SILESIAN UNIVERSITY OF TECHNOLOGY PUBLISHING HOUSE

SCIENTIFIC PAPERS OF SILESIAN UNIVERSITY OF TECHNOLOGY 2023
ORGANIZATION AND MANAGEMENT SERIES NO. 179

OCCUPATIONAL RISK ASSESSMENT IN THE POSITION OF AN OPERATIONALEMPLOYEE ON THE EXAMPLE OF A SELECTED ENTERPRISE

Patrycja DUL[1], Mateusz GAWLIŃSKI[2], Katarzyna ŁYP-WROŃSKA[3]*

[1] AGH University of Krakow; patrycjadul70@gmail.com
[2] Freelance researcher; mateusz.gawlinski.rozprawa@gmail.com
[3] AGH University of Krakow; klyp@agh.edu.pl, ORCID: 0000-0003-1076-1236
* Correspondence author

Purpose: The purpose of this paper is to conduct a detailed analysis of occupational risk using the methods of Preliminary Hazard Analysis (PHA) and the Five-Step Method. The paper aims to estimate the level of risk associated with specific operations performed by automotive sheet metal workers in a selected research facility.
Design/methodology/approach: The objectives are achieved by employing two main methods for assessing occupational risk: the Preliminary Hazard Analysis (PHA) and the Five-Step Method. The approach involves applying these methods to evaluate the potential risks associated with the tasks performed by automotive sheet metal workers. The theoretical scope of the paper covers the field of occupational risk assessment and the practical application of risk assessment techniques in a specific work environment.
Findings: In the course of the study, it was determined that the calculated risk values for the selected operations were within acceptable limits. The analysis revealed that both the PHA and the Five-Step Method were effective in identifying and assessing potential risks, providing insights into the level of risk associated with the tasks performed by automotive sheet metal workers.
Research limitations/implications: The research process was limited to a specific research facility and focused on a subset of operations performed by automotive sheet metal workers. Future research could expand the scope to other work environments and investigate a broader range of tasks to enhance the generalizability of the findings. Additionally, further investigation could explore the effectiveness of risk mitigation measures and their impact on reducing potential hazards.
Practical implications: The research outcomes have implications for enhancing occupational safety in the automotive repair industry. The findings suggest that the selected operations pose an acceptable level of risk, validating the effectiveness of current safety measures. Practitioners and managers can utilize these findings to make informed decisions regarding task assignments, employee training, and the allocation of safety resources.
Social implications: The research contributes to the broader social goal of promoting worker safety in the automotive repair sector. By providing evidence-based insights into the level of risk associated with specific tasks, this research may influence industry practices and policies related to employee safety and well-being.

http://dx.doi.org/10.29119/1641-3466.2023.179.3 http://managementpapers.polsl.pl/

Originality/value: This paper introduces a comprehensive analysis of occupational risk using the PHA and Five-Step Method, specifically applied to automotive sheet metal workers. The value of the paper lies in its practical application of established risk assessment methods to a specific work context, addressing the occupational safety concerns of a critical industry sector.

Keywords: Occupational Risk Assessment, Preliminary Hazard Analysis (PHA), Five-Step Method, Ergonomics, WCM.

Category of the paper: Case study.

1. Introduction

Risk accompanies us at every moment of our lives, in every profession, and during every activity we undertake. Its nature, level, and consequences may differ, but it is present nonetheless. There are various methods available to assess and minimize risk to the lowest possible level. These can be categorized into, among others, objective risk, subjective risk, pure risk, speculative risk, static risk, dynamic risk, fundamental risk, specific risk, individual risk, and collective risk (Ergonomia i ochrona..., 2009). Risk is closely tied to Occupational Health and Safety (OHS), as it involves identifying, evaluating, and managing potential hazards and risks in the workplace. The overarching goal of any OHS program is to create the safest possible work environment and to reduce the risk of accidents, injuries, and fatalities in the workplace. Proper adherence to OHS procedures can aid in preventing accidents, reducing the risk of employee injuries and illnesses, and mitigating costs such as sick leave, medical care, and disability benefits (Alli, 2008). There are two main components to the OHS system in Poland: the legal system and the organizational system. These together form the framework of occupational protection in the country. The legal system pertains to labor laws, applicable legal norms, and their placement within the appropriate hierarchy of health and safety laws. On the other hand, the organizational OHS system focuses on controlling workplace safety and health at a national level, within establishments, and among organizations involved in its creation (System BHP w Polsce, 2021). In Poland, the organizational OHS system outlines the institutions and associations responsible for formulating and executing tasks related to safety and health. The organizational system can be classified into two levels: national and establishment-specific. Two main standards define the occupational health and safety management system in Poland:

- PN-N-18001:2004 "Occupational Health and Safety Management Systems - Requirements".
- PN-N-18004:2001 "Occupational Health and Safety Management Systems - Guidelines" (Model systemu zarządzania BHP…, 2021).

Every enterprise should adhere to all OHS principles to prevent unwanted accidents in the workplace. Many companies set specific goals and principles and implement them. The model for such management and workplace safety is presented in Figure 1.

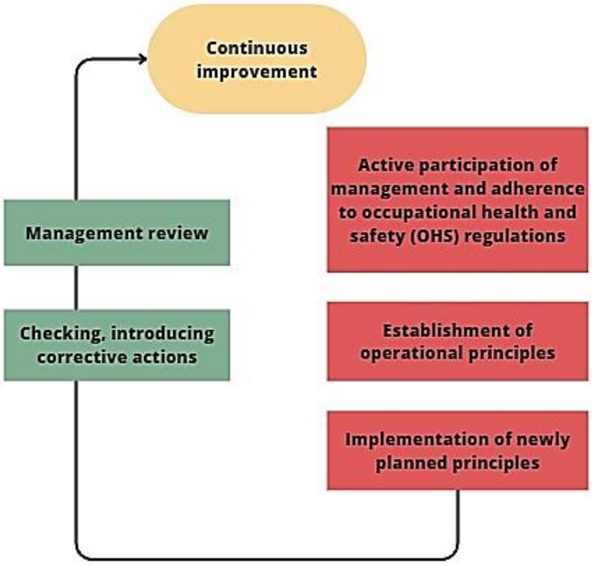

Figure 1. Deming Cycle in the management and occupational safety system.

Source: Model systemu zarządzania BHP…, 2021.

The Deming Cycle describes the various elements of continuous improvement. It begins with the active participation of management and adherence to safety and health principles. The next steps involve establishing operating procedures, and goals, and preparing specific plans for the future. Risk assessment and familiarization with the applicable laws for the enterprise to follow. The next stage is the implementation of the planned new rules, which involves aligning the entire organization, ensuring the necessary capital for the system to function properly, maintaining documentation for the occupational health and safety management system, effective communication, and providing special training to educate employees. Checking and implementing corrective actions is the subsequent step. The final element of the Deming Cycle is the review of management and continuous improvement of the company (Model systemu zarządzania BHP…, 2021).

Occupational health and safety (OHS) are closely linked to ergonomics, creating a comprehensive system for safeguarding the health and safety of employees in the workplace. Ergonomics is the science focused on adapting work to human physical and psychological requirements. It combines technical, biological, medical, psychological, sociological, and physiological aspects related to work, hygiene, law, and environmental protection. The main focus of ergonomics is the employee, ensuring that equipment, tools, and machinery are selected in a way that meets all their needs while causing moderate biological losses but maintaining high productivity and efficiency. These conditions have a positive impact on safety during work (Identifying and Addressing…, 2021). The primary goal of ergonomics is to eliminate discomfort and the risk of injuries during work, specifically reducing fatigue and injuries while increasing comfort, productivity, job satisfaction, and safety. Workplace injuries are not inevitable, and well-designed work should not lead to any harm. The employee is a priority in the workplace analysis (Ergonomia i ochrona..., 2009). Ergonomics can be divided into three categories: conceptual, corrective, and product ergonomics. Conceptual ergonomics focuses on the creation of appropriate devices, machines, tools, and entire industrial halls. It is the most important of all categories because allowing errors at this stage can lead to long-term adverse effects affecting a large number of people. An example could be construction that is not adapted for disabled individuals, due to a lack of ramps. This way, a portion of society is excluded from social and professional life (Szlązak, Szlązak, 2010). Product ergonomics mainly deals with selecting machinery, tools, and devices to match human profiles, and the operation of these objects, including productivity, repair, regulation, and ensuring the safety of the person working with the given object. An example could be a car seat specially designed to match human dimensions (Szlązak, Szlązak, 2010). Corrective ergonomics focuses on fixing technical objects that have been incorrectly realized and designed. However, the feasibility of such corrections is sometimes limited, and in such cases, an analysis of the entire equipment and its fixtures is conducted (Szlązak, Szlązak, 2010). Asimplified diagram of the concept of ergonomics is shown in Figure 2.

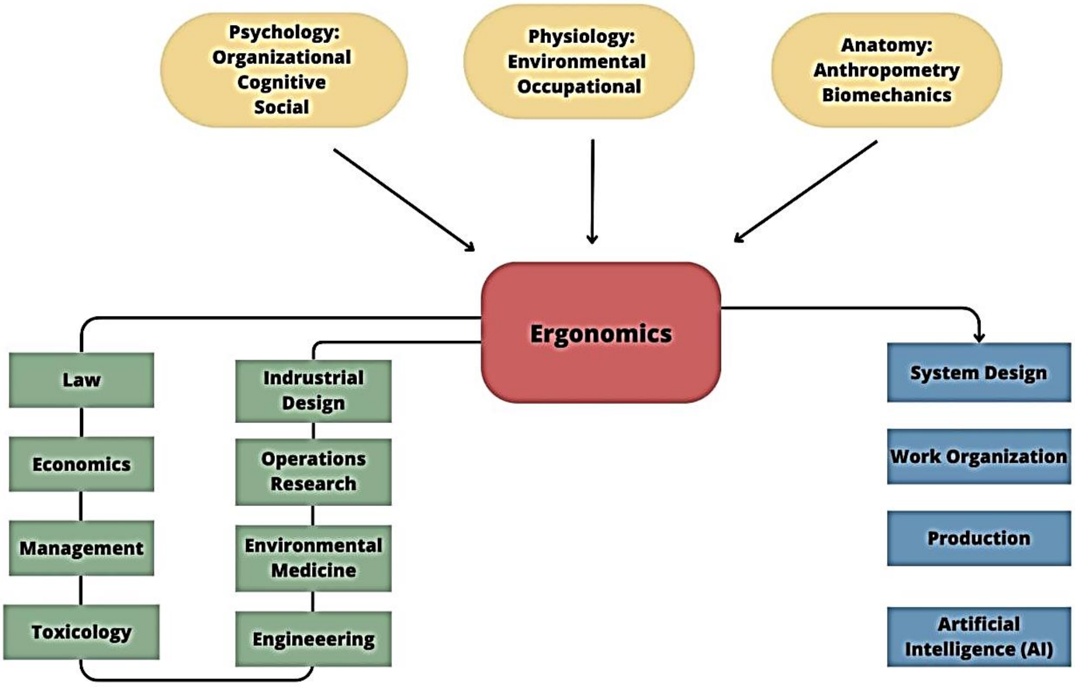

Figure 2. Simplified diagram of the concept of ergonomics.

Source: Own work.

It's also worth noting that ergonomics encompasses concepts such as law, economics, management, toxicology, industrial design, operations research, environmental medicine, and engineering, which, when combined, enable the creation of a safe work organization, appropriate system designs, production, and artificial intelligence while adhering to ergonomic principles. There are many definitions related to ergonomics created by different institutions, including the Polish Ergonomics Society, the International Ergonomics Association, and the International Labour Organization (ILO), which, along with their member groups, have created theirconcepts (Wykowska, 1994).

One of the main principles of ergonomics is to maintain a neutral posture, where the body is in a straight position, both while sitting and standing, with minimal pressure on the body and keeping the joints and spine on the correct axis. A neutral posture minimizes the strain on muscles, tendons, nerves, and bones, allowing for maximum control and energy production, working in the power/comfort zone, movement, and stretching - reducing excess energy expenditure, limiting excessive movements, contact stress, minimizing excessive vibrations, and providing appropriate lighting (https://ergo-plus.com/…, 2021).

Transitioning from OHS and ergonomics to risk management involves identifying potential hazards and implementing preventive actions to minimize risks. Risk, which accompanies every activity, is usually associated with negative consequences (Wykowska, 1994). It represents the possibility of a specific event occurring that could lead to the emergence of a threat and have specific consequences (Romanowska-Słomka, Słomka, 2014). Occupational risk involves examining the possibility of unwanted events occurring while performing work. The loss of health is an undesirable effect that can result from occupational hazards (Norma PN-N-18001:2004…). Risk assessment involves identifying hazards and harmful factors that have the potential to cause harm. Risk analysis focuses on three key tasks: risk assessment, risk management, and risk communication (Norma PN-N-18002:2000…). It involves recognizing potential obstacles and assessing risk by identifying risk that encompasses specific objects (Romanowska-Słomka, Słomka, 2014). A hazard is a potential harm that, in practice, is often associated with a condition or action that, in the absence of control, could result in injury or illness (Hazard, 2002). Hazard identification is the process of recognizing the existence of hazards and determining their characteristics (Norma PN-N-18001:2004…). Occupational exposure is a state in which employees are subject to the influence of hazardous, harmful, or burdensome factors related to their work (Hazard, 2002). Protective measures can be collective, individual, technical, or organizational and aim to minimize occupational risks (Pietrzak, 2007). "The primary goal of risk assessment is to determine the measures required by the organization to maintain and ensure the safety of employees, protect their health, and eliminate hazards leading to accidents at specific workplaces". It should also be noted that if there is no possibility of providing a 100% guarantee of eliminating risk in practice, the employer should reduce it to a minimum. "Risk assessment is intended, among other things, to prevent the effects of occupational hazards". The aim of writing method descriptions and risk assessments is to encourage the employer to plan occupational health and safety management, minimize and control risk appropriately, adhere to OHS principles, and protect employees and those who may be exposed. It is also important to present to employees and relevant authorities that the conditions at specific positions have been thoroughly considered. The goal is to demonstrate the appropriate selection of materials, workstation equipment, cleanliness during work, and a guarantee of continuous improvement in work sterility and safety (Romanowska-Słomka, Słomka, 2014). The result of the assessment should be a decision on whether the occupational risk can be acceptable in the specific position through appropriate monitoring. It may turn out that the occupational risk is high, in which case one of the assessment outcomes will indicate the safety measures to be taken to eliminate or reduce the risk (Pietrzak, 2007).

Occupational risk assessment should be conducted by the employer for each workstation, especially when dealing with a new job position or when the assessment has never been carried out before (Romanowska-Słomka, Słomka, 2014). In chemical plants, laboratories, etc., where the main work factors involve biological, chemical, carcinogenic, mutagenic substances, and various types of preparations, risk assessment is mandatory. It's also required during the setup of a workplace, changes in protective measures, and in case of an accident at work. If there is any change in workplace conditions, an occupational risk assessment must be conducted (Pietrzak, 2007). Risk assessment can be divided into five stages. The first step is hazard identification. It's important to consider possibilities that could negatively impact the employees' health or cause harm. Conducting interviews with employees aids in risk analysis. Reviewing accident documentation and health records contributes to identifying less obvious hazards. The next step is assessing the likelihood, i.e., which employees are more or less exposed to harm. This involves selecting employees divided into different job positions. Each position has specific associated hazards. This way, injuries, and health issues associated with a particular job position can be predicted. The third step is risk assessment and deciding on precautionary measures. Controlling risk in an enterprise is crucial; access to hazards must be prevented, personal protective equipment must be provided, work should be organized to reduce exposure to hazards, and first aid equipment should be organized. Then, all steps need to be documented and implemented, providing better peace of mind for employees. The final and equally important step is updating the risk assessment. Every enterprise introduces various changes, and with them, hazards change too.

There are various methods available for occupational risk assessment that allow for accurate estimation of potential work-related hazards. Some of the most commonly used methods include Preliminary Hazard Analysis (PHA), the Five Steps Method, the Risk Matrix, quantitative methods of occupational risk assessment, and the Gibson Method. The choice of an appropriate risk assessment method depends on the specific work environment and the analysis objectives. Among these methods, Preliminary Hazard Analysis allows for a precise determination of risk level at a given job position and an assessment of whether the risk is acceptable. If the analysis indicates unacceptable risk, immediate actions to minimize the hazard are necessary. This method is applicable both in service facilities and the manufacturing sector. Its simplicity allows for a quick assessment of accident likelihood or other dangerous events during work and for determining their potential consequences. The Five Steps Method, while based on different assumptions, is also a useful tool, enabling a quantitative assessment of occupational risk and considering additional parameters that influence the assessment outcome.

The article aims is to analyze occupational risk using the Preliminary Hazard Analysis (PHA) and Five Steps Method for an operational employee performing a selected repair operation on a car within a chosen research facility.

2. Methods

The research subject is an automobile service center. Throughout the year, they repair between 700 and 1000 vehicles. The technological process, in terms of continuous improvement, depicted in Figure 3, concerns specific tasks performed by an automotive panel beater during their work. Each procedure requires the correct body posture, adherence to occupational health and safety (OHS) rules, as well as caution when using the provided tools and equipment.

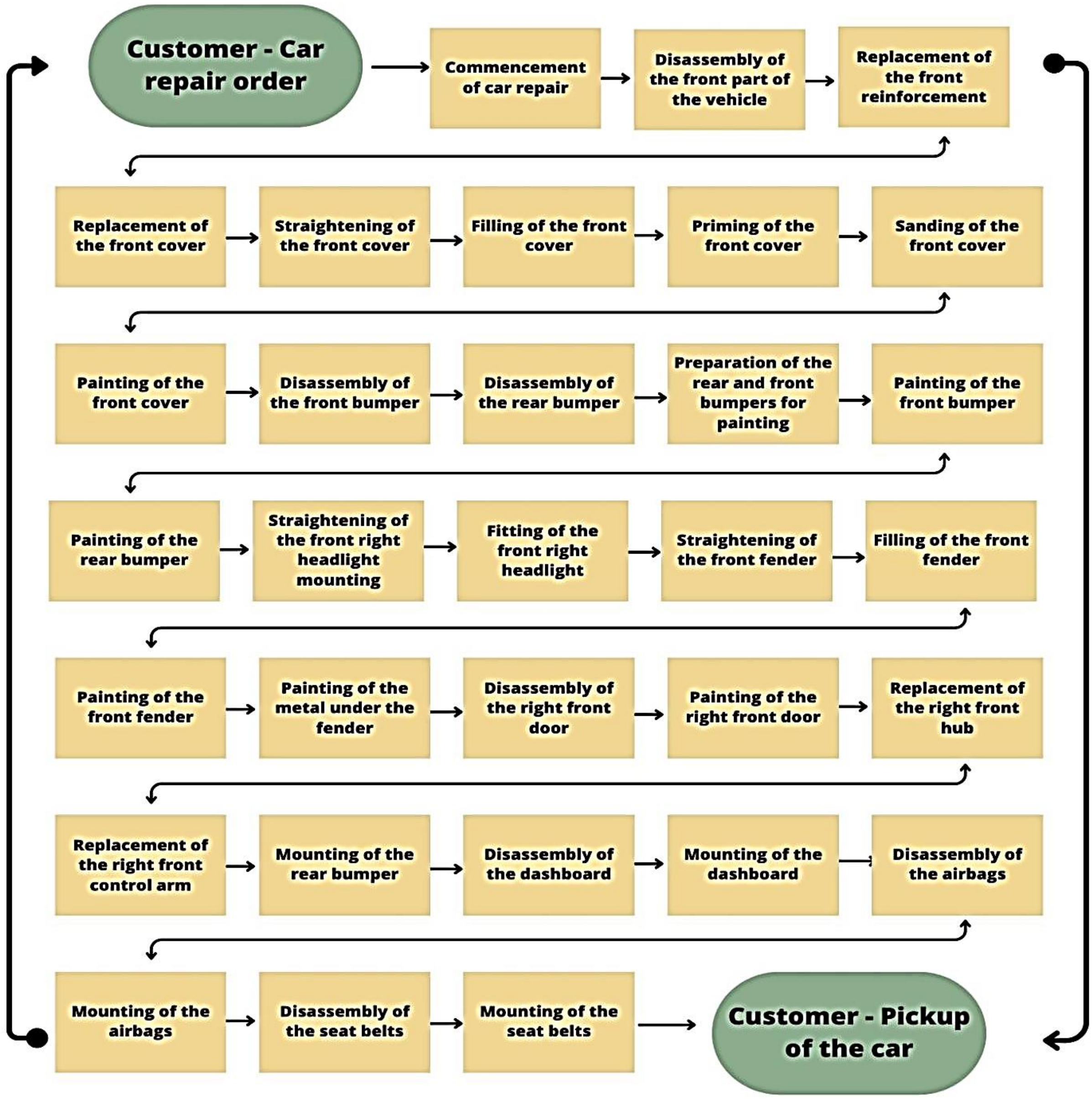

Figure 3. Simplified diagram of Deming Cycle about the technological process.

Source: Own work.

The technological process consists of various repair operations on the vehicle, starting from the customer's request and repair order to the final handover. During the execution of each task, the employee faces multiple hazards, making it crucial to adhere to OHS and ergonomic principles. The car repair process begins with disassembling the front part of the vehicle, followed by the replacement of the front reinforcement and hood. The hood undergoes operations like straightening, puttying, priming, sanding, and painting. It is essential to use proper protective clothing and paint masks during sanding and painting to prevent inhalation of harmful substances contained in the dust. Subsequent steps involve disassembling and painting the front and rear bumpers, straightening the right front headlight mount, and fitting the headlight. Straightening operations are also performed on the fender, followed by puttying and painting. The right front door is disassembled and painted. The repair process then continues with the replacement of the right front wheel hub and suspension arm, as well as the installation of the rear bumper. Afterward, the dashboard, airbags, and seat belts are disassembled and reinstalled, all within a continuous improvement cycle.

An automotive panel beater performs various production, repair, modernization, and prototype tasks involving shaping and processing sheet metal and profile sections for the automotive industry. They use specialized machinery, tools, and equipment, both manually and mechanically operated, often with control mechanisms and measurement devices (Kopańska, Chmieliński, Wierczuk, 2002).

Physical Hazards:

- Poor lighting can lead to deteriorated vision, fatigue, and headaches.
- Noise from using electric and pneumatic tools, such as a pneumatic sander.
- Infrared and ultraviolet radiation during the finishing process, particularly during drying and curing.
- Vibrations are generated by using sheet metal equipment, like a mechanical compressor.
- Electric current poses a risk of shock when using electric tools.

Chemical Hazards:

- Chemical substances present in paints, solvents, and mixtures can negatively affect health, leading to poisoning, allergies, and potentially severe conditions like cancer or skin diseases.
- Dust, including hydrochloric acid fumes and zinc oxide, is produced during sheet metal processing, depending on the materials used.

Ergonomic Hazards:

- Work posture is often forced into a bent position due to the nature of tasks, such as welding.
- Musculature strains from lifting heavy vehicle parts.

Hazards Leading to Accidents:

- Malfunctioning electric hand tools, lack of concentration on routine tasks, or using defective electrical equipment.
- Welding fragments without protective eyewear and gloves.

- Crushing risks due to faulty car frame pulling equipment.
- Burns caused by inappropriate protective clothing while using electric welders and grinders (Centralny Instytut Ochrony Pracy, 2021).

The analysis focuses on specific workstations within the automotive repair process, as depicted in Figures 4 and 5.

Figure 4. Paint Booth.

Source: Own work.

Figure 5. Car Preparation Zone for Painting.

Source: Own work.

In Figures 6-9, devices used during the repair of motor vehicles are presented. Before using any of them, it is important to ensure that the respective machine is in working order, as even a minor malfunction can lead to undesirable consequences.

Figure 6. Car Frame Straightening Machine.

Source: Own work.

Figure 7. Computer Operating the Car Frame Straightening Machine.

Source: Own work.

Figure 8. Sheet Metal Welder.

Source: Own work.

Figure 9. Welding Machine.

Source: Own work.

3. Results

Preliminary Hazard Analysis (PHA) - A semi-quantitative analysis conducted to identify all potential hazards and dangerous incidents that could lead to an accident. Subsequently, these hazards are prioritized according to their severity, and follow-up actions are developed. During this analysis, several variations of PHA are employed, including Rapid Risk Ranking and Hazard Identification (HAZID) (Ergonomia i ochrona..., 2009). PHA is a matrix-based method aimed at qualitatively determining risk associated with serious events, unforeseen situations, and hazards. This method allows for assessing the possibility of an accident occurring during a specific task and the consequences of an undesirable event. PHA results are used to compare major concepts, focus on critical risk issues, and provide input for more detailed risk analyses.

The magnitude of risk in the PHA method can be determined using the formula:

$$R = S \cdot P \tag{1}$$

where:

R - the magnitude of risk,

S - determining the magnitude of possible starts and damages,

P - determining the probability of damage or loss occurring as a result of an accident (https://ergo-plus.com/…).

The characteristics of damages and probabilities in the PHA method can be determined using six levels as described in Table 1.

Table 1.
Determination of Damage Magnitude (S) (Alli, 2008)

Level	Description of Damage
1.	Minor damage, minor injuries
2.	Severe injuries, measurable damage
3.	Severe injuries, significant damage
4.	Individual fatal accidents, severe damage
5.	Mass fatal accidents, extensive damage on the facility premises
6.	Mass fatal accidents, extensive damage on a large scale off-site

Table 2 presents the probability of damage occurrence.

Table 2.
Probability of Damage Occurrence (P) (Alli, 2008)

Level	Description of the Probability of Damage Occurrence
1.	Very unlikely
2.	Unlikely, occurring once every 10 years
3.	Occasional events, happening once a year
4.	Fairly frequent events, happening once a month
5.	Frequent, regular events happening once a week
6.	High likelihood of occurrence

Table 3 presents the risk assessment matrix using the PHA method.

Table 3.
Risk Assessment Matrix using the PHA Method (Alli, 2008)

	P - Probability of Damage Occurrence						
S - Damage	**Level**	**1**	**2**	**3**	**4**	**5**	**6**
	1	1	2	3	4	5	6
	2	2	4	6	8	10	12
	3	3	6	9	12	15	18
	4	4	8	12	16	20	24
	5	5	10	15	20	25	30
	6	6	12	18	24	30	36

Values 1-3 - Acceptable - only actions based on the regulation and management principles of critical and safety-related systems are considered. Values 4-9 - Acceptable - the application of regulation and management principles of critical and safety-related systems and consideration of further research. Values 10-25 and higher - Unacceptable - risk-reduction measures are required. Risk assessment using the PHA method for an automotive sheet metal worker during the process of pulling the car onto the repaired frame involves the potential threat of chain breakage.

1. Calculating the risk magnitude using formula (Alli, 2008), using data from tables (Identifying and Addressing…, 2021) and (Szlązak, Szlązak, 2010).

   $R = S \cdot P$

   S = 4 (Individual fatal accidents, severe damage).

   P = 3 (Occasional events, happening once a year).

   Risk Magnitude:

   $R = S \cdot P = 4 \cdot 2 = 8$

2. Evaluation of Risk Level.

   The risk assessment yielded a score of 8, indicating an acceptable level of risk.

If the risk were to exceed the acceptable threshold in this case (9<), additional training for the workers would be necessary. Operating such equipment is one of the fundamental tasks in sheet metal work, so considerations extend to interns and those who are new to the profession.

Five-Step Method

The five-step method is a qualitative and index-based risk assessment approach.

Using formula 2, it is possible to calculate risk in the Five-Step Method:

$$R = P \cdot S \cdot F \cdot L \qquad (2)$$

where:

R – risk magnitude,

S – determination of the magnitude of potential losses and damages,

P – probability of occurrence of damage or loss following an accident,

F – frequency of exposure,
L – number of exposed individuals.

The data provided in Tables 4-8 allow for the determination of risk magnitude.

Table 4.
Determination of the Probability of Damage or Loss Occurrence (Alli, 2008)

Value	**Characteristic**
0,033	Almost impossible
1,0	Very unlikely but possible
1,5	Very unlikely but possible
2,0	Possible but uncommon
5,0	Even chance
8,0	Likely
10,0	Occurs
15,0	Certain

Table 5.
Determining the magnitude of potential losses and damages (S) (Alli, 2008)

Value	**Characteristic**
0,1	Scratches, bruises
0,5	Cuts, minor injuries
2,0	Simple fractures, mild illness
4,0	Complicated fractures, serious illness
6,0	Loss of one limb, loss of an eye, permanent hearing loss
10,0	Loss of two limbs, loss of both eyes
15,0	Death

Table 6.
Exposure Frequency (F) (Alli, 2008)

Value	**Characteristic**
0,5	Once a year
1,0	Once a month
1,5	Once a week
2,5	Once a day
4,0	Hourly
6,0	Continuous

Table 7.
Number of Exposed Individuals (L) (Alli, 2008)

Value	**Characteristic**
1	1-2 individuals
2	3-7 individuals
4	8-15 individuals
12	16-50 individuals

By utilizing the data provided in the tables and appropriately assigning them to the formula, one can determine the magnitude of risk.

Table 8.
Risk Magnitude (R) (Alli, 2008).

Value	Characteristic
0-5	Negligible
5-50	Low, but negligible
50-500	High
Above 500	Unacceptable

Risk Assessment Using the Five-Step Method for an Automotive Sheet Metal Worker During Welding of Components That May Lead to Battery Short-Circuiting. The Potential Hazard Is a Vehicle Fire.

1. Calculating the risk magnitude using formula (2), taking data from tables 4-8.

$$R = P \cdot S \cdot F \cdot L \quad (2)$$

where:
P = 1 (Event possible but not daily),
S = 15 (Battery short-circuit could lead to an explosion and result in death),
F = 1.5 (Welding might be performed several times a week but not daily due to the nature of the damage),
L = 2 (Applies to all individuals in the service area).

2. Risk Magnitude.

$R = 1 \cdot 15 \cdot 1{,}5 \cdot 2 = 45$

4. Assessment of Risk Level

The risk assessment yielded a score of 45, indicating that the risk is negligible.

In this case, the risk falls below the threshold, signifying that the risk is negligible. However, it's important to remember that during each welding operation, protective devices must be connected to shield the vehicle's electronics from localized power surges.

All of these tasks involve various hazards, including poisoning, joint stress, injury, or even crushing of body parts. Therefore, it's crucial to exercise extreme caution and remain focused while performing each of these operations.

5. Discussion & Summary

This work focused on a detailed analysis of occupational risk using two methods: Preliminary Hazard Analysis (PHA) and the Five-Step Method. These methods were used to assess the risk levels for selected operations in the role of an automotive panel beater. Based on the results, the risk level was determined to be acceptable in both cases, with a risk score of 8 in the first example and 45 in the second. If the risk level were to exceed the acceptable threshold, immediate risk reduction measures, including the implementation of new safeguards and protective measures, would be necessary.

Every employer should prioritize occupational risk assessment, as they bear the highest responsibility for human lives. Adhering to workplace safety and hygiene principles, as well as ergonomic principles, is crucial and the responsibility of the employer. If the risk during a job reaches a high level, employees have the right to refuse to perform their assigned tasks and to leave the workplace without facing any consequences. It's also essential to remember that while the employer is responsible for workplace safety and hygiene, employees must follow all regulations for their well-being. Therefore, reminding employees of all applicable rules at each step in the workplace is essential.

Preliminary Hazard Analysis (PHA) allows for precise result development and risk level determination, making it one of the most frequently used methods for occupational risk assessment, well-documented in the literature.

References

1. Alli, B.O. (2008). *Fundamental Principles of Occupational health and safety.* Geneva: ILO, p. 7.
2. *Ergonomia i ochrona pracy (Ergonomics and Occupational Safety)* (2009). Skrypty uczelniane wydawnictwa AGH Kraków. Uczelniane Wydawnictwa Naukowo-Dydaktyczne.
3. Grzenkowicz, N., Kowalczyk, J., Kusak, A., Podgórski, Z., Ambroziak, M. (2008). *Podstawy funkcjonowania przedsiębiorstw (Foundations of Business Operations).* Warszawa, p. 12.
4. Hambali, A., Sapuan, S.M., Ismail, N., Nukman, Y. (28.11.2021). *Material selection of polymeric composite automotive bumper beam using analytical hierarchy process.*
5. Hazard, J. (2002). *Analysis - OSHA 3071*, pp. 5-6.
6. https://drdigitalbazaar.com/what-is-entrepreneurshipPublisher, 7.12.2021.
7. https://ehealthresearch.no/files/documents/Appendix-Definitions.pdf, 10.11.2021.
8. https://ergo-plus.com/fundamental-ergonomic-principles/, 8.11.2021.
9. *Identifying and Addressing Ergonomic Hazards Workbook* (2021). Midwest Worker Center Ergonomic Training Project.
10. Jastrzębska, U. (2021). *Organizacja i nadzorowanie obsługi pojazdów samochodowych (Organization and Supervision of Motor Vehicle Service).* Wydawnictwa Komunikacji i Łączności WKŁ.

11. Kopański, J., Chmieliński, B., Wierczuk, E. (2002). *Modułowy program nauczania – Blacharz samochodowy, 721(03) (Modular Curriculum - Automotive Sheet Metal Worker, 721(03)).* Warszawa.
12. *Międzynarodowa karta charakterystyki zagrożeń zawodowych – Blacharz samochodowy (International Hazardous Materials Data Sheet - Automotive Sheet Metal Worker)* (28.11.2021). Centralny Instytut Ochrony Pracy, Państwowy Instytut Badawczy.
13. *Model systemu zarządzania BHP wg polskich norm serii PN-N-18000 (Model of Occupational Health and Safety Management System According to Polish Standards PN-N-18000 Series)* (2021). Centralny Instytut Ochrony Pracy, Państwowy Instytut Badawczy.
14. Norma PN-N-18001:2004 System zarządzania bezpieczeństwem i higiena pracy. Wymagania (*PN-N-18001:2004 Standard - Occupational Health and Safety Management System. Requirements*).
15. Norma PN-N-18002:2000 System zarządzania bezpieczeństwem i higiena pracy. Ogólne wytyczne do oceny ryzyka zawodowego (*PN-N-18002:2000 Standard - Occupational Health and Safety Management System. General Guidelines for Occupational Risk Assessment*).
16. Pietrzak, L. (2007). *Karta oceny ryzyka zawodowego* (*Occupational Risk Assessment Card),* pp. 1-3.
17. *Podstawy prawne* (*State Labour Inspectorate* - *Legal Basis*) (2021). Państwowa Inspekcja Pracy.
18. Rausand, M. (2021). *Preliminary Hazard Analysis.* Department of Production and Quality Engineering, Norwegian University of Science and Technology.
19. Romanowska-Słomka, I., Słomka, A. (2014). *Zarządzanie ryzykiem zawodowym* (*Occupational Risk Management.* Torbanus, pp. 11-18.
20. Sudoł, S. (2006). *Przedsiębiorstwo (Enterprise).* Warszawa: PWE, p. 36.
21. *System BHP w Polsce (Occupational Health and Safety System in Poland)* (2021). Centralny Instytut Ochrony Pracy, Państwowy Instytut Badawczy.
22. Szlązak, J., Szlązak, N. (2010). *Bezpieczeństwo i higiena pracy* (*Occupational Safety and Health*). Kraków.
23. Todor, M.- P. (2018). *Systematic approach on materials selection in the automotive industry for making vehicles lighter, safer, and more fuel–efficient*. Romania: Imre Kiss University, University Politehnica Timisoara, Faculty of Engineering Hunedoara. Retrieved from: http://article.sapub.org/10.5923.j.ijme.20180803.02.html
24. Wykowska, M. (1994). *Ergonomia jako nauka stosowana* (*Ergonomics as an Applied Science*). Kraków: AGH.