity Rate), which allow monitoring of the frequency and severity of injuries as well as comparison of safety performances between different systems and time periods. According to the Health and Safety Executive and EU-OSHA, the LTIFR values below 5 are considered indicators of high safety performance, while the values above 20 indicate an increased risk, which is particularly pronounced in industries with a high degree of hazard, e.g. foundry production.

The analysis of workplace injuries in the foundry from the case study, in the observed period from 2018 to 2024, is based on monitoring absolute indicators (total number of injuries, injury structure and the number of lost workdays) as well as relative indicators of safety performances (AFR, LTIFR and SR). Such an approach allows comprehensive consideration of the safety situation, both from the aspect of frequency and the aspect of severity of injuries.

The total number of workplace injuries during the analyzed period shows moderate oscillations, without a clear trend of continuous rise or fall. The largest number of injuries were recorded in 2022 (19 injuries), (Table 1), while the lowest level was recorded in 2021 (13 injuries). These variations can be the consequence of changes in the scope of production, organization of work or the level of implementation of safety measures.

Table 1: Workplace injuries and key safety indicators in the foundry for the period 2018-2024

Year	Number of employees	Total injuries	Minor injuries	Severe injuries	Lost days due to injuries	AFR	LTIFR	SR
2018	156	14	14	0	161	44.87	44.87	516.3
2019	174	15	14	1	300	43.10	43.10	862.07
2020	179	17	17	0	350	47.49	47.49	977.65

Year	Number of employees	Total injuries	Minor injuries	Severe injuries	Lost days due to injuries	AFR	LTIFR	SR
2021	208	13	13	0	350	31.25	31.25	841.35
2022	202	19	19	0	154	47.03	47.03	381.19
2023	194	15	14	1	370	38.66	38.66	953.61
2024	170	16	13	3	466	47.06	47.06	1370.59

Although the AFR (Accident Frequency Rate) and LTIFR (Lost Time Injury Frequency Rate) indicators are often used as synonyms in practice, there is a certain difference between them. LTIFR refers exclusively to the injuries that have led to the absence from work, while AFR can encompass a wider range of reported injuries and accidents, depending on the methodology of organization or the standard being applied.

In this research, AFR and LTIFR have identical values, taking into account that all the reported injury cases resulted in the absence from work, which did not allow differentiation between these two indicators.

An especially important aspect of analysis is injury structure. Minor injuries are dominant in most years, which indicates the presence of frequent, but less serious incidents. However, the appearance of severe injuries in certain years (2019, 2023 and particularly 2024) considerably influences the overall safety evaluation. The year of 2024 stands out as critical, with three severe injuries, which represents the highest value in the observed period, and indicates the deterioration of working conditions or the insufficient efficiency of preventive measures.

The analysis of lost workdays additionally confirms these observations. Although the number of injuries does not show a drastic decrease, the number of lost days considerably varies, where the highest level was recorded in 2024 (466 days). This indicates increased severity of injuries, which is in accordance with the increased number of severe injuries in the same year. On the other hand, the year of 2022, despite the largest number of injuries, has a relatively low level of lost workdays (154), which indicates the dominance of minor injuries.

AFR and LTIFR indicators show relatively stable values over the mentioned period, with a slight decrease in 2021, which may indicate temporary improvement of safety conditions. However, there is a repeated increase afterwards, which indicates the lack of continuity in the implementation of safety measures. Unlike them, the SR indicator shows significant oscillations and clearly identifies critical years, 2020, 2023 and 2024.

The thorough analysis indicates that safety in the observed system cannot be adequately evaluated exclusively on the basis of the number of injuries. The combination of data about the structure of injuries and the indicators of severity shows that even a relatively stable number of injuries can be accompanied by a significant deterioration of consequences, which is particularly pronounced in 2024.

3.1. Analysis of AFR Indicators

The values of AFR indicators in the observed period range between 31 and 47, which shows a very high level of frequency of workplace injuries. According to the criteria of the International Labour Organization and the Health and Safety Executive, the values above 20 are considered high risk indicators, while the values above 30 indicate a very high-risk level characteristic of heavy industry.

Although certain oscillations are noticed, the lowest value was recorded in 2021 (31), which may indicate a temporary improvement of safety conditions. However, the absence of a continuous downward trend indicates the instability of the occupational safety and health management system and the insufficient efficiency of preventive measures.

3.2. Analysis of LTIFR Indicators

The values of LTIFR indicators completely follow AFR, as expected, because both indicators are based on the number of injuries with the absence from work. The range from 31 to 47 shows that the frequency of time-lost injuries is significantly above the recommended values of good practice.

If the international benchmark values for metal processing industry and steel industry are compared, it can be noticed that the analyzed foundry from the case study records considerably higher values of LTIFR indicators, which indicates an increased risk level and the need for improving occupational safety and health measures [7-9].

By comparing the obtained values of LTIFR indicators in the analyzed foundry from the case study, which, in the observed period, ranged from 31.25 to 47.49 injuries per million working hours, with the benchmark data from the Bureau of Labor Statistics and the American Foundry Society for foundry industry in the USA, where the injury rates range approximately from 6.0 to 8.0 cases per 100 employees, it can be concluded that the analyzed system is in the upper section of the range characteristic of metal processing industry and indicates an increased level of professional risk [10]. This suggests that there is a significant potential for improvement, especially in the field of prevention of injuries which result in the absence from work. The lack of a decreasing trend in LTIFR values during the observed period additionally confirms that safety measures neither were systematically improved nor produced long-term effects.

3.3. Analysis of SR Indicators

The SR Indicator Shows Additional Specificities of the Analyzed System. the Highest Value of SR Was Recorded in 2024 (1370.59), with a Simultaneous Increase in the Number of Severe Injuries and a Considerable Number of Lost Workdays. Such a Result Indicates That the Consequences of Injuries Became More Serious and That They Had a More Pronounced Impact on the Work Capacity of Employees and the Continuity of the Production Process. the High Values of SR Indicators Represent a Particularly Important Indicator in the Foundry Industry Because They Suggest the Possibility of Occurrence of More Serious Injuries Due to Work with Hazardous Materials and Equipment.

On the other hand, the year of 2021 shows the most favorable results from the aspect of injury frequency, which may indicate a more efficient implementation of occupational safety measures, better organization of the process or a reduced scope of production and exposure to risks. It is also interesting that the largest number of injuries were recorded in 2022 with the lowest SR value at the same time, which indicates that the injuries were less serious and that the employees' absences from work were shorter.

In comparison with modern practice in developed foundries, where special attention is dedicated to preventive action, risk assessment, training of employees and automation of high-risk operations, the analyzed results show the need for additional improvement of the occupational safety and health system. Special focus should be placed on the identification of causes of injury repetition, improvement of preventive measures, more consistent use of personal protective equipment as well as continued education of employees for the purpose of reducing the frequency and severity of workplace injuries. These results confirm that the frequency of injuries is not a sufficient safety indicator, but that it is necessary to analyze their severity.

The combined analyses of AFR, LTIFR and SR indicators shows that the system is characterized by a high level of injury frequency with significant oscillations in their severity. This confirms the need for an integrated approach to occupational safety and health management, which simultaneously covers the reduction of both frequency and severity of injuries.

The analysis of occupational safety and health was extended to the indicators presented in Table 2, which cover the review of injuries in relation to the workplace, injured body parts, time and day of injury occurrence, as well as the number of lost working hours in the foundry for the period 2018–2024.

3.4. Analysis of Workplaces from the Aspect of Workplace Injuries

The analysis of workplace injuries in the period 2018–2024 established that the largest number of injuries continuously occur at workplaces connected with machine molding, steel casting, core making and, therefore, these workplaces can be considered the highest risk segments of the production process (Figure 1). The years of 2019 and 2021 particularly stand out as the largest number of injuries were recorded in machine molding jobs in that period.

The increased injury frequency is connected with the specificities of the technological process, which include intensive manual labor, use of rotary tools, contact with metal surfaces, presence of dust, increased physical effort and repetitive operations. Additional risk factors are employee fatigue, reduced concentration and exposure to increased noise and vibrations. The continued presence of injuries recorded in the jobs of molding, core making and maintenance of plants indicates the existence of system risks within the production process. During 2023, an increase in the number of injuries in assembly jobs was recorded, which may be associated with increased work intensity and organizational load.

The analysis of injury structure shows that the most frequently injured body parts were arms and eyes, which is directly connected with the jobs of metal processing and material handling. The mentioned results suggest the need for more consistent application of personal protective equipment, especially for protection of hands and eyes. Based on the analysis conducted, it can be concluded that the key risk factors are manual labor, physical effort, working with tools and cast metal as well as the insufficient implementation of occupational safety and health measures. For the purpose of reducing the number of injuries, it is necessary to improve preventive activities through additional training of employees, intensified supervision over the use of protective equipment and improvement of the organization of work in the highest risk workplaces.

Table 2: Workplace injuries in relation to the workplace, body parts, time of injury occurrence, day of injury occurrence and lost hours in the foundry for the period 2018–2024

Year	Total injuries	Minor injuries	Severe injuries	Workplaces where injuries occurred	Injured body parts	Time of injury occurrence	Weekdays when the injury occurred
2018	14	14	0	Machine molding 2; Steel casting 5; Core making 3; Maintenance of equipment 1; Machining 1; Assembly 1; Crane operator 1	Head 5; Arms 6; Legs 2; others 1	1h–4; 2h–2; 3h–3; 4h–2; 5h–1; 6h–1; 8h–1	Monday 6; Tuesday 3; Wednesday 3; Friday 2
2019	15	14	1	Machine molding 5; Steel casting 4; Core making 1; Maintenance of equipment 2; Sand preparation 1; Pattern maker 1; Electrical engineer 1	Head 3; Arms 5; Legs 3; Eye 4	1h–4; 2h–1; 3h–2; 4h–1; 5h–2; 6h–2; 7h–1; 8h–2	Monday 3; Tuesday 1; Wednesday 2; Thursday 2

								2; Friday 6; Saturday 1
2020	17	17	0	Machine molding 6; Steel casting 4; Core making 1; Semi-automatic mold- ing 1; Forklift operator 1; Mainte- nance of equipment 2; Melter/Furnace operator 2;	Head 1; Arms 6; Legs 2; Eye 8	1h-0; 2h-0; 3h-4; 4h-2; 5h-3; 6h-3; 7h-2; 8h-3		Monday 4; Tuesday 2; Wednesday 3; Thursday 2; Friday 4; Saturday 2
2021	13	13	0	Machine molding 10; Core making 1; Semi-automatic molding 2	Head 1; Arms 5; Eye 7	1h-2; 2h-2; 3h-2; 4h-1; 5h-1; 7h-2; 8h-3		Monday 2; Tuesday 2; Wednesday 6; Thursday 1; Friday 1; Saturday 1
2022	19	19	0	Machine molding 4; Steel casting 3; Core making 3; Melter/Furnace opera- tor 1; Maintenance of equipment 1; Forklift operator 1; Semi-automatic molding 2; Electrical maintenance 1; Structures 1; Work on CNC laser 1; Painter 1	Head 4; Arms 11; Legs 3; Others 1	Arrival-1; 1h-2; 2h-2; 3h-4; 4h-2; 5h-3; 8h-5		Monday 3; Tuesday 2; Wednesday 6; Friday 2; Saturday 6
2023	15	14	1	Machine molding 4; Steel casting 1; Maintenance of equipment 1; Forklift operator 1; Assembly 5; Painter 1; Melter/Furnace operator 1; Core mak- ing 1	Head 1; Arms 6; Legs 3; Eye 5	1h-1; 2h-1; 3h-1; 4h-2; 5h-1; 6h-5; 7h-1; 8h-3		Monday 2; Tuesday 3; Wednesday 1; Thursday 3; Friday 3; Saturday 3
2024	16	13	3	Machine molding 1; Electrical maintenance 1; Maintenance 2; Fork- lift operator 1; Machining 1; Toolmaker 1; Melter/Furnace operator 1; Core making 2; Machine molding 2; Controller 1; Semi-automatic mold- ing 2; Melter/Furnace operator 1	Head 2; Arms 6; Legs 3; Eye 5	1h-1; 2h-4; 3h-4; 4h-2; 5h-2; 6h-2; 7h-1; 8h-0		Monday 3; Tuesday 3; Wednesday 3; Thursday 2; Friday 3; Saturday 2

3.5. Analysis of Injuries by Body Part

Analysis of injuries by body part shows that in the period 2018–2024 arms were most frequently injured, which indicates a high degree of manual labor and an indirect contact between employees and tools, castings and work equipment (Figure 2). There were a significant number of eye injuries since eyes were most often exposed to metal chips, dust and sparks in grinding and metal processing.

Injuries of heads and legs were less common, but their continuous presence indicates the existence of hazards related to impacts, falls and improper handling of materials in the production process. The obtained results confirm that the jobs of metal machining, grinding and molding are operations with an increased risk of mechanical injury. Therefore, it is necessary to improve the use of personal protective equipment, especially for hand and eye protection, as well as strengthen the supervision over the implementation of occupational safety and health measures.

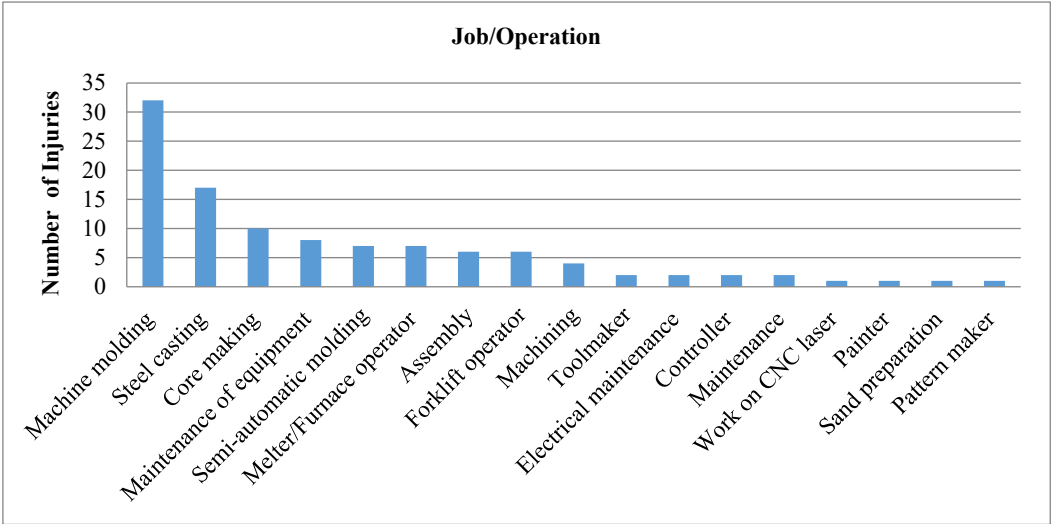


Figure 1: Total number of injuries by workplace (2018-2024)

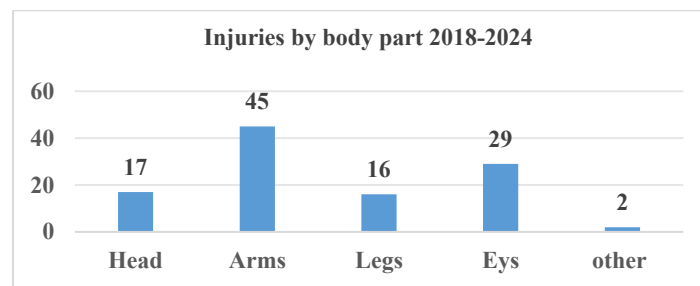


Figure 2: Injuries by body part (2018-2024)

3.6. Analysis of Injuries During the Time of Occurrence

Based on the data presented in Figure 3, it can be concluded that the distribution of injuries during the working time shows pronounced oscillations and clearly identified critical periods of injury occurrence. The highest frequency of injuries was recorded in the period which included the first three hours of work, with the peak in the third hour, which indicates an increased level of load and a possible fall in employees' concentration in the early phase of the working process. After that, there is a gradual decrease in the number of injuries in the middle of the shift, while a significant rise is again recorded at the end of the working time.

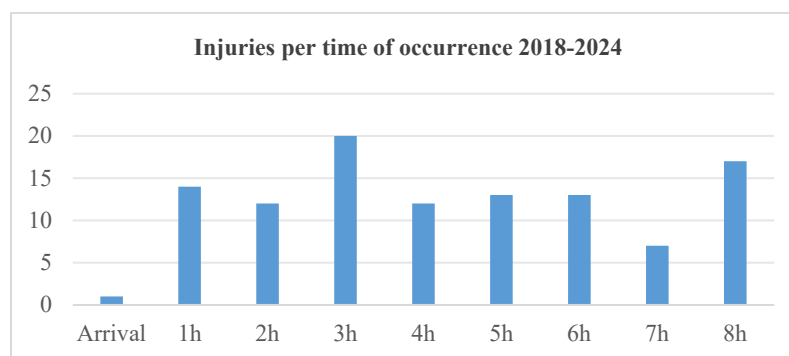


Figure 3: Injuries per time of occurrence (2018-2024)

The obtained results suggest that the factors such as fatigue, monotonous work, psychophysical load and reduced attention significantly affect the occurrence of injuries. What is particularly important is that the increase in the number of injuries occurs even at the end of the shift, which may indicate the consequences of long working hours and exhaustion of employees. The analysis of the diagram confirms the need for improvement of occupational safety and health measures, especially in the periods of increased risk. Preventive activities, e.g. organizing adequate breaks, task rotation, additional training of employees and continuous supervision of work processes, can contribute to the reduction of the number of injuries and the increased overall safety of the work environment.

3.7. Analysis of Injuries by Weekday

The analysis of injuries by weekday shows that the injury frequency is not uniformly distributed during the working week, but that there are distinct time periods of increased risk. The most critical days are Wednesday and Monday, while the lowest risk was recorded on Thursdays. The obtained results indicate a significant influence of psychophysical load, work-related fatigue and the level of employees' concentration on the occurrence of workplace injuries.

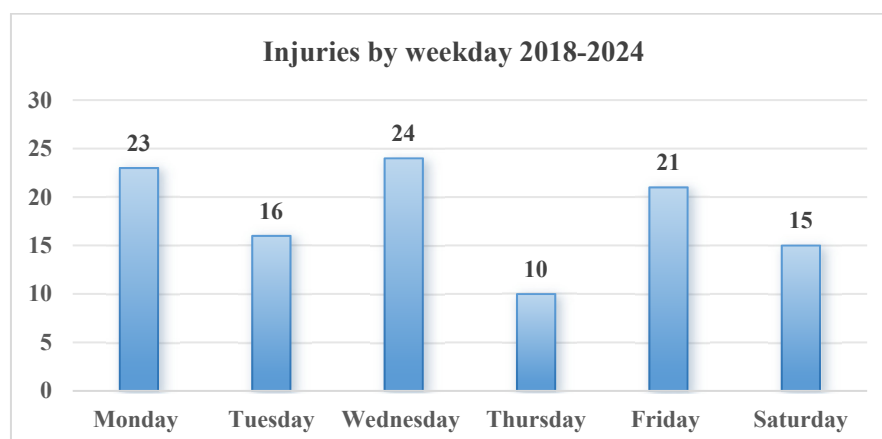


Figure 4: Injuries by weekday (2018-2024)

The results of research confirm the need for continuous improvement of preventive occupational safety measures, especially in the days of increased risk. Organization of work, adequate breaks, additional education of employees and intensified supervision of work processes can contribute to the reduction of the number of injuries and increased safety of the work environment.

4. CONCLUSION

Based on the analysis of key performance indicators regarding the occupational safety and health (AFR, LTIFR and SR) in the foundry from the case study, it can be concluded that KPI implementation and monitoring enable the efficient identification of professional risks and the assessment of the employee safety level in the foundry industry, which confirms the key research question of the paper. The analysis of values of indicators in the period 2018–2024 shows that the observed foundry is characterized by an increased level of professional risk, which is reflected in the frequency and severity of workplace injuries.

The research results indicate that the specificities of the casting process, such as high temperatures, increased physical load, presence of dust, vibrations and handling of metal materials and tools, considerably affect the safety and health of employees. The analysis of the structure of injuries established that the highest risk workplaces are connected with machine molding, grinding and final treatment of castings, while the most frequently injured body parts are hands and eyes. Also, the critical time periods of injury occurrence were identified, especially in the first hours of work, at the end of the shift as well as at the beginning and in the middle of the working week, which indicates a significant impact of fatigue, monotonous work, psychophysical load and organizational factors.

The obtained results confirm that the analysis of KPI indicators is an important tool for the assessment of success of an occupational safety and health system and the identification of areas which require the improvement of preventive action. The aim of this paper related to the assessment of the level of professional risk in the foundry industry and definition of the possibilities for improving employee protection measures has thus been achieved.

Based on the research results, it can be concluded that the existing occupational safety and health system in the analyzed foundry is not sufficiently oriented to preventive action and continuous improvement of working conditions. Therefore, it is necessary to develop an integrated approach to occupational safety and health management, which implies the improvement of risk assessment, more intensive education of employees, more consistent application of personal protective equipment, improvement of the organization of work and modernization of technological processes, with the aim to reduce the exposure of employees to hazards and harmful effects as well as to reduce the number and severity of injuries.

Further research should be directed to a more detailed analysis of the causes of injuries by applying modern methods of risk assessment, research into the influence of ergonomic and psychophysical factors on the occurrence of injuries, as well as the analysis of the connection between the organization of work and the occupational safety and health level. Special importance is assigned to the investigation of possibilities regarding the implementation of automation and digitalization in high-risk phases of production as well as the development of predictive analysis of injuries based on statistical and software tools. Also, future research can involve the comparison of safety indicators in different foundries and the evaluation of efficiency of preventive measures for the purpose of developing a sustainable and safer production process in the foundry industry.

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