MPPKI (October, 2024) Vol. 7 No. 10

ISSN 2597– 6052

DOI: https://doi.org/10.56338/mppki.v7i10.6174

MPPKI

Media Publikasi Promosi Kesehatan Indonesia

The Indonesian Journal of Health Promotion

Review Articles *Open Access*

Risk Factors for Work Fatigue in Welding Workers in the Oil and Gas Industry: Literature Review

Ridho Pradana Mahaputra[1]*, Baiduri Widanarko[2]

[1]Fakultas Kesehatan Masyarakat Universitas Indonesia | email: Pradana.best@gmail.com

[2]Fakultas Kesehatan Masyarakat Universitas Indonesia | email: baiduri@ui.ac.id

* Corresponding Author: Ridho Pradana Mahaputra | Pradana.best@gmail.com

ABSTRACT

Introduction: Welding workers in the Oil and Gas Industry are often exposed to heat sources such as sunlight and welding machines, especially when working outdoors. The welding process involves cutting, heating, grinding, joining, painting, and sanding, which can lead to significant fatigue, impacting their health and safety.

Objective: Workers who do welding are often exposed to heat sources, including sunlight and heat from welding machines because some employees do welding outdoors. Cutting iron, heating, grinding, joining, painting, and sanding are steps in the welding process carried out in a work environment exposed to sunlight. Thus, is fatigue a risk for welding workers in the Oil and Gas Industry. This study aims to determine the level of risk of causing work fatigue in welding workers in the Oil and Gas Industry.

Method: This study is a systematic literature review using the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta Analyses) method. Literature searches were obtained from Google Scholar, Science Direct, and Neliti Jurnal. The keywords "risk of causing work fatigue" and "Risk of Causing Work Fatigue" and "work fatigue in welding workers" and "work fatigue in welding workers" were used in articles published from 2019-2023. with international journal rankings Q1 and Q2.

Result: A total of 105 articles were found, but only 16 articles were suitable for use after going through an elimination process that was adjusted to the research topic, passed duplication, and could be accessed in full. There are four risk factors for work fatigue in welding, namely, too much work, lack of time, conflict with welding workers, and the nature of ambiguity in each worker.

Conclusion: This finding is useful for knowing the risk factors for work fatigue in welding workers, there are four factors, namely, too much work, lack of time, conflict with welding workers, and the nature of ambiguity in each worker. To reduce the risk at work is by socializing related to occupational safety and health, increasing awareness of the importance of health and safety for workers with the aim of creating safe working conditions and ensuring occupational safety and health.

Keywords: Health and Safey; Oil and Gas Industry; Welding; Work Fatigue

INTRODUCTION

In industries with significant safety risks, fatigue at work can pose dangers and lead to workplace accidents resulting in fatalities. This occurs due to decreased performance caused by fatigue, which is likely to increase the likelihood of safety issues in the work environment. Fatigue in the workplace is a complex condition with several causes and manifests in various ways. Many variables, both personal and environmental, contribute to fatigue during work [1].

According to the Occupational Safety and Health Administration (OSHA), fatigue is a primary cause of accidents in the agro-industrial sector. In the agro-industrial sector alone, it is estimated that 34% of lost work hours are related to fatigue, and workers' compensation is often used to address this issue [2]. According to European OSHA, fatigue is the most pressing problem in the agro-industrial sector, with one in four employees reportedly complaining about it in the workplace [2].

Data from the Social Security Administering Agency (BPJS Ketenagakerjaan) in Indonesia records the number of work accidents in 2015 at 105,182 cases, including 2,375 cases of serious accidents. This data accounts for at least 32% of work accidents, particularly in the construction welding sector, which is closely related to the level of awareness and behavior of workers regarding the use of personal protective equipment (PPE). Based on hazard findings in companies in Indonesia, 66% of workers have suffered eye injuries due to not using eye protection [3].

The Law of the Republic of Indonesia Number 1 of 1970 serves as the legal basis for occupational safety in Indonesia. This law discusses the rights and obligations of workers and the safety requirements that must be implemented in every company. Another related law is Law No. 13 of 2003 concerning manpower, where Article 86 states that every organization must implement occupational safety and health efforts to protect worker safety. Article 87 states that every company is required to have an integrated Occupational Health and Safety Management System (SMK3) that aligns with other management sections of the company [4].

Workers often overlook fatigue, which is unfortunate because it is related to the protection of worker health. Workplace fatigue can affect workers' ability to perform their jobs and lead to physical and psychological illnesses. It can also impact workers' overall health [5][6].

Based on initial observations conducted in the oil and gas industry, the working conditions present risks of workplace accidents due to worker fatigue, such as exposure to welding sparks, eye irritation, skin injuries, and exposure to welding light, among others. In such conditions, many welders report fatigue after performing tasks related to their work, which may affect employee efficiency. Evidence has been gathered regarding employee performance, which often varies, especially in the welding department, through conversations with the company. Additionally, there are still many welding results that do not meet standard requirements, such as defects or imperfections in welding, where the work is not performed according to established standards or based on ANSI, ASME, ASTM, AWS, ISO standards, and so forth [7].

METHOD

This study employs the "PRISMA" (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) methodology, beginning with a literature search using the Science Direct search engine. The next step involves screening, which includes selecting titles, abstracts, publication years, and the research methods used. For the articles that have been screened, a quality assessment (feasibility) of the data is conducted based on full-text articles that meet the inclusion and exclusion criteria.

The inclusion criteria for this study are: journals related to risk factors for musculoskeletal disorders among healthcare workers, literature published in the last five years (2019–2023), quantitative research methods, and articles published in international journals ranked Q1 and Q2. The exclusion criteria used in this study are research published before 2019 and research with unclear methodologies.

The data sources for this study are derived from literature found through internet searches in the Science Direct database. The keywords used were “risk of causing work fatigue,” “work fatigue,” and “work fatigue in welding workers.” The search results from 2019 to 2023 yielded a total of 5,657 journals. The articles selected for this study consist of 16 journals concerning risk factors related to the causes of work fatigue among oil and gas welding workers.

RESULTS

The search results from 2019 to 2023 yielded a total of 5,657 journals. The articles selected for this study consist of 16 journals concerning risk factors related to the causes of work fatigue among oil and gas welding workers. Below is the list of selected journals related to the risk factors for work fatigue among industrial oil and gas welding workers.

No	Authors	Title	Method	Instruments	Results
1.	Mariani Juliana, Anita Camelia, Rahmiwati. et.,al., (2018)	Analysis of Risk Factors for Work Fatigue Among Employees in the Production Department at PT. Arwana Anugrah Keramik, Tbk	This study uses an analytical research method with a cross-sectional approach. The sampling technique involved obtaining a sample of 75 individuals.	Primary data collection was conducted using questionnaires, while secondary data was gathered through documentation studies. Data processing techniques employed the Chi-Square analysis method.	Factors associated with work fatigue among employees in the production department at PT. Arwana Anugrah Keramik, Tbk include anemia status, work shifts, sleep quality, workload, and hot working conditions, with a p-value of 0.793.
2.	Muhammad Farrel Bramantyo. Et., al., (2020)	Analysis of Factors Causing Work Fatigue Using the Subjective Self-Rating Test Method (Case Study: Employees in the Production Floor at PT. Marabunta Berkarya Ceperindo)	The characteristics of this study are descriptive research using a quantitative approach.	The research instruments used statistical tests, namely the Reliability Test and Spearman Correlation Test.	External factors that can trigger work fatigue among production floor workers at PT. Marabunta Berkarya Ceperindo include physical factors such as air temperature and lighting levels, as well as ergonomic factors such as work posture.
3.	Mohammad Husein (2022)	The Relationship Between Worker Factors and Welding Light Intensity With Eye Fatigue Among Workers	This study is a quantitative descriptive research. The sample for this study consists of 132 workers.	This study uses a cross-sectional approach as its research instrument.	The intensity of welding light has the most dominant relationship with eye fatigue among workers at PT. MTI, Balaraja - Tangerang, where high welding light intensity poses a risk of fatigue, with a p-value of 0.026.
4.	D. Okumus (2023)	The Impact of Fatigue on Health, Occupational Safety, and Performance of Shipyard Welding Workers	The welding samples were evaluated by three expert naval architects, with an average field experience of 18 years.	Using the Discrete Event Simulation instrument (Rockwell ARENA).	This approach is applied to two case studies to demonstrate the impact of fatigue in manual gas welding operations. As part of this research, a hypothesis test was first established to examine the effects of short-term fatigue.
5.	Suheri Jumartika., et.,al.,	Risk Analysis for Welding Workers at PT. Industri	The type of research used is a quantitative approach employing	Using analytical observational instruments and a cross-sectional study design.	The relationship at PT. Industri Kapal Indonesia (Persero) is positive and can be interpreted as having a very strong

		Kapal Indonesia (Persero) in Makassar City.	analytical observational methods with a cross-sectional study design. The sample for this study consists of 50 workers from PT. Industri Kapal Indonesia (Persero) in Makassar in 2020.		relevance. From these research results, it is hoped that the company will pay more attention to the working conditions, particularly in the welding environment within the production area. The results of this study indicate that the human aspect ($p = 0.072 > \alpha = 0.05$), the work equipment aspect ($p = 0.423 > \alpha = 0.05$), and the working environment aspect ($p = 0.002 < \alpha = 0.05$).
6.	Mulyadi., et., al (2018)	Analysis of Factors Causing Worker Losses at PT. Makanan Saba Mandiri Terbaik in Makassar.	The design of this study is analytical with a cross-sectional study approach. The sample for this study consists of 61 production workers.	The testing instrument used is the Chi-Square test.	Management of the environment and the workers themselves is essential to address worker fatigue. This can be achieved by effectively and correctly implementing environmental risk management, such as arranging room layouts and assigning tasks according to the age and tenure of the workers, with a p-value of 0.375.
7.	Stefani Avelliana Megaranti., et., al. (2022)	Analysis of Risk Factors for Fatigue Complaints Among BRT (Bus Rapid Transit) Drivers at Transjakarta in 2022.	This study is a quantitative research with a descriptive analytical design. The sample consists of 124 BRT drivers.	Data analysis was conducted using bivariate analysis with the Chi-Square test and multivariate analysis with logistic regression.	The variables of BMI, age, and sleep quantity have a significant relationship with fatigue. The most dominant work factor influencing fatigue is workload, although no significant relationship was found.
8.	Made Adhyatma Prawira Natha Kusuma., et., al. (2022)	Analysis of Risk Factors for Fatigue Among Young Workers in Construction Projects at PT. ABC	The study design of this research is a cross-sectional study. The sample for this research involves 212 young workers.	Data were analyzed univariately to describe the frequency distribution and percentage of each variable.	There is fatigue among young workers in the construction sector under conditions that pose a critical risk for workplace accidents.
9.	Haslinda., et.,al (2023)	Analysis of Fatigue and Work Stress Levels Using the Subjective Self-Rating Test (SRRT) Method	The method used is a quantitative approach. The sample consists of 10 respondents.	The assessment of fatigue levels is conducted subjectively using the Subjective Self Rating Test (SSRT) questionnaire.	During breaks, operators should engage in stretching exercises to reduce feelings of boredom and monotony while working. Getting into the habit of taking breaks frequently, around 5-15 minutes every 1-2

		Among Welding Operators			hours, is sufficient to reduce fatigue, improve productivity, and decrease the risk of accidents, especially in monotonous jobs.
10.	Sallehedine Bendak (2020)	Fatigue in aviation: A systematic review of the literature	This study, which takes both academic and industrial perspectives, aims to examine the causes, consequences, measurement, and mitigation of fatigue and related risks in aviation operations through a systematic literature review.	This research relies on a systematic insight into published scientific literature regarding fatigue in aviation, primarily based on the Preferred Reporting Items for Systematic Review and Meta-Analyses (PRISMA) guidelines.	Fatigue resulting from reduced sleep duration is one of the most frequently used paradigms to explain the relationship between long working days, shift work, work stress, and decreased sleep time.
11.	Xiaoting Fan (2023)	Investigation and analysis of the safety risk factors of aging construction workers	The method used is the Analytic Hierarchy Process (AHP) to evaluate the impact of worker aging in construction on safety risk factors. The sample for this study consists of 100 indices.	The instrument in this study uses the Analytic Hierarchy Process (AHP), which is adopted for quantitative analysis.	For a construction company and government regulatory departments, it is essential to formulate policies and actions, such as classifying jobs for elderly workers based on various ages and conditions that limit high-risk work.
12.	Nur Fatihatul Faeda (2023)	Health Hazard Analysis for Welders	This study uses questionnaires and interviews.	The research instrument uses the Nordic Body Map.	During the welding process, light and radiation are generated that can be hazardous to welders and other workers nearby. This light includes visible light and other types of radiation.
13.	Ainnaya Natin Ristanti., et.,al., (2023)	Factors Related to Complaints of Visual Function Decline Among Welders in the Kedaung Kali Angke and Kapuk Areas, Cengkareng District, West Jakarta	This study employs a quantitative method with a cross-sectional design. The sample for this research consists of 59 individuals from 15 workshops located in the Cengkareng District, West Jakarta.	The instrument testing uses validity testing methods.	Recommendations for the low use of personal protective equipment (PPE) among workers include requiring workshop owners to provide appropriate and suitable PPE based on needs, educating workers, and ensuring that they adhere to proper PPE usage. Statistical tests indicate a relationship between age (P-value = 0.004) and length of service (P-value = 0.020).

14.	Setyo Riyadi, (2021)	Factors Causing Work Fatigue Among Workers at PT. Dungo Reksa in Minas	This research employs a quantitative method with a cross-sectional study design. The sample for this study includes all workers at PT. Dungo Reksa in Minas, totaling 53 individuals.	Univariate analysis is conducted to describe the characteristics of each variable being studied.	Implementing workload distribution ensures that the workload is not concentrated in one group, or transitioning to an automated system. For workers reaching a certain age, early retirement options can be offered with compensation. The p-values are as follows: age (p-value = 0.491), workload (p-value = 0.026), and length of service (p-value = 0.257).
15.	Oktriansyah(2021)	The Relationship Between Welding Activities and Eye Fatigue Complaints Among Welders at PT. X in Citeureup Village, Bogor Regency, 2019	This study is an analytical type of research, employing a cross-sectional approach. The population includes all welders at PT. X, with a sample size of 32.people.	-	It is recommended that workers rest their eyes briefly after welding to reduce the risks associated with their work and to use personal protective equipment while working. The company should frequently remind and reprimand workers who do not wear personal protective equipment during their tasks. The analysis results obtained are as follows: • Relationship between Age and Eye Fatigue Complaints (p=0.000) • Relationship between Knowledge (p=0.413) • Relationship between Attitude (p=0.021) • Relationship between Exposure Duration (p=0.892) • Relationship between Rest Activities (p=0.361) • Relationship between Personal Protective Equipment (p=0.021)

					• Relationship between Type of Work (p=1.000)
16.	Dinda Arsyah Febriana (2023)	Analysis of Risk Factors for Work Fatigue Among Couriers at PT Tiki Jalur Ekakurir (JNE) in Pondok Gede District, Bekasi City, 2022	This study employs a cross-sectional design using quantitative methods. The sample in this study consists of 31 individuals.	The research instrument uses the Subjective Self Rating Test (SSRT) questionnaire.	Based on individual factors, fatigue is experienced by respondents aged less than 35 years, with insufficient sleep quantity, poor sleep quality, excess nutritional status, a habit of having breakfast, and mild fear of COVID-19.

DISCUSSION

Based on the literature review above, it is found that one of the causes of workplace accidents is the inadequate implementation and supervision of safety and fatigue management overall. Continuous efforts to improve workplace safety are necessary to prevent accidents and occupational diseases. If workplace safety is well implemented, workplace accident cases can be minimized, and unnecessary costs arising from such cases can be avoided, resulting in a safe, comfortable, and healthy work environment, as well as increased productivity.

Welding has many potential hazards, with the highest risks being the inhalation of welding fumes, sparks hitting flammable materials or gas cylinders, the presence of hydrogen gas in enclosed welding areas, falls/slips from heights, and other high-risk hazards. Other risks associated with welding activities include electric shock, burns from sparks, heat exposure in enclosed spaces, being struck by materials, punctured by sharp materials, hand injuries, falls, explosions or fires, fatalities, injuries/fainting, dehydration, cuts on the hands, and burns.

As stated in the research by [7], work fatigue is one of the health and safety issues that can become a risk factor for accidents at work. Fatigue can be caused by several factors, both internal and external. In line with the research by [8], it is mentioned that welding is a risky job that can lead to eye fatigue, endangering workers. Welders are constantly exposed to various risks and work fatigue. [9] states that the factors influencing fatigue are divided into internal and external factors. Internal factors include age, nutrition, psychology, and work attitude, while external factors include work shifts, work duration, work climate, and workload. A high workload is not matched with appropriate work shifts per SOP. Fatigue can also occur due to fluctuating work climates. Work fatigue is often interpreted as a process of declining efficiency, work performance, and reduced physical strength/stamina to continue the required tasks.

Faedah et al. [10] state in their research that the use of modern equipment will facilitate the production process and worker productivity. However, it also increases the risk to workplace safety and health. Welding work contains many hazards and risks for workplace accidents and occupational diseases. This work involves the use of welding tools that generate potential hazards, including fumes, radiation (welding radiation), noise, electrical hazards, electric fields, magnetic fields, fire and explosion hazards, and others. All conditions that may pose hazards can lead to respiratory problems, eye pain, or even blindness. Related to the research by [11], workers exposed to physical environments (temperature, noise, lighting) exceeding the Threshold Limit Value (TLV) are at risk of experiencing work fatigue. Fatigue is a condition of reduced body efficiency that can affect work productivity and result in workplace accidents.

Haslinda et al. [5] indicate in their research that work fatigue and work stress are issues in occupational health. Work fatigue and work stress can lead to illnesses and workplace accidents. Factors associated with work fatigue include job-related factors and individual factors. Job-related factors include the heaviness of the work, stress in the job, working hours, working conditions, and monotonous tasks, while individual factors include age, education level, gender, and sleep quality. Work stress can lead to increased risks of workplace accidents, poor performance, and judgment errors. As a result, stress decreases workers' well-being and quality of life.

Kusuma et al. state that [2] fatigue is a consequence of work that decreases both physical and mental work capacity and is one of the contributing factors to accidents in the construction field. Fatigue can occur among workers

of various age ranges, including young workers aged 15-24 years. Observations of workers show that the majority do not use personal protective equipment (PPE), particularly eye protection such as welding goggles or shields [12]. From statistical tests on several factors triggering fatigue, it was found that work experience (years) has a significant relationship with worker fatigue ($p = 0.04$), worker age significantly relates to worker fatigue ($p = 0.046$), room temperature significantly relates to worker fatigue ($p = 0.014$), and workers' attitudes while working significantly relate to fatigue ($p = 0.014$). However, humidity does not significantly relate to worker fatigue ($p = 0.375$). Riyadi et al. [9] state that the research shows that 21 respondents (65.5%) did not wear eye protection while welding. This is because some operators still do not use standard work tools, such as only wearing regular sunglasses while welding, and there is still a lack of supervision by supervisors in the field [13].

Megaranti [14] states that the categorization of fatigue complaints uses a cutoff value of 1.04 from the values of all study respondents. Based on the cutoff point, values greater than or equal to 1.04 indicate fatigue, while values less than or equal to 1.04 indicate no fatigue. In relation to the research by Dinda et al. in 2023 [15], the factors of work fatigue from test results show that 51.6% (16 people) experience moderate fatigue, 35.5% (11 people) experience mild fatigue, and 12.9% (4 people) are not fatigued. Moderate fatigue tends to occur with excessive working hours (39.3%), low workload (75%), adequate rest (45%), daytime work shifts (41.7%), work experience > 5 years (47.1%), long commuting time (57.1%), satisfaction with the reward system (45%), satisfaction with the incentive system (47.4%), age ≤ 35 years (37.9%), sleeping less than 7 hours (53.8%), excessive nutrition status (40%), and mild fear of COVID-19 (40%).

Analysis of Risk Factors for Work Fatigue Among Oil and Gas Industry Welders

Fatigue is influenced by various aspects, including:

Age

The performance of body parts declines with age due to ongoing organ degeneration. Older workers become more fatigued as their organs become less effective [16].

Gender

Every month, the physical mechanics cycle among employees affects the deterioration of the body and psychology, resulting in data showing that men experience fatigue at a lower level than women [16].

Illness

Certain illnesses lead to hypotension or hypertension in bodily organs, irritating the outer layers of tissue and worsening several nerves. Consequently, subsequent stimuli can change the worker's body condition and disrupt or endanger the brain's nerve center [17].

Workload

Activities that use excessive and irrational energy cause muscles to contract, leading to fatigue [17].

Work fatigue is caused by various factors, including:

Excessive Work

A significant accumulation of tasks to complete may result from a lack of skilled workers.

Insufficient Time

It may be unreasonable to allow deadlines for preparing orders. Supervisors often assign new tasks when workers wish to raise complaints.

Role Conflict

The inherent authority associated with specific jobs and functions can lead to conflicts between employees and incumbents in other departments.

Role Ambiguity

Workers may perform tasks that, from a skills and position perspective, should not be done if their job descriptions are unclear.

According to Australian Standard/New Zealand Standard 4360:2004 in [13], hazard identification is a step in the risk management process to identify what causes or may cause failure and how the failure scenarios occur. The identification of hazards among welders involves identifying potential hazards, such as falling from heights, being

punctured by sharp objects, being struck by sparks, and exposure to heat, among others. Observations of the work process and the welding activities with the tools used in the welding process are necessary to identify these hazards [12].

In welding, workers typically perform various positions or work postures and do so over extended periods, such as squatting, bending, or standing. Most workers use static movements or remain in one position for long periods, leading to common complaints of fatigue, stiffness, or pain, especially in the lower back, which is a common issue among welders [8].

Risk Exposure Analysis

After researching exposure risks, which refer to the frequency or duration of a person's exposure to a hazard source in the workplace, the exposure frequency indicates the extent of existing exposure [15]. Occupational safety and health standards are obligations that must be adhered to during the welding process, particularly in companies. To reduce risks for welders, it is essential to promote safety and health practices, raise awareness of the importance of health and safety among workers to create a safe working environment, ensure workers' health, and provide personal protective equipment (PPE), such as earplugs, to prevent accidents during welding in the oil and gas industry.

CONCLUSION

The research conducted using a literature review method on the risk of work fatigue among welders in the oil and gas industry concludes that there are four risk factors for work fatigue among welders. Work fatigue is caused by various factors, including:

Excessive Workload, an excessive accumulation of tasks that must be completed can result from a lack of skilled workers, leading to fatigue in unskilled workers.

Insufficient Time, it may be unreasonable to allocate time for preparing orders. Supervisors often assign new tasks when workers wish to voice complaints. The lack of time for workers to complete their tasks contributes to fatigue; therefore, working time should be better balanced with the workload.

Role Conflict, conflicts inherent in specific jobs and functions can create tensions among workers engaged in their tasks.

Role Ambiguity, workers may perform tasks optimally from the perspective of skills and positions; however, they should not undertake these tasks if their job descriptions are unclear.

SUGGESTION

Suggestions for Reducing Work Fatigue Risks Among Welders in the Oil and Gas Industry: 1) Workload Management: Adjust the workload according to the skills and capacities of workers, and implement job rotation to prevent fatigue. 2) Time Management: Provide sufficient time for workers to complete their tasks and implement more flexible work policies. 3) Role Conflict Management: Establish clear communication to avoid role conflicts and clarify authority and responsibilities. 4$ Clear Job Descriptions: Provide clear job descriptions to prevent confusion and ensure a proper understanding of roles. These steps are expected to help reduce fatigue and improve productivity and workplace safety.

REFERENCES

1. Zetli, S. (2018). PENGUKURAN KELELAHAN KERJA PADA SOPIR ANGKUTAN UMUM DALAM UPAYA MENGETAHUI FAKTOR KECELAKAAN TRANSPORTASI UMUM DI KOTA BATAM. *Jurnal Rekayasa Sistem Industri*, 11-17.
2. Kusuma, M. A. (2022). ANALISIS FAKTOR RISIKO KELELAHAN PADA PEKERJA MUDA DI PROYEK KONSTRUKSI PT. ABC. *Prosiding Forum Ilmiah Tahunan IAKMI (Ikatan Ahli Kesehatan Masyarakat Indonesia)*, 1-10.
3. Zurriyah. (2018). Faktor Yang Berhubungan Dengan Kecelakaan Kerja Pada Bengkel Las Di Bengkel Las Kota Makassar. 761-769.
4. Widajati. (2017). Risk Assessment Pada Pekerja Pengelasan Perkapalan Dengan Pendekatan Job Safety Analisisys. ;5(4):148–157.
5. Haslinda. (2023). INGKAT KELELAHAN DAN STRES KERJA DENGAN MENGGUNAKAN METODE SUBJECTIVE SELF RATING TEST (SRRT) PADA OPERATOR PENGELASAN. *Prosiding Seminar Nasional Teknologi Industri X 2023*, 156-163.
6. Jumartika, S. (2021). ANALISIS RISIKO PADA PEKERJA PENGELASAN DI PT. INDUSTRI KAPAL INDONESIA (PERSERO) KOTA MAKASSAR. *Window Of Publich Health*, 328-338.

7. Juliana, M. (2018). ANALISIS FAKTOR RISIKO KELELAHAN KERJA PADA KARYAWAN BAGIAN PRODUKSI PT. ARWANA ANUGRAH KERAMIK, Tbk. *Jurnal Ilmu Kesehatan Masyarakat, Maret 2018, 9(1):53-63*, 53-63.
8. Husein, M. (2022). Hubungan Faktor Pekerja dan Intensitas Cahaya Las Dengan Kelelahan Mata Pada Pekerja. *Jurnal Ilmiah Universitas Batanghari Jambi*, 339-343.
9. Riyadi, S. (2021). Faktor Penyebab Terjadinya Kelelahan Kerja Pada Pekerja Pt. Dungo Reksa Di Minas. *Jurnal Pengabdian Kesehatan Komunitas*, 32-37.
10. Faedah, N. F. (2023). ANALISIS BAHAYA KESEHATAN PADA TUKANG LAS. *Journal of Innovation Research and Knowledge*, 1-12.
11. Bramantyo, M. F. (2022). ANALISIS FAKTOR-FAKTOR PENYEBAB KELELAHAN KERJA DENGAN METODE SUBJECTIVE SELF RATING TEST (STUDI KASUS: PEKERJA BAGIAN LANTAI PRODUKSI PT. MARABUNTA BERKARYA CEPERINDO). 1-10.
12. Ristanti, A. N. (2023). Faktor-Faktor yang Berhubungan dengan Keluhan Gangguan Fungsi Penglihatan pada Pekerja Pengelasan di Wilayah Kedaung Kali Angke dan Kelurahan Kapuk, Kecamatan Cengkareng Jakarta Barat. *Jurnal Ilmiah Kesehatan Masyarakat*, 1-6.
13. Oktriansyah. (2021). HUBUNGAN AKTIVITAS PENGELASAN DENGAN KELUHAN KELELAHAN HUBUNGAN AKTIVITAS PENGELASAN DENGAN KELUHAN KELELAHAN KABUPATEN BOGOR TAHUN 2019. *Jurnal Mahasiswa Kesehatan Masyarakat* , 259-268.
14. Megaranti, S. A. (2022). Analisis Faktor Risiko Keluhan Fatigue Pada Pramudi BRT (Bus Rapid Transit) Transjakarta Tahun 2022. *NATIONAL JOURNAL OF OCCUPATIONAL HEALTH AND SAFETY (NJOHS)*, 84-98.
15. Febriana, D. A. (2023). Analisis Faktor Risiko Kelelahan Kerja pada Kurir PT Tiki Jalur Ekakurir (JNE) di Wilayah Kecamatan Pondok Gede Kota Bekasi tahun 2022. *NATIONAL JOURNAL OF OCCUPATIONAL HEALTH AND SAFETY (NJOHS)*, 15-26.
16. Fan, X. (2023). Investigation and analysis of the safety risk factors of aging construction workers. *Safety Science*, 1-10.
17. Bendak, S. (2020). Fatigue in aviation: A systematic review of the literature. *Safety Science*, 1-9.
18. ANALISIS TINGKAT KELELAHAN DAN STRES KERJA DENGAN MENGGUNAKAN METODE SUBJECTIVE SELF RATING TEST (SRRT) PADA OPERATOR PENGELASAN. (2023). *Prosiding Seminar Nasional Teknologi Industri X 2023, e-ISSN 2964-1896*, 156-163.