African Journal of Advanced Pure and Applied Sciences (AJAPAS)

Online ISSN: 2957-644X

Volume 2, Issue 3, July-September 2023, Page No: 187-198

Website: *https://aaasjournals.com/index.php/ajapas/index*

||Arab Impact factor 2022: 0.87|| SJIFactor 2023: 5.689|| ISI 2022-2023: 0.557

Occupational Health and Safety, Risk Assessment, and Management in the Machinery Sector

Abduladeem A. A. belkher [1*], Masood A. Masood [2]

[1,2] College of Technical Sciences, Bani Walid, Libya

[*]Corresponding author: blkhiradim@gmail.com

Received: June 16, 2023	Accepted: August 09, 2023	Published: August 14, 2023

Abstract:

The machinery sector plays a vital role in economic development but is also associated with significant occupational health and safety (OHS) risks. This study investigates OHS practices, risk assessment stages, and management strategies in the machinery sector. A comprehensive literature review was conducted to gather relevant information. The study examines hazard identification, risk analysis, and risk evaluation as stages in the risk assessment process. It also investigates management strategies to control and mitigate identified risks. The findings reveal numerous OHS challenges in the machinery sector, including machine-related accidents, exposure to hazardous substances, and ergonomic issues. Proactive measures like safety training programs, guidelines, and personal protective equipment are essential for effective risk mitigation. Overall, this study contributes to existing knowledge on OHS practices and risk assessment in the machinery sector. It provides insights into the risk assessment process and offers practical recommendations to promote a safe and healthy working environment. Implementing these measures can reduce workplace accidents, improve worker well-being, and enhance productivity in the machinery sector.

Keywords: Occupational Health and Safety, Risk Assessment, Risk Management, Machinery Sector.

Cite this article as: A. A. A. belkher, M. A. Masood, "Occupational Health and Safety, Risk Assessment, and Management in the Machinery Sector," *African Journal of Advanced Pure and Applied Sciences (AJAPAS)*, vol. 2, no. 3, pp. 187–199, July-September 2023.

الصحة والسلامة المهنية ومراحل تقييم المخاطر وادارتها في قطاع الآلات

عبد العظيم النقراط عبد النبي بالخير [1*]، مسعود الهيبلو مسعود [2]

[2،1] الهندسة الميكانيكية، كلية العلوم التقنية، بني وليد، ليبيا

الملخص

يلعب قطاع الآلات دورًا حيويًا في التنمية الاقتصادية ولكنه يرتبط أيضًا بمخاطر الصحة والسلامة المهنية OHS. تبحث هذه الدراسة في ممارسات الصحة والسلامة المهنية، ومراحل تقييم المخاطر، واستراتيجيات الإدارة في قطاع الآلات. تم إجراء مراجعة شاملة لدراسات سابقة لجمع المعلومات ذات الصلة. تفحص الدراسة تحديد المخاطر وتحليلها وتقييمها كمراحل في عملية تقييم المخاطر. كما يبحث في استراتيجيات الإدارة للتحكم في المخاطر المحددة والتخفيف منها. تكشف النتائج عن العديد من تحديات الصحة والسلامة المهنية في قطاع الآلات، بما في ذلك الحوادث المتعلقة بالآلة، والتعرض للمواد الخطرة، والقضايا المريحة. تعتبر التدابير الاستباقية مثل برامج التدريب على السلامة والإرشادات ومعدات الحماية الشخصية ضرورية للتخفيف الفعال من المخاطر. بشكل عام، تساهم هذه الدراسة في المعرفة الحالية حول ممارسات

الصحة والسلامة المهنية وتقييم المخاطر في قطاع الآلات. أيضًا، يوفر البحث نظرة ثاقبة لعملية تقييم المخاطر ويقدم توصيات عملية لتعزيز بيئة عمل آمنة وصحية. يمكن أن يؤدي تنفيذ هذه التدابير إلى تقليل حوادث مكان العمل، وتحسين رفاهية العمال، وتعزيز الإنتاجية في قطاع الآلات.

الكلمات المفتاحية: الصحة والسلامة المهنية، تقييم المخاطر، إدارة المخاطر، قطاع الآلات.

Introduction

The machinery sector plays a vital role in modern industrial activities, providing essential equipment and machinery for various sectors such as manufacturing, construction, agriculture, and transportation. However, this sector also presents significant occupational health and safety (OHS) risks due to the nature of its operations, machinery complexity, and the presence of multiple hazards. Workers in the machinery sector are exposed to various physical, chemical, and ergonomic hazards that can have detrimental effects on their health and well-being [1].

The effective management of OHS risks is essential to ensure a safe working environment and prevent workplace accidents and occupational illnesses. Risk assessment is a fundamental process in OHS management, which involves identifying hazards, assessing the associated risks, and implementing control measures to minimize or eliminate those risks. In the context of the machinery sector, risk assessment becomes even more critical due to the potential severity of accidents and injuries that can occur [2].

While there have been numerous studies on OHS and risk assessment in various industries, there is a need for specific research focused on the machinery sector. This sector poses unique challenges and requires tailored approaches to address the specific hazards and risks associated with machinery operations. Understanding the stages involved in the risk assessment process and identifying effective management strategies specific to the machinery sector are crucial for ensuring the safety and well-being of workers.

This study aims to contribute to the existing body of knowledge by examining OHS practices, risk assessment stages, and management strategies in the machinery sector. Through a comprehensive literature review and analysis, the study will explore the various stages of risk assessment, including hazard identification, risk analysis, and risk evaluation, within the context of the machinery sector. Additionally, it will investigate the management strategies implemented to control and mitigate identified risks.

The findings of this study will provide valuable insights into the OHS challenges faced by the machinery sector and the specific risks associated with machinery operations. Furthermore, it will shed light on the importance of adopting a systematic approach to risk assessment and the effective management of identified risks. The study will also provide recommendations for improving OHS practices in the machinery sector, aiming to create a safer working environment, reduce accidents and injuries, and enhance overall productivity.

By enhancing our understanding of OHS practices and risk assessment in the machinery sector, this study will contribute to the development of proactive measures and guidelines for promoting occupational health and safety in this industry. Ultimately, it is hoped that the findings of this study will facilitate the adoption of effective risk management strategies and the implementation of comprehensive OHS programs to ensure the well-being and safety of workers in the machinery sector.

Risk assessment stages and management

In general terms, risk assessment is the work that should be carried out in order to identify the dangers that are present or likely to occur in the workplace and its environment, which have the characteristics of causing material and moral damage to the employees, the workplace and its environment, and to take measures against the identified dangers. There are three types of risk assessments that are generally used to determine the risk and eliminate the identified risk factors. The said types are quantitative, qualitative and the third are mixed type risk assessment methods that will cover both of these two classes. In the quantitative type of risk assessment, the risk phenomenon uses various mathematical methods while determining through the collected data. In the qualitative type assessment method, various descriptive names (high, very high, acceptable, etc.) are assigned to the probability of occurrence of the hazard, the impact value of the hazard and similar parameters, and these values are calculated using mathematical methods. Mixed-type methods are suitable for qualitative and quantitative application examples [3].

During the risk assessment phase, various methods are used when determining and calculating existing or potential risks. When the risk assessment methods that are used frequently around the world are investigated, many methods currently in use are encountered. The most fundamental difference between these methods is the

unique methods they apply in order to obtain the risk score during the creation phase. The most used of these methods, which may vary according to the application area, are: Fine Kinney method, Matrix method, fault tree analysis, multivariate x-type matrix diagram, event tree analysis, primary risk analysis, preliminary hazard analysis, primary risk analysis, root cause analysis, environmental risk assessment, machine risk assessment analysis, energy analysis risk assessment decision matrix [4].

Danger; The potential for harm or damage that exists in the workplace or that may come from outside, that may affect the employee or the workplace, risk: The possibility of loss, injury or other harmful result resulting from the hazard.

Occupational Health and Safety Standard; Occupational health and safety management systematic, which is the most widely applied in our country, risk: the combination of the probability of a dangerous event and the severity of the physical problems that will be encountered when this event occurs, danger; It is defined as the possibility of harm that may affect the employee, prevention: it is the set of phenomena designed and implemented in order to eliminate or minimize the risk phenomena related to occupational health and safety at every stage of the work performed in the work area. acceptable level of risk; It refers to the risk reduced to the acceptable risk level according to the legal requirements and corporate occupational safety system of the organization [5].

Near-miss incident; occurring in the workplace; It can be defined as an event in which there is no adverse event when there is a possibility of damaging the employee, workplace or work equipment.

Risk assessment; It can be defined as the studies that need to be done within this framework, aiming to determine the hazards that may be encountered inside or outside the workplace, and to measure and categorize the risks arising from these hazard groups with the parameters that cause the identified hazards to become any risk factor, and to determine the necessary control steps as a result. There are three basic elements of occupational accidents:

Unsafe acts: These acts, which cause most of the occupational accidents, can be defined as the whole of the negative practices performed by the working personnel. Reasons for unsafe acts; excessive working hours, lack of education, being unsuitable for the job, incompetence, fatigue, carelessness, lack of organization, lack of decision-making ability, illness, not following the rules determined for the job [6].

Unsafe situations: Situations that occur as a result of machines or equipment being used are not suitable for use (Machines and equipment are not suitable for use standards, machines and equipment suitable for the job are not used, there are no risk assessments specific to the workplace and risk assessments of the machines used in the workplace, risk charts are not created within the framework of the workplace's situation plan. , ergonomic factors of the workplace are not suitable for work, not using personal protective equipment suitable for the work done) [7]

Occupational Health and Safety in the Machinery Manufacturing Sector

In this context, it has been seen that high noise creates a problem in the focus of the employees and this focusing problem stands out as an important factor in the formation of other risks. For this reason, it has been suggested that lower noise and higher performance machines and automation systems should be used among the measures to be taken. At the same time, it has been found among the findings that the noise that causes shock vibrations causes the machines to malfunction and wear out in a shorter time [4].

When the studies conducted in this context are examined, it is stated in the study published in 2001 by Kaçmaz that another problem encountered is electricity-related risks, and that electrical risks that cause both work accidents and great dangers of machinery and equipment create an infrastructure for the formation of many similar problems both in our country and in the world. situation has been examined in the context of electrical and electronic engineering science and within the framework of occupational safety and health. Among the results, there is also the fact that our country ranks first in the world.

Occupational Health and Safety (OHS) in the machinery manufacturing sector is a critical aspect of ensuring the well-being and safety of workers involved in the production of machinery and equipment. This sector encompasses a wide range of activities, including the design, manufacturing, assembly, installation, and maintenance of machinery used in various industries [1, 6].

The machinery manufacturing sector poses unique OHS challenges due to the nature of its operations. Workers in this sector are exposed to a variety of hazards, including the operation of heavy machinery, exposure to hazardous materials, noise, vibrations, ergonomic strains, and potential risks associated with manual handling and working at heights.

To address these challenges, effective OHS practices and regulations are implemented in machinery manufacturing facilities. These practices aim to identify and mitigate potential risks, protect workers from harm, and create a safe working environment. OHS measures in the machinery manufacturing sector typically include [8]:

- Risk Assessment: Conducting comprehensive risk assessments to identify potential hazards and evaluate associated risks. This involves analyzing machinery-related risks, material handling, electrical safety, exposure to hazardous substances, and ergonomic factors.
- Machinery Safety: Ensuring that machinery is designed, manufactured, and maintained in compliance with safety standards. This includes implementing safety features, guards, interlocks, emergency stop mechanisms, and adequate training for machinery operators.
- Personal Protective Equipment (PPE): Providing appropriate PPE, such as safety helmets, goggles, ear protection, gloves, and protective clothing, to safeguard workers from specific hazards.
- Training and Education: Offering comprehensive training programs to educate workers on OHS procedures, safe machinery operation, hazard recognition, and emergency response protocols.
- Ergonomics: Incorporating ergonomic principles into workstations, machinery design, and processes to prevent musculoskeletal disorders and optimize worker comfort and productivity.
- Hazardous Substances Management: Implementing control measures to minimize exposure to hazardous substances, including proper labeling, safe handling procedures, and the use of ventilation systems and personal protective equipment.
- Maintenance and Inspection: Establishing regular maintenance schedules and inspection protocols to ensure machinery is in proper working condition, minimizing the risk of malfunctions and accidents.
- Health Surveillance: Conducting health surveillance programs to monitor and assess workers' health conditions, identify early signs of occupational illnesses, and provide necessary medical interventions.

By implementing robust OHS practices, the machinery manufacturing sector aims to prevent workplace accidents, reduce occupational illnesses, and create a culture of safety and well-being. Compliance with OHS regulations not only safeguards workers but also improves overall productivity, reduces downtime due to injuries, and enhances the reputation of machinery manufacturing companies.

Additionally, the machinery manufacturing sector has witnessed advancements in technology and automation, which have brought both benefits and new OHS considerations. Automation and robotics have the potential to improve productivity, efficiency, and worker safety by reducing manual labor and repetitive tasks. However, the introduction of these technologies requires careful risk assessment and control measures to ensure the safe interaction between humans and machines. This includes implementing safety systems, training workers on safe interaction with automated systems, and establishing protocols for maintenance and troubleshooting [9].

Collaborative robots, known as cobots, have also gained popularity in the machinery manufacturing sector. These robots work alongside human operators, sharing the same workspace. Ensuring the safe integration and operation of cobots requires specific risk assessments, proper training, and the implementation of safety measures such as sensors and protective barriers.

Furthermore, the machinery manufacturing sector is subject to regulatory frameworks and standards that govern OHS practices. These regulations vary across jurisdictions but typically include guidelines on machinery safety, hazardous materials management, noise control, and ergonomic considerations. Compliance with these regulations is crucial to protect workers and maintain legal and ethical responsibilities.

Continuous improvement in OHS performance is essential in the machinery manufacturing sector. This involves regular monitoring, analysis of incidents and near misses, and feedback from workers. Effective communication channels between management and employees, such as safety committees or worker involvement programs, facilitate the identification and resolution of OHS issues [10].

By prioritizing occupational health and safety in the machinery manufacturing sector, companies can achieve several benefits. These include reducing workplace accidents and injuries, improving worker morale and

satisfaction, enhancing productivity, minimizing downtime and associated costs, and fostering a positive corporate image.

Occupational health and safety in the machinery manufacturing sector is crucial for protecting the well-being of workers and ensuring a safe working environment. By implementing comprehensive risk assessment practices, adopting appropriate safety measures, providing adequate training, and complying with regulations, companies can mitigate hazards, prevent accidents, and promote the overall well-being of their workforce. Embracing advancements in technology and automation while maintaining a strong focus on OHS enables the machinery manufacturing sector to thrive and contribute to a sustainable and safe industrial landscape [11].

In order to achieve effective occupational health and safety in the machinery manufacturing sector, a collaborative approach is necessary. This involves the commitment and involvement of all stakeholders, including management, workers, regulatory bodies, and industry associations. By fostering a culture of safety, promoting open communication, and providing necessary resources, a comprehensive OHS framework can be established.

Regular training programs and educational initiatives play a crucial role in equipping workers with the knowledge and skills to identify hazards, follow safety protocols, and respond effectively to emergencies. These training programs should cover topics such as machinery operation, proper use of personal protective equipment, safe material handling, and hazard recognition. Ongoing education ensures that workers remain updated on the latest safety practices and technologies.

Furthermore, effective OHS management requires the implementation of robust reporting and incident investigation systems. Encouraging workers to report near misses, accidents, and potential hazards promotes a proactive approach to safety and enables organizations to identify underlying causes and implement corrective measures. Incident investigations help in understanding the root causes of accidents and developing strategies to prevent similar incidents in the future [8].

Regular inspections and audits are essential to identify and rectify potential safety deficiencies in the machinery manufacturing sector. These assessments should cover machinery maintenance, workplace layout, storage and handling of materials, electrical safety, and compliance with OHS regulations. Findings from inspections should be addressed promptly to ensure a safe and compliant working environment.

Collaboration with suppliers and contractors is also important in ensuring OHS standards are met throughout the supply chain. Engaging with suppliers to evaluate their safety practices, ensuring the use of certified equipment and materials, and promoting responsible procurement practices contribute to overall OHS performance in the machinery manufacturing sector [3].

Lastly, continuous improvement and learning from past experiences are essential in OHS management. Regular review and evaluation of OHS programs, benchmarking against industry standards, and adopting best practices from within the sector enable organizations to enhance their safety performance over time.

By implementing a comprehensive OHS framework that encompasses risk assessment, training, incident reporting, inspections, collaboration, and continuous improvement, the machinery manufacturing sector can strive towards creating a safer and healthier workplace for all employees. Prioritizing occupational health and safety not only protects workers from harm but also contributes to the long-term success and sustainability of the industry as a whole [12].

Risk assessment

Occupational Health and Occupational Health and Safety lead to conceptual confusion. One of the main factors that differentiate the concept of Occupational Health and Safety is that it includes the prediction and analysis of risks and the measures and studies taken to eliminate or minimize these risks. When we look at the international definitions, it is emphasized that Occupational Health and Safety should be handled with a proactive approach, not reactive, and the risks should be analyzed beforehand and necessary precautions should be taken [13].

It is emphasized that risk analysis, which can be done by a board formed by the company, external assessment experts, risk analysis firms or the state, is of great importance in terms of the concept of occupational health and safety. In this context, if the risk analysis is carried out by the team formed by the company, the people who should be in the team formed are listed as follows [14]:

- Employer or employer's representative.
- Occupational safety specialists and workplace physicians who carry out health and safety services in the workplace.
- Employee representatives at the workplace.
- Support staff at the workplace,

Work carried out in the workplace and determined to represent all units in the workplace, current or employees with knowledge of potential sources of danger and risks.

Risk assessment is a crucial process in the machinery sector that aims to identify, evaluate, and manage potential hazards and risks associated with machinery operations. It involves a systematic approach to understanding the nature of hazards, assessing the likelihood and severity of their consequences, and implementing control measures to reduce or eliminate risks.

In the machinery sector, risk assessment is essential due to the complex nature of machinery and the potential for accidents and injuries. Machinery operations involve various hazards, such as mechanical hazards (e.g., moving parts, pinch points), electrical hazards, ergonomic risks, exposure to hazardous substances, and the potential for falls or collisions.

The risk assessment process in the machinery sector typically involves several stages [15]:

Hazard Identification: This stage involves identifying potential hazards associated with machinery operations. It includes examining the machinery itself, the work environment, the tasks performed, and the materials or substances used.

Risk Analysis: Once hazards are identified, a risk analysis is conducted to assess the likelihood and severity of potential consequences. This involves considering factors such as the frequency of exposure, the potential harm to workers, and the possibility of multiple hazards interacting.

Risk Evaluation: The identified risks are then evaluated to determine their level of acceptability. This involves comparing the assessed risks against predetermined criteria, such as legal requirements, industry standards, and organizational policies.

Control Measures: Based on the risk evaluation, control measures are implemented to reduce or eliminate the identified risks. These measures may include engineering controls (e.g., machine guarding, safety interlocks), administrative controls (e.g., training programs, standard operating procedures), and the use of personal protective equipment.

Monitoring and Review: The effectiveness of the implemented control measures is continuously monitored and reviewed. This ensures that the risk controls remain effective over time and that any changes in machinery, processes, or work conditions are appropriately addressed.

Risk assessment in the machinery sector is often a collaborative effort involving various stakeholders, including machinery manufacturers, employers, workers, and OHS professionals. Collaboration is crucial to gather relevant expertise, share information, and ensure that all perspectives are considered in the risk assessment process.

By conducting thorough risk assessments, organizations in the machinery sector can proactively identify potential hazards, implement appropriate control measures, and create a safer working environment. This not only protects the well-being of workers but also helps to prevent costly accidents, production delays, and damage to machinery. Moreover, effective risk assessment demonstrates a commitment to occupational health and safety, enhances regulatory compliance, and promotes a positive safety culture within the machinery sector [16].

Risk assessment in the machinery sector requires a comprehensive understanding of the specific hazards and risks associated with different types of machinery and their operations. Each stage of the machinery lifecycle, from design and manufacturing to installation, operation, and maintenance, presents unique challenges that must be addressed through thorough risk assessment.

During the design phase, risk assessment focuses on identifying and eliminating potential hazards by implementing safety features and incorporating protective measures. This includes considering the ergonomics of the machinery, ensuring proper machine guarding, and designing clear warning systems [17].

In the manufacturing phase, risk assessment involves evaluating the risks associated with the production processes, such as material handling, assembly, and testing. It also considers the safety of workers involved in the manufacturing operations, ensuring that proper training, safety protocols, and personal protective equipment are provided.

Risk assessment continues during the installation phase, where potential hazards related to transportation, positioning, and the interaction of the machinery with its surroundings are assessed. This includes addressing risks associated with electrical connections, structural stability, and ensuring the machinery is installed in accordance with safety guidelines.

During operation, ongoing risk assessment is necessary to identify and control hazards that may arise from equipment malfunction, human error, or changes in work processes. Regular inspections, maintenance, and monitoring of machinery performance are essential to detect potential risks and take preventive measures [18].

The maintenance phase also requires risk assessment to identify hazards associated with repair, servicing, and cleaning activities. Proper lockout/tagout procedures, maintenance schedules, and training on safe maintenance practices are essential to mitigate risks during these tasks.

Risk assessment in the machinery sector is an iterative process that involves continuous monitoring, evaluation, and improvement. It requires a proactive approach to identify emerging risks, address changing work conditions, and incorporate new technologies or processes. By implementing robust risk assessment practices, organizations in the machinery sector can minimize the occurrence of accidents, injuries, and occupational illnesses. It enables them to comply with regulatory requirements, enhance worker safety, and protect the reputation and productivity of the business [19].

Furthermore, effective risk assessment fosters a safety culture within the machinery sector, where all stakeholders are actively engaged in identifying and managing risks. It encourages open communication, empowers workers to report hazards, and promotes a collective commitment to continuous improvement in occupational health and safety. Moreover, it is important to recognize that risk assessment in the machinery sector is not a one-time activity, but an ongoing process. As technology advances and work processes evolve, new risks may emerge, requiring regular reassessment to ensure that safety measures remain effective and up to date.

To facilitate effective risk assessment in the machinery sector, several guidelines and standards have been developed. These include international standards such as ISO 12100:2010 on machinery safety and ISO 31000:2018 on risk management, as well as industry-specific regulations and best practices. Adhering to these standards helps organizations ensure a systematic and consistent approach to risk assessment and management [20].

In addition to regulatory compliance, there are several benefits to conducting thorough risk assessments in the machinery sector. Firstly, it helps prevent accidents, injuries, and occupational illnesses, safeguarding the well-being of workers. By identifying and mitigating risks, organizations can create a safer working environment and protect their employees from harm.

Secondly, effective risk assessment contributes to operational efficiency. By addressing potential hazards and implementing appropriate control measures, organizations can minimize disruptions caused by accidents or machinery breakdowns. This leads to increased productivity, reduced downtime, and lower maintenance costs.

Furthermore, risk assessment plays a crucial role in legal and financial aspects. Compliance with OHS regulations and standards help organizations avoid penalties, lawsuits, and reputational damage. It also demonstrates a commitment to responsible business practices, which can enhance the organization's standing among stakeholders, customers, and partners [21].

Finally, an organization's proactive approach to risk assessment and management in the machinery sector can provide a competitive advantage. Customers, suppliers, and investors increasingly prioritize safety and ethical considerations when making decisions. Demonstrating a strong commitment to occupational health and safety

through effective risk assessment practices can differentiate organizations and contribute to their long-term success.

In conclusion, risk assessment in the machinery sector is a vital process for identifying, evaluating, and managing potential hazards and risks associated with machinery operations. It ensures the safety and well-being of workers, minimizes disruptions, ensures legal compliance, and enhances the organization's reputation. By adopting a systematic and ongoing approach to risk assessment, organizations can foster a culture of safety, drive operational excellence, and thrive in a competitive marketplace.

Risk in welding:
One of the primary hazards in welding is the release of hazardous fumes and gases. Welding fumes can contain toxic substances such as metal particles, gases, and vapors, which can pose significant health risks if inhaled. Risk assessment in welding considers the types and quantities of fumes generated, as well as the duration and frequency of exposure to determine the associated risks and appropriate control measures [22].

Another hazard in welding is the intense heat and radiation produced during the process. Welders can be exposed to high temperatures, infrared radiation, and ultraviolet (UV) radiation, which can lead to burns, eye injuries, and long-term effects such as skin cancer or cataracts. Risk assessment evaluates the potential for heat and radiation exposure, taking into account factors such as welding techniques, work environment, and the use of protective measures like welding curtains, shields, and personal protective equipment (PPE).

Electrical hazards are also a concern in welding, as it involves the use of electric currents for welding equipment. Improper handling or faulty equipment can lead to electric shock or fires. Risk assessment in welding addresses electrical safety, including the inspection and maintenance of welding equipment, proper grounding, and the use of safety switches and circuit breakers. Other hazards associated with welding include noise exposure, physical hazards from flying sparks or metal debris, and ergonomic risks from awkward postures or repetitive movements. Risk assessment examines these hazards and determines appropriate control measures, such as hearing protection, barrier systems, and ergonomic interventions [23].

To conduct effective risk assessment in welding, organizations should consider industry-specific standards and guidelines, such as those provided by organizations like the American Welding Society (AWS) or the International Institute of Welding (IIW). These standards provide recommendations on safe welding practices, control measures, and PPE selection. Regular training and education for welders are essential components of risk assessment in welding. Welders should be knowledgeable about the hazards associated with their work, trained on safe work practices, and informed about the proper use of PPE. Ongoing monitoring and evaluation of welding operations, including regular inspections, incident reporting, and worker feedback, contribute to continuous improvement in risk assessment and management [24].

By conducting thorough risk assessments in welding, organizations can minimize the potential for accidents, injuries, and long-term health effects. Implementing appropriate control measures, such as proper ventilation systems, PPE usage, and safe work procedures, helps protect welders and ensure a safe working environment. Effective risk assessment in welding not only safeguards the well-being of workers but also promotes compliance with regulations, reduces operational disruptions, and enhances the overall performance and reputation of the organization.

Risk in heat treatment:
One of the primary hazards in heat treatment is the exposure to high temperatures and thermal energy. Workers involved in heat treatment operations may face risks such as burns, heat stress, and fire hazards. Risk assessment in heat treatment considers factors such as the temperature range, duration of exposure, and the adequacy of thermal insulation and protective measures to assess the associated risks and implement appropriate control measures.

Another significant risk in heat treatment is the potential release of hazardous substances. Certain materials used in heat treatment, such as coatings, paints, or contaminants on the surface of the workpieces, can generate toxic fumes, gases, or dust when exposed to high temperatures. Risk assessment evaluates the types and quantities of hazardous substances present, as well as the effectiveness of ventilation systems and the use of personal protective equipment (PPE) to control exposure and protect workers' health [25].

Additionally, heat treatment processes may involve the use of various equipment, such as furnaces, ovens, and quenching tanks, which can pose mechanical hazards. Risk assessment considers potential risks associated with

moving parts, pinch points, and the handling of heavy loads during the heat treatment process. Adequate machine guarding, safety interlocks, and proper training on equipment operation and maintenance are essential to mitigate these hazards.

Electrical hazards also exist in heat treatment operations due to the use of electrical heating elements and control systems. Improper electrical connections, inadequate grounding, or equipment malfunction can lead to electric shock or fires. Risk assessment in heat treatment addresses electrical safety, including the inspection and maintenance of equipment, compliance with electrical codes and standards, and the use of safety switches and circuit breakers.

Moreover, the potential for environmental impacts should be considered in the risk assessment process for heat treatment. Heat treatment processes may generate waste heat, emissions, or wastewater that require proper management to prevent pollution and comply with environmental regulations. Risk assessment evaluates these environmental risks and ensures the implementation of appropriate mitigation measures and waste management practices [26].

Regular training and education for workers involved in heat treatment operations are crucial for effective risk assessment. Workers should be trained on the hazards associated with heat treatment, safe work practices, emergency procedures, and the proper use of PPE. Ongoing monitoring and evaluation of heat treatment operations, including regular inspections, incident reporting, and worker feedback, contribute to continuous improvement in risk assessment and management.

By conducting thorough risk assessments in heat treatment, organizations can minimize the potential for accidents, injuries, and adverse health effects. Implementing appropriate control measures, such as proper ventilation systems, PPE usage, machine guarding, and safety protocols, helps protect workers, prevent environmental impacts, and ensure a safe working environment. Effective risk assessment in heat treatment not only safeguards the well-being of workers but also promotes compliance with regulations, reduces operational disruptions, and enhances the overall performance and reputation of the organization [27].

Risk in metal casting:

Risk in metal casting refers to the potential hazards and uncertainties associated with the process of casting molten metal into desired shapes and forms. Metal casting is a widely used manufacturing process that involves pouring molten metal into a mold and allowing it to solidify to create various metal components and products. While metal casting offers numerous benefits, it also presents certain risks that need to be effectively managed.

One of the primary risks in metal casting is the exposure to high temperatures and thermal energy. Workers involved in the casting process may face the risk of burns, heat stress, and other thermal-related injuries. The handling of molten metal, the operation of furnaces, and the use of heating equipment pose significant risks. Adequate thermal protection, such as appropriate personal protective equipment (PPE) and insulation materials, as well as safe work procedures, are essential to mitigate these risks [28].

Another risk in metal casting is the potential release of hazardous substances. The materials used in metal casting, including alloys, binders, and coatings, can generate fumes, gases, or dust that may be toxic or harmful to workers' health if inhaled or exposed to the skin. Proper ventilation systems, effective control measures, and adherence to safety guidelines and regulations are crucial to minimize exposure to hazardous substances and protect the health of workers.

Mechanical hazards are also prevalent in metal casting operations. The use of heavy machinery, moving parts, and lifting equipment can lead to risks such as crush injuries, pinching, or being struck by objects. Adequate machine guarding, safety interlocks, and comprehensive training on safe equipment operation and handling are necessary to mitigate these risks and ensure the safety of workers.

Additionally, ergonomic risks may arise in metal casting due to the manual handling of molds, patterns, and heavy castings. Awkward postures, repetitive movements, and excessive physical exertion can contribute to musculoskeletal disorders and injuries. Ergonomic assessments, the implementation of proper lifting techniques, and the provision of ergonomic tools and equipment can help mitigate these risks and promote worker well-being.

Environmental risks should also be considered in metal casting. The process may generate emissions, waste materials, and energy consumption, which can have adverse effects on the environment if not properly managed.

Effective waste management practices, energy-efficient technologies, and compliance with environmental regulations are necessary to minimize the environmental impact of metal casting operations [29].

To mitigate these risks, organizations engaged in metal casting need to conduct thorough risk assessments. This involves identifying potential hazards, evaluating their likelihood and severity, and implementing appropriate control measures to eliminate or reduce the risks. Regular training, communication, and monitoring are essential to maintain a safe working environment and prevent incidents or accidents.

By effectively managing risks in metal casting, organizations can protect the health and safety of workers, minimize environmental impacts, ensure compliance with regulations, and maintain operational efficiency. A proactive approach to risk management promotes a culture of safety, continuous improvement, and sustainable practices within the metal casting industry [30].

Conclusion

In conclusion, this study has highlighted the importance of occupational health and safety (OHS) and risk assessment in the machinery sector. The machinery sector is known for its complex and potentially hazardous work environments, where workers are exposed to various physical, chemical, and ergonomic risks.

Through an examination of OHS practices and risk assessment stages, it becomes evident that a comprehensive approach is necessary to ensure the well-being of workers and the effective management of risks. The study has emphasized the significance of integrating OHS measures into all stages of machinery operations, from design and installation to operation and maintenance. This includes the implementation of engineering controls, administrative measures, and the proper use of personal protective equipment (PPE) to minimize risks and protect workers from harm.

Furthermore, the study has underlined the importance of conducting systematic risk assessments in the machinery sector. Risk assessments help identify potential hazards, evaluate their likelihood and severity, and implement appropriate control measures. By conducting thorough risk assessments, organizations can proactively address risks, reduce the occurrence of accidents and injuries, and create a safer work environment for all employees.

The study has also emphasized the need for ongoing training and education programs to ensure that workers are aware of potential hazards, understand safe work practices, and are equipped with the necessary knowledge to utilize safety measures effectively. Continuous monitoring, evaluation, and improvement of OHS practices and risk management strategies are crucial to maintain a culture of safety and promote the overall well-being of workers in the machinery sector.

By integrating effective OHS measures and robust risk assessment practices, organizations in the machinery sector can not only protect the health and safety of their workers but also enhance their productivity, reduce operational disruptions, and foster a positive work environment. Ultimately, the implementation of comprehensive OHS and risk management strategies contributes to the overall success and sustainability of the machinery sector.

Additionally, this study highlights the legal and regulatory framework surrounding occupational health and safety in the machinery sector. Compliance with applicable laws, regulations, and industry standards is essential to ensure a safe working environment and avoid legal liabilities. Organizations must stay up-to-date with the evolving OHS regulations and proactively implement measures to meet or exceed the required standards.

Moreover, the study emphasizes the need for effective communication and collaboration between management, workers, and relevant stakeholders. Establishing a culture of safety and fostering a participatory approach can enhance hazard identification, risk assessment, and the implementation of control measures. Encouraging workers' involvement and feedback can contribute to the continuous improvement of OHS practices and risk management strategies.

It is worth noting that while this study focuses on the machinery sector, the principles and insights can be applicable to other industries as well. The significance of occupational health and safety and risk assessment cannot be overstated, regardless of the sector or the nature of the work. Organizations across various industries can draw valuable lessons from the findings of this study and adapt them to their specific contexts.

In conclusion, this study provides a comprehensive overview of occupational health and safety and risk assessment stages and management in the machinery sector. It underscores the importance of prioritizing worker safety, conducting systematic risk assessments, implementing appropriate control measures, and fostering a culture of safety. By integrating these principles into daily operations, organizations can create a safer work environment, protect workers' well-being, and contribute to the overall success and sustainability of the machinery sector. Continuous research, improvement, and collaboration among industry stakeholders are key to ensuring ongoing advancements in occupational health and safety practices in the machinery sector and beyond.

References

[1] I. Iavicoli, L. Fontana, and V. Leso, "OSH strategies to Industry 4.0: the example of risk assessment and management of nanomaterials," Safety and Health at Work, vol. 13, p. S30, Jan. 2022, doi: 10.1016/j.shaw.2021.12.807.

[2] A. Moatari-Kazerouni, Y. Chinniah, and B. Agard, "A proposed occupational health and safety risk estimation tool for manufacturing systems," International Journal of Production Research, vol. 53, no. 15, pp. 4459–4475, Aug. 2014, doi: 10.1080/00207543.2014.942005.

[3] V. Nyirendaavwil, Y. Chinniah, and B. Agard, "Identifying Key Factors for an Occupational Health and Safety Risk estimation Tool in Small and Medium-size Enterprises," IFAC-PapersOnLine, vol. 48, no. 3, pp. 541–546, 2015, doi: 10.1016/j.ifacol.2015.06.137.

[4] F. Gauthier, S. Lambert, and Y. Chinniah, "Experimental Analysis of 31 Risk Estimation Tools Applied to Safety of Machinery," International Journal of Occupational Safety and Ergonomics, vol. 18, no. 2, pp. 245–265, Jan. 2012, doi: 10.1080/10803548.2012.11076933.

[5] H. M. N. Raafat, "Risk assessment and machinery safety," Journal of Occupational Accidents, vol. 11, no. 1, pp. 37–50, Jun. 1989, doi: 10.1016/0376-6349(89)90004-7.

[6] C. Badenhorst, "1636e Good practice guidance on occupational health risk assessment," Mining Occupational Safety and Health, Apr. 2018, doi: 10.1136/oemed-2018-icohabstracts.700.

[7] T. Matsumoto, "Current Situation and Risk-Based Approach to Safety of Machinery," Journal of Occupational Safety and Health, vol. 3, no. 1, pp. 37–46, 2010, doi: 10.2486/josh.3.37.

[8] U. Tongsantia and S. Chaiklieng, "1397 Applied occupational health and safety assessment system (ohsas18001) for health risk assessment of workers at gasoline stations," Occupational Health in the Chemical Industry, Apr. 2018, doi: 10.1136/oemed-2018-icohabstracts.1038.

[9] L. B. Gratt, "Occupational Health and Safety Risk Analysis for Oil Shale," Risk Analysis in the Private Sector, pp. 93–104, 1985, doi: 10.1007/978-1-4613-2465-2_8.

[10] H. Lingard, "Occupational health and safety in the construction sector," Increasing Occupational Health and Safety in Workplaces, pp. 219–241, 2019, doi: 10.4337/9781788118095.00020.

[11] J. F. Whiting, "Risk Assessment," Global Occupational Safety and Health Management Handbook, pp. 63–77, Feb. 2019, doi: 10.1201/9780429056475-5.

[12] K. M. Savolainen and P. Kalliokoski, "Chemical Safety and Risk Assessment," Global Occupational Health, pp. 19–35, Feb. 2011, doi: 10.1093/acprof:oso/9780195380002.003.0002.

[13] C. Bofinger and D. Cliff, "Occupational health and safety in the mining sector," Increasing Occupational Health and Safety in Workplaces, pp. 201–218, 2019, doi: 10.4337/9781788118095.00019.

[14] Z. Pawłowska, "Occupational Risk Assessment," Handbook of Occupational Safety and Health, pp. 473–481, May 2010, doi: 10.1201/ebk1439806845-29.

[15] S. Horie, "Occupational Health Policies on Risk Assessment in Japan," Safety and Health at Work, vol. 1, no. 1, pp. 19–28, Sep. 2010, doi: 10.5491/shaw.2010.1.1.19.

[16] P. A. Erickson, "Hazard and risk assessment," Practical Guide to Occupational Health and Safety, pp. 13–23, 1996, doi: 10.1016/b978-012240570-9/50002-6.

[17] H. Pacaiova, "Machinery Safety Requirements as an Effective Tools for Operational Safety Management," Risk Assessment, Feb. 2018, doi: 10.5772/intechopen.71152.

[18] I. N. Işık and E. Atasoylu, "Occupational safety and health in North Cyprus: Evaluation of risk assessment," Safety Science, vol. 94, pp. 17–25, Apr. 2017, doi: 10.1016/j.ssci.2016.12.020.

[19] V. Mučenski, "Occupational Health and Safety Risk Assessment for Demolition Processes in Construction," Ergonomics International Journal, vol. 1, no. 2, 2017, doi: 10.23880/eoij-16000112.

[20] N. Desai, R. Rajesh, and A. Raiyani, "Occupational Health Risk Assessment (OHRA) Tool – A way to determine exposure estimation and risk management," Safety and Health at Work, vol. 13, p. S199, Jan. 2022, doi: 10.1016/j.shaw.2021.12.1372.

[21] P. K. Marhavilas and D. E. Koulouriotis, "Risk-Acceptance Criteria in Occupational Health and Safety Risk-Assessment—The State-of-the-Art through a Systematic Literature Review," Safety, vol. 7, no. 4, p. 77, Nov. 2021, doi: 10.3390/safety7040077.

[22] M. Colak, C. Aygurler, and T. Cetin, "Risk analysis for occupational health and safety in mining sector," Pressacademia, vol. 7, no. 1, pp. 285–289, Sep. 2018, doi: 10.17261/pressacademia.2018.899.

[23] H. TOMITA, "Analysis of the current situation of electric shock fatal occupational accident and trial of risk assessment to electric shock occupational accidents," Journal of Occupational Safety and Health, vol. 14, no. 2, pp. 177–187, Sep. 2021, doi: 10.2486/josh.josh-2021-0006-cho.

[24] Y. SATO, "Consideration of support measures for implementing risk assessment considering unintended reactions," Journal of Occupational Safety and Health, vol. 12, no. 1, pp. 25–32, Feb. 2019, doi: 10.2486/josh.josh-2018-0014-cho.

[25] F. Vivian SW Chan, “Risk Assessment and Communication in Pharmaceuticals: Recognizing the Differences in Occupational Health and Medication Safety,” Journal of Toxicology and Risk Assessment, vol. 5, no. 1, Dec. 2019, doi: 10.23937/2572-4061.1510019.
[26] P. Badida, S. Janakiraman, and J. Jayaprakash, “Occupational health and safety risk assessment using a fuzzy multi-criteria approach in a hospital in Chennai, India,” International Journal of Occupational Safety and Ergonomics, pp. 1–10, Aug. 2022, doi: 10.1080/10803548.2022.2109323.
[27] M. Etemadi, A. Mohd Mahdzir, and N. Mohd Noor, “Occupational Health and Safety Risk Assessment of Nano Workplaces In Malaysia,” Jan. 2023, doi: 10.20944/preprints202301.0478.v1.
[28] R. C. McKinnon, “Fire Risk Assessment,” The Design, Implementation, and Audit of Occupational Health and Safety Management Systems, pp. 251–252, Nov. 2019, doi: 10.1201/9780429280740-48.
[29] M. D. Rowe, “Assessing Occupational Health And Safety Risks Of Renewable Energy Technologies At The National Level,” Health and Environmental Risk Assessment, pp. 237–257, 1985, doi: 10.1016/b978-0-08-031578-2.50021-1.
[30] A. F. Rahmadini, D. Andarini, A. Camelia, N. Ermi, and M. Lestari, “Occupational Health and Safety Risk Assessment on Informal Workers in Ogan Ilir, South Sumatra,” The Indonesian Journal Of Occupational Safety and Health, vol. 10, no. 3, p. 412, Nov. 2021, doi: 10.20473/ijosh.v10i3.2021.412-419.