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Occupational Health and Safety Risk Analysis Using AS/NZS Standards 4360:2004 in a Fish Meatball Industry

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Abstract: The Indonesian fishing industry developed by 1.4% in 2020, compared to the previous year, as shown by the existence of around 773 seafood factories. Such growth caused the emergence of different working conditions due to the use of complex machines. In 2019, the industrialization process generated an immense potential for accidents on occupational health as the mishaps increased from 60 to 270 cases. For this reason, this study aimed to identify the value and level of risk, using HIRARC (Hazard Identification Risk Assessment and Risk Control) following AS/NZS 4360:2004 standards. The study was conducted at the fish meatball company located in East Java, for six months. The results showed that the company could manage the occupational health and safety, as indicated by the reduction of the levels of risk from acceptable (33.4%), priority 3 (14.3%), priority 2 risk (38.1%), priority 1 risk (9.5%), and very high risk (4.8%) to acceptable (76%) and priority 3 (24%). The risk assessment matrix had shifted from yellow (moderate) to green (low). Some recommendations implemented in the workplace included creating a safety organization, organizing training sessions among employees, fostering a safety culture, applying ergonomic principles, and controlling work hours.

Keywords: Fish, hazard analysis, occupational health and safety, risk control, seafood industry.

Introduction

Indonesia has an important position in the main economic activities of fisheries, with abundant marine wealth resulting in bountiful seafood industry development [1][2]. The growth in seafood production reached around 7% per year, placing Indonesia as the largest producer in Southeast Asia [3]. The operation of about 773 or more seafood processing facilities showed a 1.4% increase in 2020, compared to the previous year[4]. Fish processing plants serve to prepare wild-caught or farmed seafood for final retail and consumption. They play a crucial role in preserving seafood, which are highly perishable; they help protect fish after harvest. On the other hand, the rapid development of the industry creates a diverse workplace and is also accompanied by greater risks and more diverse hazards due to increasingly complex machines and work equipment to support production.

According to the International Labor Organization (ILO)'s data, in 2020, over 2.78 million people died from workplace-related accidents or diseases, equating to one death every fifteen seconds. Whereas the rate of fatal work injury per 100,000 full-time equivalent workers of fisheries, agriculture, and forestry industries reached the top 14 [5]. In Indonesia, the largest number of work-related accidents in the seafood manufacturing industries was found in East Java; 60 accidents occurred in 2016, increasing to 270 in 2019 [6][7]. Despite the dependence of the country on the seafood processing business, researchers and industry management have not significantly compromised and discussed the importance of occupational health and safety (OHS) to support the seafood processing industry's sustainability [8]. Studies of OHS in Indonesian fisheries only focused on the capture fisheries field regarding safety at small-scale fishing vessels [9], creating decent work for fishermen [10][11], ergonomic awareness among fishermen [12], safety of purse seine fishermen at the ocean fishing port (PPS) [13], and OHS risk assessment for informal jobs such as fishermen [14]. Whereas, the seafood manufacturing industries have not been widely revealed, even though [15] stated that certain hazards encompassing physical, biological, dropped objects, repetitive work injuries, exposure to chemicals, heat and cold, as well as confined space and noise are likely to occur during the production.

OHS issues among seafood workers are more frequent because of the increased consumption and processing of seafood. [16] reported that workers who process fish are likelier to report OHS issues, such as injuries, skin and respiratory allergy symptoms, and other health issues. The increased levels of seafood production and processing also arise the use of hazardous materials, large machines, complex tools, and incompatible standard

operation procedures, despite the workers' lack of skills and work training and nescience about new sources of hazards, that leads to the potential of work accidents [17][18]. These workplace health issues have caused afflicted workers to be more incapacitated and absent more frequently.

The fish meatball company located in East Java that is classified as a semi-modern company since it combines human and machine powers. As a seafood processing plant, it must consider replacing any damage related to its operation and providing medical and maintenance costs. In fact, the company had not yet implemented an acceptable OHS program. Deaths, injuries, and diseases can be avoided with the help of OHS programs that proactively remove and regulate dangers by following certain standards[19]. Several standards governing risk-management include Indonesian Government Regulation no. 12 of 2012, International Standardization Organization (ISO) 45001:2018 and Australian Standard/New Zealand Standard AS/NZS 4360. Safety studies can uncover stakeholders' knowledge, attitudes, and behaviors, an understanding of which is critical for developing effective OHS interventions [20][21]. However, the literature shows limited data about research that revealed the risk assessment in fish meatball industries in Indonesia to explore views regarding safety conditions at the workplace, which can be a decisive factor in preventing fatalities, injuries, and illnesses. For this reason, this current study aimed to fill this gap by exploring, identifying, and analyzing hazards in the fish meatball company using AS/NZS 4360 standards, which provide general guidelines for risk management and can be widely applied in various activities, decision-making, and operations within companies. The standards have been commonly used in public, private, and people's companies an even at group or individual levels. AS/NZS 4360 helps companies in terms of determining contexts, identifying hazards, carrying out risk assessments, and implementing risk control. As a result, the company became able to take precautionary measures against potential threats. The results of this study can also be used as a benchmark for further OHS studies of seafood industries in Indonesia.

Methods

This research was conducted at the fish meatball industry. The object of this study was the production area of surimi and fish meatballs. The researchers collected the data by way of literature studies and field surveys through interviews with company management and several employees for six months, from June to December 2022. As many as 25 employees, one general manager, and one production department supervisor, were interviewed. The method used in this study was HIRARC (Hazard Identification, Risk Assessment and Risk Control) to identify the value and level of risk of potential hazards. The procedure included determining the characteristics of potential hazards and evaluating the impacts that may arise using a risk assessment matrix. Risk assessment was conducted according to the Australian Standard/New Zealand 4360:2004 Standards for Risk Management [22].

Table 1. Semi-quantitative factor risk analysis [22]

Category	Description	Rating
	Consequences	
Catastrophe	Mass death; permanent damage to the environment	100
Disaster	Death; permanent locational damage to the environment.	50
Very Serious	Permanent disability; temporary environmental damage	25
Serious	Serious effects on workers but not permanent; adverse environmental impact but not major	15
Important	Requires medical assistance; exhaust emissions occur but do not cause damage	5
Noticeable	Minor injury or illness; minor loss of production; minor loss of equipment or machinery but no effect on production	1
	Exposure	
Continuously	> 1 per day	10
Frequently	> about 1 per day	6
Occasionally	> 1 per week/month	3
Infrequent	> 1 per month/year	2
Rare	Unpredicted	1
Very Rare	Very unpredicted	0.5
	Probability	
Almost certain	The most likely occurrence	10
Likely	The chances of an accident are 50:50	6
Unusual but Possible	It's not common, but it might happen.	3
Remotely Possible	The probability of an accident occurring is very small.	1
Conceivable	There hasn't been an accident in years, but it might happen.	0.5
Practically Impossible	Very unlikely	0.1

The data obtained were analyzed with a predetermined analysis and then processed into informative and comprehensive data. Data processing was carried out using a semi-quantitative descriptive method. At the same time, the risk calculation was done based on William T. Fine's formula [23]. The value of risk was determined by the values of the impact (consequences), exposure, and likelihood (probability) as shown in Equation (1):

$$Risk\ Score = Consequences\ x\ Exposure\ x\ Probability \quad (1)$$

The risk matrix was developed based on the level of impact (consequence), exposure, and likelihood (probability) of various possible risks, as seen in Table 1.

The level of risk score is shown in Table 2.

Table 2. Level of risk

Risk Level	Degree	Action	Hierarchy of control
350	Very High	Stop the activity until the risk is reduced	Engineering
180 – 350	Priority 1	Requires immediate corrective action	Administrative
70 – 180	Substantial	Requires corrective action	Training
20 – 70	Priority 3	Requires attention and supervision	Personal Protective Equipment (PPE)
20	Acceptable	The intensity of activities that pose a risk is reduced to a minimum	-

After the risk score of each threat was obtained, some recommendations were arranged by management to reduce the level of risk. The actions comprised prevention, detection, control, mitigation, and emergency response to oversee the hazards. Eventually, the basic and final of risk values can be plotted in the risk matrix using the Equation (2).

$$Risk\ Matrix\ Value = \frac{Total\ Risk\ Value}{Number\ of\ Causes/Threats} \quad (2)$$

Results and Discussions

Fish Meatball Production Process Flow

Figure 1 illustrates the workflow for producing fish meatballs at the industry.

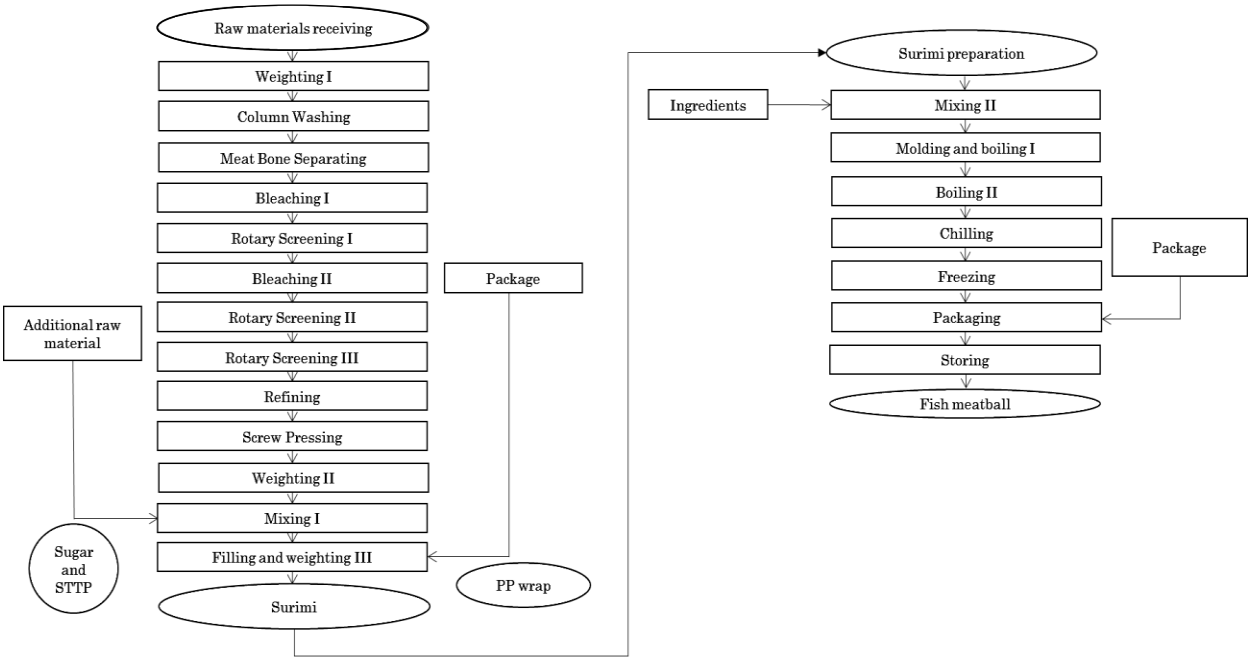


Figure 1. Meatball production process flow

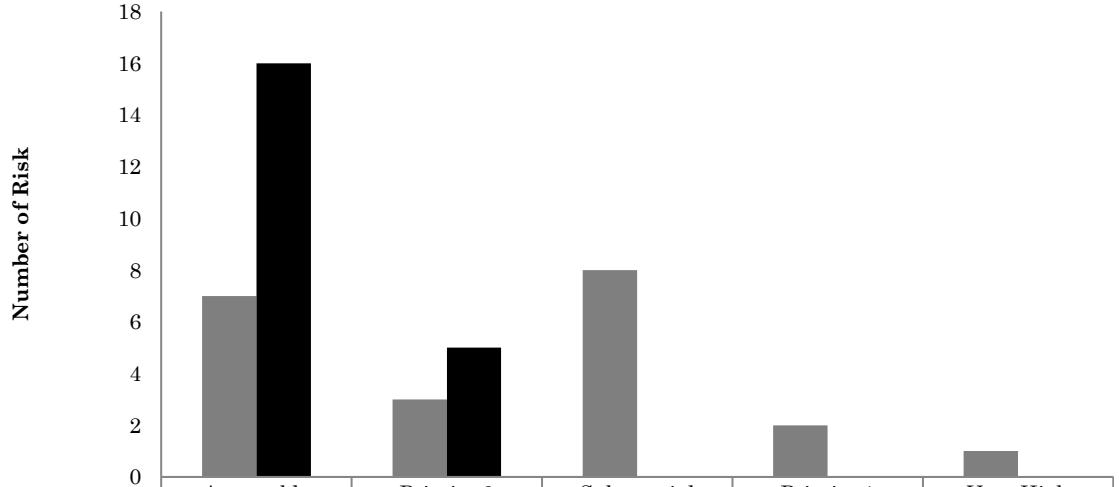
The surimi production process at industry commenced with raw materials loading from suppliers and was then followed by weighing I and washing in the column to clean the dirt on the fish's body at 7°C. The clean fish were conveyed to the meat-bone separating machine to separate between the meat, skin, and bones prior to being washed at bleaching I with a salt and calcium chloride solution at 100°C in the first holding tank. Next, the fish meat was detached from the water at the rotary screen I and then forwarded to the second tank to be washed (bleaching II). The step was followed by the water separation process at the rotary screens II and III. Afterwards, the fish meat was pumped into the refining machine to separate the remaining fine thorns and scales. Then the screw press process was carried out to reduce the water content in the fish meat. Sugar and sodium tripolyphosphate (STTP) were poured and mixed evenly with meat. Then surimi was ready to be molded with a weight of 10 kg to be packaged using PP (polypropylene) plastic and frozen using a contact plate freezer machine.

Meanwhile, the fish meatball production began with the preparation of raw materials utilizing surimi that had been thawed and cut into smaller pieces. This process also used cassava starch, STTP, isolated soy protein flour (ISP), palm oil, salt, sugar, flavoring, egg powder, and ice cubes. All ingredients were mixed gradually until they reached desired texture. The finished dough was then brought to the molding machine and the boiling processes, which consisted of 2 stages: the first boiling carried out for 15 minutes at 45°C - 50°C and the second one at a temperature of 95°C - 100°C for 20 minutes to elude the denaturation process and attain a perfect texture. At the next stage, the fish meatballs were cooled by soaking them in cold water and put them into a freezing machine, namely IQF (Individual Quick Frozen), at a temperature of -30°C. These frozen fish balls were packaged with a weight of 250 g and then eventually stored in cold storage at a temperature of -25°C.

Risk Calculation

The risk assessment was conducted by recording the risks of hazards that occurred during the production process through direct interviews with employees and observations in the plant. The calculation involved two types of risk: basic and existing. In this term, the former refers to the risk that already existed in the workplace, while the latter means that occurring after the application of preventive and control measures in the fish meatball production. The results of the risk assessment at the company can be seen in Table 3.

A risk assessment was conducted to investigate the efficiency of risk control in the workplace. As shown in Table 3, risk reduction outcomes were produced by subtracting the basic risk value from the existing risk value and then multiplying the results by 100%. Risk reduction means the percentage of risk that a company can diminish through implementing risk management [24]. Overall, 21 types of risks have been found that potentially induce accidents in OHS of fish meatball production. Meanwhile, the distribution of both basic and existing risks can be seen in Figure 2.



	Acceptable	Priority 3	Substantial	Priority 1	Very High
Basic Risk	7	3	8	2	1
Existing Risk	16	5	0	0	0

Figure 2. Basic and existing risk values

Table 3. Level of risk in the fish meatball industry

No	Process	Causes/ threats	Consequences	Basic risk value			Risk value	Risk level	Existing risk value			Risk value	Risk level	Risk reduction (%)
				C	E	P			C	E	P			
1.	Surimi production process	Slips, trips, and falls	Sprain; dislocation	1	6	6	36.0	Acceptable	1	2	3	6.0	Acceptable	83.3
		Electricity	Injury; death	50	1	1	50.0	Priority 3	15	0.5	0.5	3.8	Acceptable	92.5
		Struck down by deadweight (Dropped object)	Minor/severe finger injury	15	3	3	135.0	Substantial	5	3	3	45.0	Priority 3	66.7
		Punctured by fishbone/ spine	Injury/infection	15	6	10	900.0	Very High	1	6	10	60.0	Priority 3	93.3
		Sharp tools cut	Minor/severe fingers	25	1	3	75.0	Substantial	5	1	1	5.0	Acceptable	93.3
		Sprained on the hand	Minor injury	1	3	6	18.0	Acceptable	1	3	3	9.0	Acceptable	50.0
		Minor hand injury	Minor injury	1	10	10	100.0	Substantial	1	3	10	30.0	Priority 3	70.0
2.	Fish meat dough process	Slips, trips, and falls	Sprain, dislocate	1	3	3	9.0	Acceptable	1	1	3	3.0	Acceptable	66.7
		Sharp tools cut	Minor/severe finger injury	25	1	3	75.0	Substantial	5	1	1	5.0	Acceptable	93.3
		Noise	Hearing disorders	25	1	6	150.0	Substantial	1	1	6	6.0	Acceptable	96.0
3.	Fish ball production process	Exposed to hot water	Minor/severe injury	5	6	6	180.0	Substantial	1	6	10	60.0	Priority 3	66.7
		Struck down by deadweight (Dropped object)	Minor/severe injury	1	3	1	3.0	Acceptable	1	3	1	3.0	Acceptable	0.0
		Slips, trips, and falls	Sprain; dislocation	1	3	3	9.0	Acceptable	1	3	3	9.0	Acceptable	0.0
		Hot surface/heat stress/hot room temperature	Burnt/dehydra-tion	5	6	10	300.0	Priority 1	1	6	6	36.0	Priority 3	88.0
		Insufficient lighting	Eye discomfort (burning, etc.) and headaches	1	2	3	6.0	Acceptable	1	2	3	6.0	Acceptable	0
		Noise	Hearing disorders	15	1	6	90.0	Substantial	1	1	6	6.0	Acceptable	93.3
4.	Fish meatball packaging	Sitting too much	Back pain	15	2	10	300.0	Priority 1	1	2	6	12.0	Acceptable	96.0
		Stuck in the vacuum sealer	Minor injury	5	3	6	90.0	Substantial	1	1	6	6.0	Acceptable	93.3
		Struck down by deadweight (Dropped object)	Minor/severe injury	5	2	6	60.0	Priority 3	1	2	6	12.0	Acceptable	80.0
		Insufficient lighting	Eye discomfort (burning, etc.) and headaches	1	2	3	6.0	Acceptable	1	2	3	6.0	Acceptable	0.0
		Boredom	Lack of concentration, leading to injury	1	3	10	30.0	Priority 3	1	1	10	10.0	Acceptable	66.7

The basic risk calculation showed the following results: acceptable (33.4%), priority 3 (14.3%), priority 2 risk (38.1%), priority 1 risk (9.5%), and very high risk (4.8%). After risk control was implemented in the company, as shown in Table 3, there was a significant decrease in the existing risk, namely 16 acceptable (76%) and five priority 3 (24%) risks. The elimination was conducted based on the actions shown in Table 4.

Table 4. Occupational accidents hazard in fish meatball industry

Causes/threats	Prevention	Potential consequences	Detection	Control	Mitigation	Emergency response
Slips, trips, and falls	Proper making and signage** (√) Sufficient level of lighting* (√) Non-slip surfaces** (√) Personnel protective equipment (PPE)* (√) Proper location design* HSE awareness (e.g., health monitoring, etc.)* (√) Specialized inspection personnel** Trained and competent personnel* (√) Performing routine inspection and maintenance* (√) Designed and scripted in the proper language** (√) Strategic and eye-catching location and design** (√) Material selection and applications** Good housekeeping** (√) Proper QA/QC* (√) Budget for purchasing PPE** Workshop training and awareness program* (√) Routine socialization** (√) Providing campaign signage/poster** (√) HSE induction** Modifying, if necessary**	Personnel serious injuries/fatalities Reputation loss	CCTV* (√).	Cleaning equipment* (√) Spill and drainage system* (√)	Signage of spills and wet areas** (√)	Emergency response*(√) First Aid Tool* (√) Insurance* (√) Social media policy** (√) Public communication officer** (√)
Electricity	Material selection* (√) Design and specifications, codes, and standards* (√) Independent review and verification of the design* (√) Maintenance and inspection* (√) Maintenance procedure* (√) Specialized inspection personnel** Trained and competent personnel* (√) Proper QA/QC* (√) Budget for purchasing PPE** Workshop training and awareness program* (√) Routine socialization** (√) Providing campaign signage/poster** (√) HSE induction**	Personnel serious injuries/fatalities Production loss Reputation loss	Active and passive firefighting** CCTV* (√) Neat cabling system** (√) System design coverage**	Emergency Shutdown System (ESD)** Certified Electrical Equipment* (√)	Fire Extinguisher* (√)	Escape and Evacuation Routes* (√) Muster Area* (√) General Alarm* (√) Fire Blanket** Emergency Response* (√) First Aid Tool* (√) Insurance* (√)
Struck down by deadweight (Dropped object) Punctured by fish bone/spine. Sharp tools cut Sprained on the hand Minor hand injury	Proper making and signage** (√) Providing adequate barriers** Using proper PPE** (√) Quality PPE** Selection and application of proper PPE** (√) Budget for purchasing PPE** Performing routine inspection and maintenance* (√) Manual handling procedures** (√) Designed and scripted in the proper language** (√) Strategic and eye-catching location and design** (√) Workshop training and awareness program Routine socialization* (√) Providing campaign, signage/poster** (√) HSE awareness (e.g., health monitoring, etc.)* (√)	Personnel serious injuries/ fatalities	CCTV* (√). System design coverage**	Equipment orientation location and equipment geometry where possible** (√) Certified equipment** (√)	Signage of heavy and sharp materials** (√) SOP of the process** (√)	Emergency Response* (√) First Aid Tool* (√) Routine socialisation* (√) Insurance* (√) Social media policy** (√) Public communication officer** (√)
Noise	Personnel protective equipment (PPE)* (√) Selection and application of proper PPE** (√) Quality PPE** Proper making and signage** (√) Workshop training and awareness program* (√) Routine socialization** (√) Providing campaign signage/poster** (√)	Personnel serious injuries/ fatalities Reputation loss	Noise detector**. System design coverage**	Certified equipment* (√)	Noise enclosures and walls* (√)	Emergency Response* (√) First Aid Tool* (√) Routine socialisation* (√)

Causes/threats	Prevention	Potential consequences	Detection	Control	Mitigation	Emergency response
	HSE awareness (e.g., health monitoring, etc.)* (√)					
Exposed to hot water	Proper making and signage** (√) Using proper PPE (√)** Quality PPE** Selection and application of proper PPE** (√) Budget for purchasing PPE** Performing routine inspection and maintenance* (√) Manual handling procedures** (√) Workshop training and awareness program* (√) Routine socialization** (√) Providing campaign signage/poster** (√) HSE awareness (e.g., health monitoring, etc.)* (√)	Personnel serious injuries/ fatalities	Insulate hot surface* (√) Active and passive firefighting** CCTV* (√) System design coverage**	Emergency Shutdown System (ESD)** Certified equipment* (√)	Fire Extinguisher* (√) Dry Chemical Fire Extinguisher** First Aid Tool* (√)	General Alarm* (√) Fire Blanket** Emergency response* (√) Routine socialisation* (√) Insurance* (√)
Hot surface/ heat stress/ hot room temperature	Proper making and signage** (√) ** (√) Designed with protection cage for equipment and piping at high temperature** Perform campaign posters in the workplace** (√) Designed and scripted in the proper language** (√) Proper and good planning** Time management/working hours restrictions** (√) Strategic and eye-catching location and design** (√) Sufficient amount and competency of workers** Company general rules* (√)	Personnel serious injuries/fatalities Production loss Reputation loss	Active and passive firefighting** CCTV* (√) System design coverage**	Emergency Shutdown System (ESD)**	Fire Extinguisher* (√). Dry Chemical Fire Extinguisher**. First Aid Tool* (√).	Escape and Evacuation Routes* (√) Muster Area* (√) General Alarm* (√) Fire Blanket** Emergency response* (√) Routine socialisation* (√) Insurance* (√) Social media policy** (√) Public communication officer** (√)
Stuck in the vacuum sealer	Personnel protective equipment (PPE)* (√) Selection and application of proper PPE** (√) Quality PPE** Proper making and signage** (√) Workshop training and awareness program* (√) Routine socialization** (√) Providing campaign signage/poster** (√) HSE awareness (e.g. health monitoring, etc.)* (√)	Personnel serious injuries/fatalities	CCTV* (√)	Certified equipment* (√)	First Aid Tool* (√) SOP of the process** (√)	Emergency response* (√) Routine socialisation* (√) Insurance* (√) Social media policy** (√) Public communication officer** (√)
Insufficient lighting	Designing sufficient lighting* (√) Proper and good planning* (√) Sufficient level of lighting* (√) Performing routine inspection and maintenance* (√) Designed and scripted in the proper language** (√) Routine socialisation** (√) Providing campaign signage/poster** (√) Modifying, if necessary**	Personnel serious injuries/ fatalities	Active and passive firefighting** CCTV* (√) System design coverage**	Certified equipment* (√)	Fire Extinguisher* (√) Dry Chemical Fire Extinguisher** First Aid Tool* (√)	Escape and Evacuation Routes* (√) Muster Area* (√) General Alarm*(√) Fire Blanket** Emergency response* (√) Routine socialisation* (√) Insurance* (√)
Sitting too much Fatigue/ boredom	Independent review and verification of the design* (√) Human factors engineering (HFE)** Operating and maintenance procedures* (√) Review, audit, and update** Fatigue and stress checks (e.g., thermal growth)** Maintenance and inspection* (√) Maintenance procedure* (√) Specialized inspection personnel** Trained and competent personnel* (√) Ergonomic principles** Standard working hours* (√)	Personnel serious injuries/ fatalities	CCTV* (√). System design coverage**	Certified equipment*(√)	SOP of the process** (√)	Emergency response* (√) Routine socialisation* (√) Insurance* (√) Social media policy** (√) Public communication officer** (√)

Notes:
* Actions that already existed in the company and were improved during the study
** Actions that were added/installed during the safety study
(√) Actions that were undertaken in the company

Table 4. reported that the OHS analysis in the fish meatball industry showed 14 threats that appeared during the surimi and fish meatball productions. However, the company focused more on the emergency response than on the prevention, control, and mitigation factors. Therefore, hazards were likely to happen during the production process. After the risk assessment, as shown in Table 3 and Table 4. , the company listed several aspects that comply with the factory to be used as guidelines at the workplace to eliminate hazards. The company, for some reasons, did not incorporate all of the recommendations but it still worked on enhancing the quality of OHS in the workplace for a long period by establishing a safety organization with trained and skillful personnel [25][27] who served as role models for employees, and provided them with guidance and social cues when determining what to value and prioritize.

Secondly, the company managed to hold training and knowledge sharing among workers periodically since it could boost safety in the workplace. Indeed, offering practical training has advantages [28]. It has been evidenced that higher learner-engagement techniques (such as behavioral modeling, simulation, and hands-on training) are more effective at improving safety knowledge and performance than low-engagement techniques are (e.g., lectures, video, and pamphlets) [29].

Managers should ensure that staff members can speak up anytime with questions, concerns, and feedback beyond the scheduled training sessions. Workers' compensation claims for injuries and disability can be significantly decreased by training the workers, to (1) improve the company's responses to workers' concerns, including early mentions of discomfort, and (2) communicating proactively with them since there is still a lack of safety organization in the company.

Thirdly, the company increased safety culture, by which the OHS outcomes may be predicted in part. A study reported that safety culture is significantly connected with employees' safety awareness, performance, and results in different industries [30][31][32]. A fair culture where managers do not punish employee faults or occurrences to "obscure systemic weaknesses and to blame one of the victims" is one of the positive organizational features that firm leadership and managers can cultivate over time.

Afterwards, the principles of ergonomics are thus a further crucial consideration to be concerned. Managers should put all the components of efficient ergonomic programs into practice to reduce musculoskeletal injuries and diseases. Participatory ergonomic solutions involve getting employees involved in problem-solving and giving the background and technical information that are needed to comprehend ergonomic principles and the authority to change the work processes [33]. In Table 3 and Table 4. , most of the hazards are associated with ergonomic mistakes, contributing to muscle strain, muscle imbalances, and fatigue. Many muscle strains result from performing the same motion repeatedly, which can cause repetitive stress injuries commonly occurring at workplaces [34].

Lastly, managing work hours is also necessary. [35][36][37] reported that the risks to OHS and productivity increase by long hours and shift work. Workers' physiological performance deteriorates with very long shifts; When 12-hour shifts are combined with more than 40 hours of labor a week, they can suffer from higher injury and sickness rates. Companies should therefore establish methods for managing tiredness risk. Managers should consider that the average person needs 8 hours of sleep per night to stay alert. Because of this, non-work time should be more than 8 hours to give workers a "real sleep opportunity" after attending to essential personal needs like eating and maintaining personal hygiene. Allowing workers to participate in creating their schedules is one strategy for lowering hazards associated with weariness, in addition to offering regular and suitable breaks [38].

In general, the risk matrix between basic and existing risks after the company performing risk control can be seen in Table 5.

Table 5. Risk matrix

Risk		Severity				
		1	2	3	4	5
		Not significant	Low	Moderate	High	Extreme
Probability	Almost certain					
	Likely					
	Possible					
	Unlikely	**16		*125		
	Rare					

Note:
*Basic Risk; **Existing Risk

Low | Moderate | High | Extreme

In the risk assessment matrix, the calculation was conducted based on Equation 2 where the basic risk occupied a yellow color, showing hazards rarely occurred (unlikely) with a moderate level of impact, requiring further control measures. Meanwhile, the existing risk was placed in green color, indicating that hazards often occurred (possible) with an insignificant level requiring solely control with routine procedures to prevent hazard risks [39][40]. In general, there was a change in the color level the company has taken preventive and supervisory measures. However, this only decrease the impact, not the possibility of occurrence, of hazards. Hazards remain occurring but rarely.

Conclusion

The HIRARC indicated 21 hazards in the fish meatball company based on AS/NZS 4360 standards. The basic risk was successfully reduced from acceptable (33.4%), priority 3 (14.3%), priority 2 risk (38.1%), priority 1 risk (9.5%), and very high risk (4.8%) to be the existing risk, with 16 acceptable (76%) and five priority 3 (24%) risks. The risk zone color also showed a reduction, from yellow to green. Some recommendations were applied to cover not only an emergency response but also prevention, detection, control, and mitigation measures, such as installing proper making signage, holding routine socializations, installing CCTV, creating SOP, providing sufficient fire extinguishers, etc. This finding showed that AS/NZS 4360 standards could be used to perform risk management in the seafood industries. Nevertheless, the industry must still set up a safety organization, perform training sessions and knowledge sharing among employees, practice a safety culture, apply ergonomic principles, and manage work hours. The researchers recommend that further studies monitor the recommendations until the company implements all the aspects. Similar studies in other fish meatball industries shall also be investigated to collect more thorough and extensive risk data regarding OHS.

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