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ENHANCING OCCUPATIONAL HEALTH AND SAFETY PRACTICES IN THE MODERN LEMURU FISH PROCESSING INDUSTRY: AN EVALUATION OF THE QUALITY CONTROL UNIT

Peningkatan Praktik Kesehatan dan Keselamatan Kerja di Industri Pengolahan Ikan Lemuru Modern: Evaluasi Unit Pengendalian Mutu

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ABSTRACT

Optimal implementation of Occupational Health and Safety (OHS) is important to create a safe, efficient, and productive work environment. This study examines the implementation of OHS in the modern lemuru fish processing industry. Various integrated strategies are implemented to minimize accident risks, increase productivity, and maintain product quality. Advanced technology approaches such as Internet of Things (IoT)-based monitoring systems, computer-based OHS management systems, and Virtual Reality (VR) technology for training are used. Automation of risky processes with robotics and automatic control technology reduces human involvement in hazardous activities. Data analytics based on machine learning and big data help predict and prevent potential accidents. The results of the study indicate that the integration of appropriate OHS technology and policies improves worker safety, strengthens industry competitiveness, and contributes significantly to long-term success in the modern lemuru fish processing industry.

Keywords: Occupational Health and Safety, Optimization, Lemuru Fish Processing, QC, technology

ABSTRAK

Penerapan Keselamatan dan Kesehatan Kerja (K3) yang optimal penting untuk menciptakan lingkungan kerja yang aman, efisien, dan produktif. Penelitian ini mengkaji penerapan K3 pada industri pengolahan ikan lemuru modern. Berbagai strategi terpadu diterapkan untuk meminimalkan risiko kecelakaan, meningkatkan produktivitas, dan menjaga kualitas produk. Pendekatan teknologi mutakhir seperti sistem pemantauan berbasis Internet of Things (IoT),

sistem manajemen K3 berbasis komputer, dan teknologi Virtual Reality (VR) untuk pelatihan digunakan. Otomatisasi proses berisiko dengan robotika dan teknologi kontrol otomatis mengurangi keterlibatan manusia dalam aktivitas berbahaya. Analisis data berdasarkan machine learning dan big data membantu memprediksi dan mencegah potensi kecelakaan. Hasil penelitian menunjukkan bahwa integrasi teknologi dan kebijakan K3 yang tepat dapat meningkatkan keselamatan pekerja, memperkuat daya saing industri, dan memberikan kontribusi yang signifikan terhadap keberhasilan jangka panjang industri pengolahan ikan lemuru modern.

Kata Kunci: Kesehatan dan Keselamatan Kerja, Optimasi, Pengolahan Ikan Lemuru, QC, Teknologi

INTRODUCTION

Occupational Safety and Health (OHS) is an important aspect in the food processing industry, including the fisheries industry (Noroozi & Taherian, 2023b, 2023a; Nugraha *et al*., 2025; Pawening & Martiana, 2023). The implementation of OHS aims to protect workers from the risk of work accidents and occupational diseases that can occur during the production process (Aryantha & Pamungkas, 2022; Farza, Muhammad, 2022; Hamja *et al*., 2022; Karim *et al*., 2023; Lating & Dolang, 2023; Olcay *et al*., 2021; Purnawati, 2006; Tauwi & Pagala, 2022; Tisna, 2024; Wibowo & Widodo, 2022). The modern lemuru fish processing industry has the responsibility to ensure that the OHS system is implemented optimally to ensure worker safety and the quality of the products produced.

The modern lemuru fish processing industry involves various processes that have the potential for accident risks, such as the use of sharp equipment, exposure to chemicals, and wet and slippery work environments (Handoko & Thabrani, 2023; Rizkina *et al.,* 2023; Singapurwa *et al*., 2023). Based on data from the Indonesian Ministry of Manpower, work accidents in the fisheries and food processing sectors are still relatively high compared to other sectors (Nugraha *et al.,* 2021, 2024). Therefore, this study is important to improve and optimize the implementation of OHS in the Quality Control (QC) unit in the modern lemuru fish processing industry in order to improve work safety and production efficiency (Kurniawati et al., 2023).

Although the implementation of OHS in the modern lemuru fish processing industry has been running well, there are still several obstacles, especially in the Quality Control (QC) unit. This unit plays a crucial role in ensuring product quality before distribution, so workers in this section are often faced with various work risks, such as direct contact with raw fish materials, use of laboratory equipment, and exposure to low temperatures in the storage room.

Several studies have shown that one of the factors that influences the effectiveness of OHS implementation is worker awareness and compliance with safety procedures. In addition, the existence of work safety facilities and company policies also play an important role in reducing the risk of accidents. Therefore, this study will identify factors that need to be optimized in the implementation of OHS in the QC unit of the modern lemuru fish processing industry in order to improve work safety and productivity.

Various theories about OHS have been developed to improve safety in the work environment. One of them is the Domino theory by Heinrich which states that work accidents occur due to a series of interrelated factors, such as unsafe conditions and unsafe actions. In addition, the Five Steps to Risk Assessment model from the Health and Safety Executive (HSE) emphasizes the importance of exposing hazards, evaluating risks, and implementing preventive measures.

Previous studies have discussed the implementation of OHS in various industrial sectors, including fisheries (Holmen *et al.,* 2022; Nugraha *et al.,* 2025; Souto Cavalli *et al.,*

2023; Thorvaldsen *et al.,* 2022; Yadav *et al.,* 2023). Several studies have shown that compliance with OHS standards can improve work efficiency and reduce the number of accidents. However, there is still a gap in research related to optimizing the implementation of OHS specifically in the Quality Control unit in the fish processing industry. Therefore, this study attempts to fill this gap by analyzing and optimizing OHS practices in the QC unit of the modern lemuru fish processing industry.

The main objective of this study is to initiate and optimize the implementation of OHS in the lemuru fish processing process in the QC unit of the modern lemuru fish processing industry. By analyzing the OHS system that has been implemented, this study is expected to provide more effective recommendations to improve occupational safety and health.

Theoretically, this study can contribute to the development of the concept of implementing OHS in the food processing industry, especially in the Quality Control unit. Practically, the results of this study are expected to help the modern lemuru fish processing industry in improving OHS policies and practices, reducing the risk of work accidents, and increasing productivity and the quality of the products produced.

METHODS

This study uses a qualitative descriptive approach with the aim of understanding in depth the implementation of OHS in the processing of lemuru fish in the QC unit of XYZ industry at Jembrana, Bali. The QC unit of XYZ industry was chosen as the location of the study because this unit has a crucial role in maintaining product quality and ensuring food safety standards. In addition, the QC unit is a part that has a high work risk due to direct contact with fish raw materials, the use of laboratory equipment, and exposure to low temperatures in the storage room. Although the implementation of OHS has been running well, there are still opportunities to optimize the existing system to improve work safety and efficiency. With this study, it is hoped that a more effective strategy can be found in the implementation of OHS in the QC unit of XYZ industry.

Material

The materials used in this study cover various important aspects that support the analysis of OHS implementation. The main raw material used is Sardinella lemuru fish, which requires hygienic and safe handling to maintain product quality and prevent the risk of contamination. Processing equipment and machines, such as cutting tools, digital scales, packaging machines, and laboratory equipment for quality testing, are also used. This equipment has the potential for accident risks, so the implementation of proper OHS procedures is important. In addition, Personal Protective Equipment (PPE) equipment, such as waterproof gloves, non-slip shoes, masks, face shields, lab coats, and head covers, are used to reduce the risk of injury and contamination. Laboratory chemicals and reagents, including cleaning agents and ice for cooling, are also an important part of this study, where their use must be in accordance with safety standards to prevent hazardous exposure.

In addition, OHS policy and regulatory documents, such as national and international standards including ISO 45001, are used as references in the evaluation and implementation of safety procedures. Finally, human resources (HR) consisting of workers in the QC unit, supervisors, and management teams are also an important part of this study, considering that their awareness and compliance with procedures are key to creating a safe and productive work environment.

Tools

This study is a qualitative descriptive study, where data is collected and analyzed to understand the implementation of and identify aspects that need to be optimized. The data sources used consist of primary data and secondary data. Primary data was obtained through interviews with management, supervisors, and workers in the QC unit of XYZ industry regarding the implementation of . Meanwhile, secondary data was obtained from literature studies, regulations, and occupational safety reports from companies and related agencies. Data collection techniques in this study include direct observation in the workplace to identify working conditions, potential hazards, and the implementation of. In addition, in-depth interviews were conducted with workers and management to understand the obstacles and opportunities for optimizing . Document analysis, such as SOPs, work accident reports, and company policies related to occupational safety, was also carried out to obtain a more comprehensive understanding.

Research Design

This research employs a descriptive qualitative approach combined with quantitative data analysis to explore and optimize the implementation of Occupational Health and Safety (OHS) in the modern lemuru fish processing industry. The study is designed to identify potential hazards, assess existing OHS practices, and propose technological and managerial strategies for improvement.

Research Stage

This research was conducted through several systematic stages. The first stage is problem identification and formulation of research objectives, where a literature study was conducted related to the concept of OHS and the challenges of its implementation in the fish processing industry. This stage aims to understand the gap between existing OHS practices and expected standards. The second stage is data collection, which is carried out through direct observation in the industrial environment, interviews with workers and management, and distributing questionnaires to measure the level of worker awareness and compliance with OHS procedures. In addition, documents related to safety standards, accident reports, and company policies were analyzed to obtain secondary data.

The third stage involves data analysis, where qualitative data is analyzed using thematic analysis to identify patterns and key challenges in the implementation of OHS. Meanwhile, quantitative data is analyzed statistically. This analysis is also supported by the application of risk assessment models, such as Heinrich's Domino Theory and Five Steps to Risk Assessment from HSE, to identify potential hazards and design mitigation strategies. The fourth stage is to provide input for the development of optimization strategies, which include recommendations for the application of advanced technologies such as IoT-based monitoring systems, training using Virtual Reality (VR), and automation of risky processes with robotic technology. The fifth stage is the strategy trial and validation, where the proposed strategy is tested on a small scale in an industrial environment to evaluate its effectiveness in improving work safety and efficiency. The results of this trial are then analyzed and adjusted based on feedback from workers and management. The final stage is the preparation of the report and dissemination of the research results, where the findings, recommendations, and practical implications of the study are presented. The final report is expected to make a significant contribution to the development of OHS practices in the modern lemuru fish processing industry, creating a safer, more productive, and more competitive work environment in the global market.

Analysis Procedure

The study on optimizing the implementation of Occupational Health and Safety (OHS) in the modern Lemuru fish processing industry used a mixed methods approach, combining qualitative and quantitative methods to ensure a comprehensive understanding of existing safety practices and the development of effective optimization strategies. The qualitative approach involved interviews, observations, and document analysis to explore worker perceptions, management policies, and safety culture. Simultaneously, the quantitative approach included the collection and statistical analysis of data related to accident rates, safety compliance, and productivity, which allowed for an evaluation of the effectiveness of current OHS measures. Data collection methods included systematic observation of processing activities to identify safety risks, semi-structured interviews with employees and management to understand safety challenges, and questionnaires distributed among workers to assess awareness and attitudes towards OHS protocols. In addition, document analysis was conducted to evaluate compliance with national and international safety standards. The data analysis process combined thematic analysis for qualitative data and statistical techniques as for quantitative data, which ensured a thorough examination of the relationship between OHS practices and safety outcomes. Risk assessment models, including Heinrich's Domino Theory and the Health and Safety Executive's Five Step Risk Assessment, were applied to identify and mitigate workplace hazards. To ensure the validity and reliability of the study, triangulation was used to cross-validate data from multiple sources, and expert review was conducted to refine the findings and recommendations. A pilot test of the proposed OHS optimization strategy was also conducted in a controlled environment to evaluate its practicality and effectiveness. Ethical considerations, such as maintaining confidentiality, obtaining informed consent, and ensuring objectivity by minimizing researcher bias, were strictly adhered to throughout the research process. This comprehensive methodology ensures that the study provides robust insights and practical recommendations to improve OHS implementation in the modern Lemuru fish processing industry, ultimately contributing to a safer workplace, increased productivity, and greater industry competitiveness.

RESULTS

The implementation of Occupational Safety and Health (OHS) in the company has a very important role in creating a safe, healthy, and productive work environment for all employees, including the QC Unit in the XYZ industry. As a form of commitment to OHS standards, the company has ensured that every QC member uses adequate safety equipment, such as hats, masks, and protective shoes while working. The use of this equipment not only serves to protect workers from potential accident risks in the production area, but also helps prevent contamination that can affect product quality. With good OHS implementation, the company can reduce work incidents and increase operational efficiency. Details regarding the OHS equipment used by QC can be seen in Table 1 and Table 2.

Table 1. OHS Equipment in QC Unit

Room	OHS Equipment	Quantity	Documentation
Receiving raw materials	- Hat (men)	3 Pcs	
	- Hijab (women)	3 Pcs	
	- Work uniform	3 Pcs	
	- Mask	3 Pcs	
	- Gloves	3 Pairs	
	- Boots	3 Pairs	
	- Socks	3 Pairs	
Production room	- Hat (men)	5 Pcs	
	- Hijab (women)	5 Pcs	
	- Work uniform	5 Pcs	
	- Mask	5 Pcs	
	- Gloves	5 Pair	
	- Boots	5 Pairs	
	- Socks	5 Pairs	
Laboratory	- Hat (men)	5 Pcs	
	- Hijab (women)	5 Pcs	
	- Work uniform	2 Pcs	
	- Mask	2 Pcs	
	- Gloves	2 Pairs	
	- Boots	2 Pairs	
	- Socks	2 Pairs	
Seamer section production room	- Hat (men)	1 Pcs	
	- Hijab (women)	1 Pcs	
	- Work uniform	2 Pcs	
	- Mask	2 Pcs	
	- Gloves	2 Pairs	
	- Boots	2 Pairs	
	- Socks	2 Pairs	
Retort	- Hat (men)	1 Pcs	
	- Hijab (women)	1 Pcs	
	- Work uniform	1 Pcs	
	- Mask	1 Pcs	
	- Gloves	1 Pair	
Finished product warehouse	- Hat (men)	2 Pcs	
	- Hijab (women)	3 Pcs	
	- Work uniform	5 Pcs	
	- Mask	5 Pcs	
	- Gloves	5 Pairs	

Table 2. Function of OHS Equipment in QC Unit

Equipment	Function
Hat (Men)	Protects hair from falling into the product during processing. Maintains cleanliness and hygiene of the work area. Protects the head from dust or particles that can damage the product..
Hijab (Women)	Functions as a head covering for female workers to keep hair covered and not contaminate the product. Maintain hygiene and neatness while working in the production area.
Work Uniform	Protecting the body from splashes of raw materials or liquids that can harm the skin. Maintaining cleanliness and professionalism in the work environment. Preventing cross-contamination between personal clothing and processed products.
Mask	The occurrence of droplets or splashes of workers' saliva so as not to damage the product. Protects workers from dust, vapors, or hazardous particles that can be inhaled.
Gloves	Protecting hands from injury, chemicals, or extreme temperatures that may be present in the production process. There is direct contamination between the worker's hands and the product being processed.
Boots	Protects feet from sharp objects, spills of liquids, or chemicals in the production area. Reduces the risk of slipping or falling in wet or slippery work environments.
Socks	Provides additional comfort and protection when wearing boots. Absorbs sweat to maintain the cleanliness and health of workers' feet.

DISCUSSION

Optimizing the implementation of OHS in the lemuru fish processing process in the XYZ industrial QC unit is very important to create a safe and productive work environment. For this reason, various strategies are needed that focus on increasing worker awareness, improving facilities, and strengthening company policies related to occupational safety and health (OHS). Optimizing the implementation of Occupational Health and Safety (OHS) in the lemuru fish processing process in the XYZ industrial QC Unit can also be done through computer system engineering with a sophisticated technology approach and integrated system. By implementing the following strategies, the implementation of OHS in the XYZ industrial QC unit can be optimized. This will contribute to minimizing the risk of work accidents, increasing productivity, and maintaining the quality of the products produced. Good implementation of OHS not only provides benefits for workers but also for the company's desires and success in the long term. By implementing the strategies below, XYZ industry is expected to optimize the implementation of OHS in the QC unit, creating a safer, more productive, and quality work environment. Some steps that can be taken to achieve this goal include:

1. Increasing Awareness and OHS Training
   The first important step is to conduct regular training on OHS procedures, including how to use personal protective equipment (PPE) properly and handle lemuru fish raw materials safely. This training not only increases workers' understanding of the importance of safety, but also equips them with skills to reduce the risk of accidents. In addition, consistent socialization and occupational safety campaigns need to be carried out to increase awareness of all workers about the implementation of OHS. Periodic

evaluations are also needed to ensure that workers understand and comply with established procedures.

2. Improving Facilities and Work Environment
   Providing adequate PPE facilities is very important to protect workers from hazards in the work environment. Companies must ensure that gloves, masks, non-slip shoes, and work clothes comply with applicable safety standards. In addition, it is important to keep the work environment hygienic and safe. Improving ventilation systems, lighting, and floor conditions so that they are not slippery will reduce the risk of accidents. In addition, installing safety signs in the work area and routine maintenance of the tools and machines used are also important steps to ensure worker safety.
3. Improvement of Monitoring and Evaluation System
   Establishing a special team responsible for supervising the implementation of OHS is essential to ensure that OHS policies are implemented consistently. Routine inspections need to be conducted to identify potential hazards and take corrective action if necessary. In addition, an effective work incident reporting system must be in place so that any accidents or near misses can be explained and prevent similar incidents from happening again. Periodic internal OHS audits also need to be conducted to assess the effectiveness of the policies implemented and determine the necessary corrective measures.
4. Strengthening Company Policies and Regulations
   The company's OHS policies must always be adjusted to national and international regulations applicable in the fisheries industry. In addition, providing incentives to workers who consistently implement OHS procedures can increase their motivation and compliance with safety standards. Integrating OHS policies into the company's work culture is also very important. Making occupational safety and health part of the main indicators of worker performance will create a stronger commitment to implementing OHS at every level of the organization.
5. IoT (Internet of Things) Based Environmental Monitoring System
   Optimizing the implementation of Occupational Health and Safety (OHS) in the QC area can be done through the implementation of an IoT (Internet of Things) based environmental monitoring system. One of the main efforts is to install IoT sensors to control temperature, humidity, and air quality in real-time. This is important to prevent the creation of hazardous working conditions and ensure that the work environment remains safe and comfortable. In addition, automatic sensors are needed to detect hazardous gases, such as ammonia gas or other chemicals used in the fish preservation process. Early detection of leaks or increased levels of hazardous gases will reduce the risk of hazardous exposure to workers. Monitoring machine performance is also an important part of this system. The IoT system can be used to integrate and unify the performance of quality testing equipment in the QC Unit. If potential damage or decreased machine performance is detected that could endanger workers, this system will provide an early warning, so that preventive and corrective actions can be taken immediately. With the implementation of this technology, the risk of work accidents can be minimized and productivity in the QC area is maintained.
6. Computer-Based OHS Management System
   Optimizing the implementation of Occupational Health and Safety (OHS) in the QC Unit can be done through an integrated computer-based OHS management system. One important component in this system is the risk management application, which functions to identify, trigger, and control OHS risks in the work environment. This application allows companies to proactively manage potential hazards, so that the risk

of accidents can be minimized. In addition, this system is equipped with an automatic incident reporting application that allows real-time incident reporting. With this feature, every incident that occurs can be immediately recorded and reported, so that the OHS team can analyze incident patterns and provide appropriate solutions quickly. To facilitate monitoring, this system also provides an OHS dashboard that displays visual data related to OHS, such as accident statistics, audit results, and the level of compliance with safety procedures. This structured and easy-to-understand data display helps management make data-based decisions to improve work safety and efficiency in the QC Unit.

7. Virtual Training and VR (Virtual Reality)-Based Simulation
   The implementation of virtual training and technology-based simulation is a strategic step in optimizing Occupational Health and Safety (OHS) in the QC Unit. One effective method is emergency situation simulation using Virtual Reality (VR) technology. This technology allows workers to experience and occupy the handling of various emergency conditions, such as fires or chemical spills, in a safe and controlled environment. Thus, workers will be more prepared and skilled in dealing with high-risk situations in the real world. In addition, companies can also utilize the computer-based OHS e-learning platform. This platform provides interactive learning modules that can be accessed at any time by QC Unit employees, so that training is not limited by time and place. Through the combination of VR and e-learning, the training process becomes more flexible, effective, and easy to understand, which will ultimately increase workers' awareness and compliance with OHS standards in the work environment.
8. Automation of High-Risk Processes
   The application of robotics and automation in the Quality Control (QC) process is an important step to improve work safety in the QC Unit. Robotic technology can be used to reduce human interaction in high-risk processes, such as cutting fish samples and testing hazardous chemicals, so that the potential for work accidents can be minimized. In addition, the use of automated process control systems ensures that processing standards are met without excessive manual intervention, which not only reduces the risk of accidents but also increases efficiency and quality consistency at every stage of processing. By integrating robotics and automation, the QC Unit can create a safer, more productive, and OHS-compliant work environment.
9. Data Analytics for Risk Prediction
   The application of Machine Learning (ML) technology and Big Data analysis play an important role in optimizing the implementation of Occupational Health and Safety (OHS) in the QC Unit. ML algorithms can be used to analyze OHS data in depth and predict areas with high potential for accidents, so that companies can take preventive measures before an incident occurs. In addition, Big Data analysis allows companies to analyze historical data to identify patterns and trends related to workplace accidents or violations of safety procedures. By understanding these risk trends, companies can optimize OHS policies and develop more effective strategies in creating a safe, efficient, and productive work environment.
10. Early Warning and Rapid Response System
    The application of wearable devices and automated emergency response systems is an important step in improving occupational safety in the QC Unit. Smart devices such as smartwatches are used by workers to monitor vital signs, such as heart rate and body temperature, and provide early warnings if dangerous conditions are detected that could endanger their health or safety. In addition, automated emergency response systems function to activate alarms and carry out automatic evacuation procedures when sensors

detect potential hazards, such as toxic gas leaks or fires. With the integration of these technologies, emergency responses can be carried out quickly and efficiently, reducing the risk of accidents and ensuring maximum protection for all workers.

CONCLUSION

Research shows that optimal implementation of OHS is essential to create a safe, efficient, and productive work environment. Through various integrated strategies, companies can minimize the risk of work accidents, increase productivity, and maintain the quality of the products produced. Good implementation of OHS provides significant benefits, not only for the safety and health of workers, but also in supporting the success and competitiveness of the company in the global market.

Optimizing the implementation of OHS can be done through several strategic steps. First, increasing awareness and training of OHS is carried out through routine training, socialization, and periodic evaluation to ensure that workers understand and comply with safety procedures. Second, improving facilities and the work environment includes providing personal protective equipment (PPE) that meets standards, improving ventilation and lighting systems, and installing safety signs. Third, improving the monitoring and evaluation system is carried out by forming a monitoring team, reporting incidents effectively, and conducting periodic internal OHS audits.

In addition, strengthening company policies and regulations is the main key with adjustments to industry regulations and providing incentives to workers who comply with OHS procedures. The implementation of an IoT-based environmental monitoring system is also very important, with the installation of sensors to monitor temperature, humidity, air quality, and detect hazardous gases in real time. A computer-based OHS management system that includes risk management applications, automatic incident reporting, and an OHS dashboard helps management in data-driven decision making.

Furthermore, virtual training and VR-based simulations allow workers to practice dealing with emergency situations in a realistic yet safe manner. Automation of high-risk processes with the use of robotics and automated control systems reduces human involvement in hazardous processes, increasing efficiency and safety. Data analytics for risk prediction using machine learning and big data helps companies predict and prevent potential accidents by analyzing historical data. Finally, early warning and rapid response systems, including the use of smart devices and automated systems, ensure maximum protection for workers with efficient responses to hazardous situations. By integrating all these strategic steps and advanced technologies, the xyz industry QC Unit can optimize OHS implementation, create a safe and productive work environment, and increase the competitiveness of lemuru fish products in the global market.

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