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RESEARCH PAPER

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Assessment of Occupational Health and Safety for Marine Cage Culture: L-type Matrix Risk Analysis

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Abstract

As marine cage aquaculture continues to increase its volume in global protein food production, the demand for workers and labor continues to grow. This increasing demand, coupled with the fact that the industry is already risky in terms of occupational health and safety, makes risk assessment even more critical. The present study was conducted with engineers, trainees, and employees working at five different marine cage aquaculture facilities, as well as academicians from three different universities. As a result of the questionnaire conducted using the L-type 5x5 matrix method, the areas with the highest risk assessment scores (RASs) were identified as net cages (RAS: 9.7±3.3), ports (RAS: 10.0±2.0) and package units-cold storage (RAS: 9.6±3.3). Although no significant differences were observed among the occupational groups, significant variations were noted based on the working area ($p>0.05$). Notable differences in opinions were observed, particularly between academicians/trainees and engineers/employees. As a result, this study will serve as a guideline for both marine cage aquaculture facilities and all personnel, as well as for future research.

Introduction

Aquaculture industry plays a key role in meeting the demand for protein-rich foods in both marine and freshwater environments depending on the increasing world population (Ahmed et al., 2019; Aydoğan, 2020; Ferdouse et al., 2018; Minaz & Kubilay, 2021). While aquaculture has shown a continuous upward trend over the years, capture production remains at a maximum level due to its potential to damage natural fish stocks (Minaz et al., 2021). It has been previously predicted that capture production will remain around 93 million tons between 2010 and 2030 (World Bank, 2013). On the other hand, production from aquaculture needs to reach 140 million tons by 2050 to meet population needs (Waite et al., 2014). In light of these assumptions, the number of aquaculture facilities worldwide is expected to increase. This growth in aquaculture facilities also implies a rise in employment within these facilities. In 2005, the number of people directly or indirectly employed in the aquaculture and fisheries sector was 23.4 million (Valderrama et al., 2010). By 2022, this number had risen to 58.5 million, with 20.7 million of these employed in the aquaculture industry (FAO, 2022).

Aquaculture facilities, which are increasingly attracting interest from investors, are in a higher risk group for occupational diseases and injuries, with very few reports addressing this issue (Mert & Ercan, 2015). Because, in addition to general agricultural technologies, personnel working in aquaculture facilities are also exposed to unusual scenarios such as water impoundments, night-time work, and offshore operations (Myers, 2010). Compared to other aquaculture systems, marine aquaculture presents higher risks due to its unique environmental and operational challenges. These include the complexities of offshore operations, exposure to harsh weather

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conditions, and the need for specialized equipment and safety measures (Ngajilo & Jeebhay, 2019). For employees in aquaculture facilities—a high-risk profession—there is a limited analysis of occupational safety and health prevention and risk reduction strategies. Consequently, scientific research emphasizes the need for a global commitment to addressing these occupational safety and health concerns (Douglas, 1995; FAO, 2020).

It is a tragic situation that global statistics show one worker dies every 15 seconds due to a workplace accident, while approximately 160 workers are exposed to work-related accidents (Mert & Ercan, 2014). Globally, it has been reported that over 2.3 million workers die each year due to workplace accidents and occupational diseases. Additionally, more than 317 million people suffer from work-related accidents. These statistics highlight the severe impact of workplace safety issues and underscore the urgent need for effective prevention and intervention measures across all industries (Kılkıs, 2013). In the aquaculture sector, the mortality rate for workers in Norway is 17 times higher compared to other industries (McGuinness et al., 2013). In the U.S. aquaculture sector, 6.8 non-fatal accidents per 100 workers were reported in 2006 (Cole et al., 2009). On the other hand, in Türkiye, the rates per 100 workers for overall incidents, permanent incapacity, and fatalities are 449.4, 4.7, and 5.7, respectively (Soykan, 2023). Workers in aquaculture facilities are particularly vulnerable to occupational injuries and diseases because of insufficient health and safety management strategies (Marques et al., 2020). The lack of comprehensive safety protocols and risk management practices in these facilities leaves employees exposed to a range of potential hazards, from physical injuries to long-term health issues. This highlights the urgent need for more robust health and safety measures to protect workers in the aquaculture industry. As a result, there remains a significant lack of awareness regarding the occupational comfort and potential risks faced by workers in the aquaculture sector. The aim of this paper is to evaluate the occupational risks that may occur in an integrated marine aquaculture facility. This was achieved by creating case scenarios based on interviews with personnel of various roles and conducting risk assessments according to these scenarios. In addition to addressing existing gaps in the literature, this study holds significant value by raising awareness among industry stakeholders regarding occupational health and safety in marine cage aquaculture. By providing insights into risk assessment and management practices, it aims to foster a safer working environment and promote best practices within the sector. The novelty of this work lies in its comprehensive approach, combining empirical data with theoretical frameworks, thereby offering a unique perspective on the intersection of safety protocols and aquaculture operations. Furthermore, the study introduces innovative risk assessment methodologies, such as the L-Matrix, which have not been extensively applied in this context, enhancing the potential for practical applications and further research in the field.

Material and Method

Marine Cage Facility

This study was conducted in five different integrated marine aquaculture facilities operating in the Southeastern Black Sea. All of these facilities have specialized in the farming of kilogram-sized rainbow trout (Turkish salmon) grown in the Black Sea region, aiming to increase competition with Norwegian salmon in recent years. As a summary of facilities within the standards of Türkiye, net cage facilities have been considered. From the perspective of occupational health and safety risk assessment, the facilities have been divided into different work areas. These are: (1) net cage, (2) boat, (3) dining hall, (4) feed storage, (5) port, (6) general, (7) administrative building, (8) package unit and chill store, (9) net repair and washing unit, and (10) locker room. The risk assessment was conducted both for the entire facility and individual work area.

Questionnaire Study and Data Collection

The questionnaire was developed in collaboration with academic experts and private sector stakeholders. The survey consists of a total of 72 questions and is structured according to a 5-point Likert scale. The questionnaire contains different questions for each work area, with the following number of questions prepared for each: net cage (9), boat (6), dining hall (5), feed storage (10), port (3), general (11), administrative building (16), packaging unit and chill store (5), net repair and washing unit (2), and locker room (5). The questions were presented within a 5x5 matrix (explained in section 2.3) that includes a case scenario and the associated risks. According to expert opinions, the survey has content validity. The internal reliability of the questionnaire is high, as indicated by a Cronbach's alpha reliability coefficient (Cronbach's Alpha=0.919).

A total of 9 participants from each facility took part in the questionnaire. These participants were evenly distributed among engineers, trainees, and employees. Additionally, the questionnaire was conducted with 15 participants from three different state universities, specifically from the faculties of fisheries, marine sciences, and the occupational health and safety departments. The four groups surveyed (engineers, academicians, interns, and workers) were selected to assess occupational health and safety risks in marine net cages from different perspectives. Engineers contribute technical knowledge, while academicians offer a scientific viewpoint. Interns represent awareness levels during the training process, and workers are the group directly exposed to on-site risks. This diversity ensures a more comprehensive risk analysis by incorporating input from all levels of expertise. The differing risk perceptions require balancing theoretical knowledge with field experience in practical applications. When academicians' theoretical approaches and engineers' technical solutions are combined with the on-site experiences of workers and interns, safety measures become more effective. This balance enhances the practicality of implementing safety precautions while highlighting the importance of training and awareness programs to address gaps in knowledge and experience among workers and interns. Thus, interviews were conducted with a total of 60 participants. The demographic characteristics of the questionnaire participants are presented in Table 1.

L Type Matrix

The L-type matrix risk assessment is a simple method that presents the relationship between likelihood and consequence for any risk factor (Table 2). The L-type decision matrix offers advantages over other methods such as Fine-Kinney, HAZOP, and FMEA due to its simplicity, speed, and ease of use. Based on likelihood and severity, this method does not require complex calculations, making it ideal for quick and practical risk assessments. While others involve more detailed analyses and require expertise, the L-type decision matrix can be easily applied by participants at all levels. Additionally, it is a cost-effective and time-saving approach, providing flexibility and rapid solutions in dynamic environments like marine net cages, where conditions change frequently. This makes the L-type decision matrix a preferred choice in such settings. The 5x5 L-type decision matrix is an ideal scale for analysts performing individual risk analyses, as it can be applied by a single expert (Özgür, 2021). An L-type matrix analysis was conducted for 72 different case scenarios (SM 1). For each case study, participants rated the likelihood and consequence on a scale from 1 to 5. The likelihood and consequence data from industry experts were multiplied to create the Risk Assessment Score (RAS) (eq. 1). Based on the resulting RAS, the risks were categorized into three groups: low risk (≤8), moderate risk (8 < risk < 15), and extreme risk (≥15) (Güner, 2018).

In the RAS calculation, the likelihood of an event scenario is first determined based on the participant (expert), and then the potential impact of the event is assessed. The scale values for the likelihood parameter are as follows: (1) almost never, (2) very rarely (once a year), (3) occasionally (several times a year), (4) frequently (once a month), and (5) very frequently (once a week, daily). The scale values for the consequence parameter are: (1) no work time loss, first aid required, (2) no workday loss, no lasting effects, (3) minor injury,

Table 1. The demographic profiles of the participants in the questionnaire

Groups		Percentage (%)
Occupational group	Academician	25.0
	Engineer	25.0
	Trainee	25.0
	Employee	25.0
Gender	Male	73.3
	Female	26.7
Age	18-24	23.3
	25-34	18.3
	35-44	31.7
	45-54	15
	55 or above	11.7
Degree	Diploma or below	25.0
	University	25.0
	Postgraduate	8.3
	PhD	41.7

Table 2. RAS, likelihood, and consequences scale

RAS		**Consequence**				
		1	2	3	4	5
Likelihood	1	1	2	3	4	5
	2	2	4	6	8	10
	3	3	6	9	2	15
	4	4	8	12	16	20
	5	5	10	15	20	225
🟩	Low risk	: Requires active or passive acceptance				
🟨	Moderate risk	: Requires response development, but not quantification				
🟥	Extreme risk	: Immediate attention and response needed				

short-term treatment, (4) serious injury, long-term treatment, occupational disease, and (5) death, permanent disability.

$$RAS = likelihood \times consequence \qquad \text{(eq. 1)}$$

Statistical Analysis

The RAS values for all case scenarios in each study area are presented as mean ± standard deviation. The normality distribution was checked using the Kruskal-Wallis test. According to this, significant differences between the groups were determined by One-way ANOVA and Tukey tests. The similarity analysis of RAS means among the study areas was determined using the Euclidean distance method. All statistical analyses were performed using the SPSS 22 software package for Windows.

Results

Each case scenario, its potential consequences, and prevention recommendations for each work area are presented in detail in SM 1. Significant differences were observed among work areas based on different occupational groups (Table 3). For academicians, the highest risk was significantly found in the package unit and chill store and the net repair and washing unit, while the lowest RAS values was in dining hall, and boat ($p<0.01$). For engineers, the highest risk levels were observed in the net cage, while the lowest risk was in the net repair and washing unit ($p<0.01$). For trainees, there were no significant differences in risk among the work areas ($p>0.05$). For employees, the highest RAS was observed at the port, while the lowest risk was in the dining hall ($p<0.01$). Finally, regardless of occupational groups, the working areas with the highest risk in the facilities were identified as the net cage, port, and package unit and chill store, while the lowest risk was in the dining hall (Figure 1; $p<0.01$).

Table 3. RAS averages for each occupational group in each working area

	Academician	Engineer	Trainee	Employee
Net cage	🟧 10,3±3,7^{ab}	🟧 9,1±4,0^{a}	🟧 11,2±4,5	🟧 9,4±4,8^{ab}
Boat	🟩 5,5±1,7^{b}	🟧 7,6±2,2^{ab}	🟧 7,4±6,5	🟧 7,6±3,9^{abc}
Dining hall	🟩 5,9±1,0^{Ab}	🟩 4,7±1,9^{ABabc}	🟩 3,3±1,5^{B}	🟩 2,4±0,4^{Bc}
Feed storage	🟧 6,4±2,2^{ab}	🟩 5,7±3,5^{abc}	🟧 7,2±5,0	🟧 6,3±4,3^{abc}
Port	🟧 7,5±0,3^{ab}	🟧 8,3±1,1^{ab}	🟧 12,0±4,8	🟧 12,3±4,7^{a}
General	🟧 8,9±3,9^{Aab}	🟩 4,7±2,5^{Babc}	🟧 9,8±4,5^{A}	🟩 4,9±2,0^{Bbc}
Administrative building	🟧 7,1±2,4^{Aab}	🟩 3,9±1,5^{Cabc}	🟧 6,3±3,8^{AB}	🟩 4,6±2,1^{BCbc}
Package unit and chill store	🟧 11,7±2,8^{a}	🟧 6,2±3,9^{abc}	🟧 11,6±4,4	🟧 8,9±5,7^{abc}
Net repair and washing unit	🟧 11,7±1,8^{Aa}	🟩 2,0±0,7^{Bc}	🟧 10,0±3,5^{A}	🟩 2,7±1,1^{Bbc}
Locker room	🟧 7,5±2,0^{Aab}	🟩 3,1±0,4^{Bbc}	🟧 10,2±3,6^{A}	🟩 3,0±0,4^{Bbc}

Lower cases represent significant differences between processes for each participant.
Capital letters represent significant differences between participants for each process.
Colors represents RAS group. Green: low risk, orange moderate risk

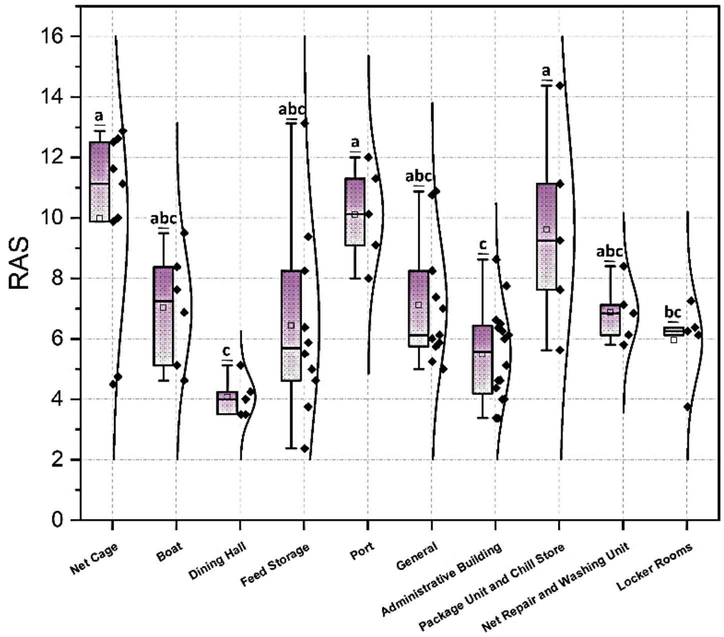

Figure 1. General RAS averages of working areas

Significant differences among occupational groups were observed in only five different working areas. While the risk in the dining hall generally falls within the low-risk category for all groups, academicians recorded higher RAS values compared to trainees and employees (p<0.01). General risks and risks in the administrative building were higher for academicians and trainees, but lower for engineers and employees. The RAS value in the net repair and washing unit was significantly higher for academicians and trainees compared to the other two groups (p<0.01). No significant differences were observed among the groups in other working areas (p>0.05). Finally, no significant differences were found among occupational groups, regardless of the working area (Figure 2).

The dendrogram graph grouped the four different occupational groups into two clusters and the ten different working areas into four clusters (Figure 3).

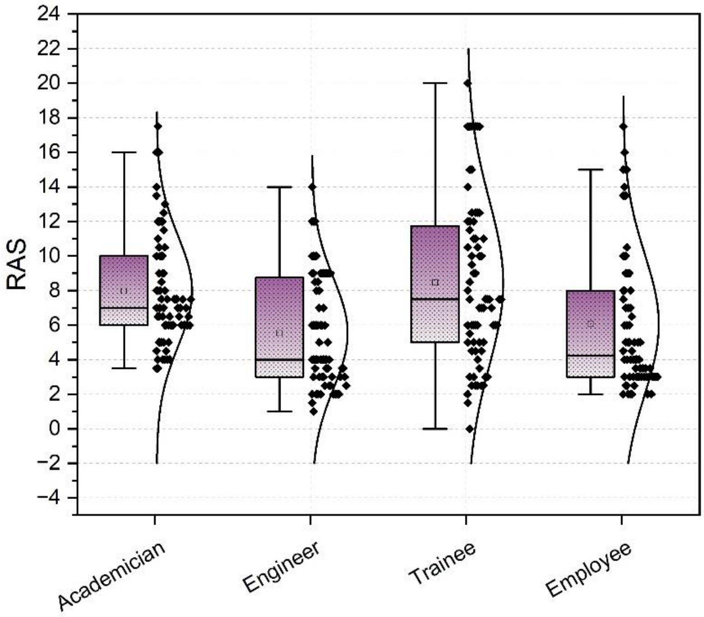

Figure 2. General RAS averages of occupational group.

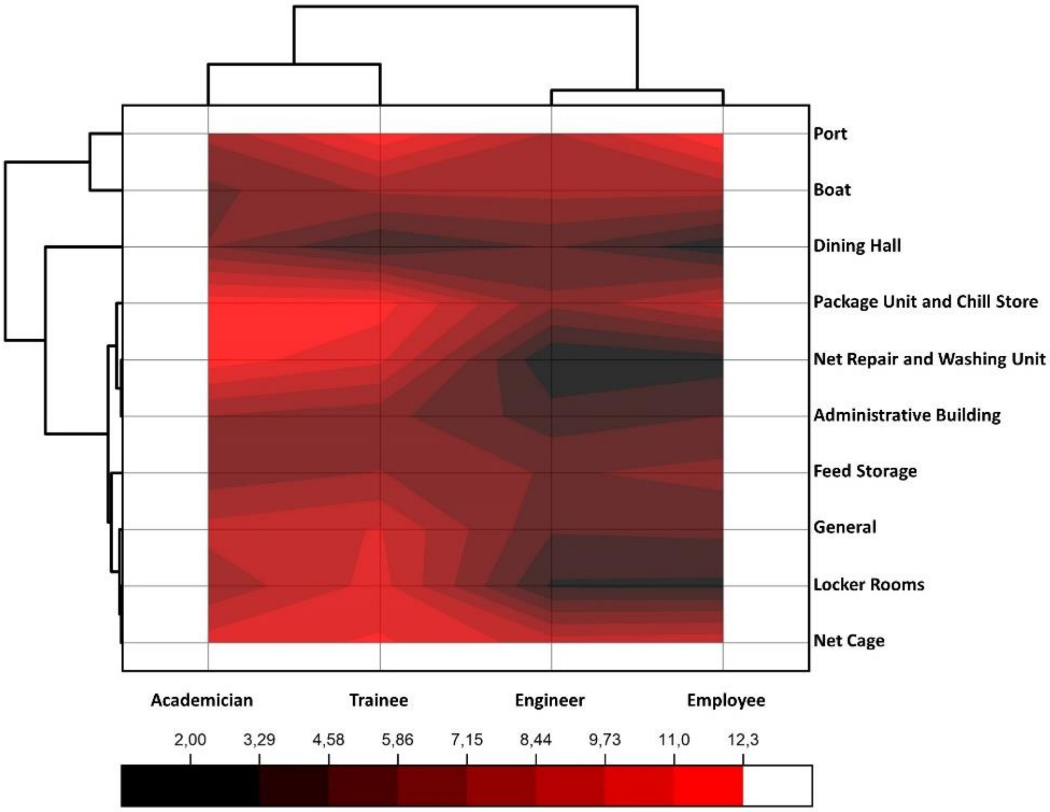

Figure 3. Grouping the evaluation criteria by euclidean dendogram graph and heat-map.

Academicians and trainees formed one cluster, while employees and engineers formed another. The distribution of working place clusters was as follows: (1) port and boat, (2) dining hall, (3) administrative building, package unit and chill store, and net repair and washing unit, and (4) others. The heat map summarized the views of all occupational groups for all working areas within the facility. According to this analysis, the areas identified as the highest risk were the package unit and chill store, and the net repair and washing unit, as determined by academicians and trainees. In contrast, the area identified as the lowest risk was the net repair and washing unit according to employees and engineers.

Discussion

National and international authorities have prioritized food safety, food quality, production, sustainability, and environmental impacts in regulatory documents related to aquaculture (Cavalli et al., 2019). In contrast, concerns about worker safety and health are rarely or never mentioned. In the aquaculture industry, workers are exposed to safety, physical, chemical, biological, ergonomic, and psychosocial hazards (Ngajilo & Jeebhay, 2019). In addition to factors such as facility scale and production volume, the species being farmed also affects the degree of hazard (Cole et al., 2009). In Norway, the occupation with the second highest risk group after fishermen is marine cage aquaculture (McGuinness et al., 2013). Ultimately, detailed risk studies in the sector are quite limited and generally focus on case studies involving noise, ergonomic, and chemical hazards (Ngajilo & Jeebhay, 2019). The current study provides a detailed risk assessment targeting different occupational groups working in marine cage aquaculture facilities. Risks are assessed separately for occupational groups and working areas. According to the study, the highest risk scenario for academicians, with a score of 17 (indicating a high-risk group), is the absence of an insulating mat on the electrical panel (S34) across the facility. Additionally, the highest scoring case scenarios affecting the riskiest working areas for academicians include “S63,” “S5,” “S3,” “S67,” “S65,” and “S4” (RAS > 12). The working areas with the highest risk, as perceived by academicians, are the package unit and chill store, and the net repair and washing unit. Occupational risk is always noteworthy in environments with higher automation and physical hazards (Sandsund et al., 2022). Especially when working in cold environments like the chill store, it is important to consider the ISO 15743:2008 directive (ISO, 2008). Because in cold environments, unprotected, low-intensity, and repetitive work can have a negative impact on muscle function and fatigue (Oksa et al., 2002). However, it has been proven that working in cold environments does not have an adverse effect on personnel once the necessary clothing and equipment are provided (Kluth et al., 2009). The case scenario with the highest RAS for academicians (electric shock “S34”) is highly painful and can lead to burns or short-term paralysis (Holen et al., 2018a). In Australia, it has been reported that two out of six fatalities in the aquaculture sector between 2003 and 2013 were caused by electric shock (Lower, 2015). Injuries that lead to the loss of limbs, such as hands or feet, caused by entrapment between rollers in the packaging and net washing unit are considered serious occupational injuries. These data are also provided by the Norwegian Labor and Inspection Authority (Holen et al., 2018a).

According to engineers, the case scenario posing the highest risk is "working under the sun for extended periods (S8)". Although the consequences may not be severe, many engineers have assigned a high likelihood score to this scenario. The working area with the highest risk, as anticipated by engineers, is the "net cage". The scenarios of the working area that pose the highest risk are “S5,” “S3,” “S8,” and “S9” (RAS > 12). Working under the sun for extended periods is a physical risk factor (solar radiation) arising from both the duration of work and the working environment (Nogueira et al., 2009; Thorvaldsen et al., 2020). A study conducted in Brazil reported that, based on data from ten different companies, the highest risk was solar radiation associated with prolonged sun exposure (25%) (Gondim et al., 2010). Working in rotating shifts on sunny days, using sun protection creams and equipment, and working in enclosed areas reduce solar radiation to a minimum level (Myers & Durborow, 2012). Net cage work areas are limited in space and have a very low comfort level. In these areas, loss of control and consequently falls are possible outcomes. Such falls are referred to as falling to a lower level rather than the same level (Holen et al., 2018a). Falls are the most frequently reported source of serious injuries in net cages and boats (Mitchell & Lystad, 2019).

The case scenario with the highest RAS for trainees is "the personnel not knowing how to swim (S10)". No differences in risk levels were observed among the working areas for trainees. Other scenarios that present the highest risks include "S5," "S25," "S9," "S63," "S35," "S32," and "S34" (RAS>15). In risk analyses, factors that lead to accidents (such as drowning) are primary considerations for conducting a risk assessment (Ale et al., 2008; Attwood et al., 2006). However, there is insufficient information on the causes of occupational injuries and fatalities in the aquaculture sector in Türkiye (Soykan, 2023). In Norway, drowning has been reported as one of the leading causes of fatalities among fishing fleets (Holen et al., 2018a; McGuinness et al., 2013). A case has been reported in which a staff member drowned during harvesting due to not wearing a life jacket (Myers, 2010). In Australia, two out of three fatal drowning incidents occurred during diving activities (Lower, 2015). Ensuring that personnel going out to sea can swim, receive training if they cannot swim, and wear life jackets when required during work will help mitigate this risk.

Finally, for employees, the most risky case scenario is "the excessive gaps in the floating system of the cage (S2)". While the port is identified as the area with the highest risk, the dining hall, net repair and washing unit, and locker room have the lowest RAS. Other case scenarios with high RAS are "S33," "S25," "S63," and "S62" (RAS>14). In marine net cages, floating is typically provided by circular plastic collars, which have gaps between them. Ships and net cages, which come into contact with seawater, are slippery and pose a high risk of falling (Holen et al., 2018a). An unstable work platform is one of the significant causes of occupational injuries (Windle et al., 2008). Excessive gaps in the cage system can cause employees to fall and result in their limbs, such as feet and hands, getting caught. Therefore, platforms should be constructed to be suitable for walking, and employees should be required to wear non-slip shoes while on the platform.

Regardless of the occupational group, risk assessment among working areas shows that net cage, port, and package unit and chill store have significantly high risks. The overall highest average RAS in the facility causes from wet and slippery floors (S63) in the package unit and chill store. Employees should work in non-slip boots, a sign should be placed for slippery floors, and the floor should be made of non-slip material. This situation has shown a high likelihood and somewhat high consequence for all occupational groups. Similarly, the risk of "using unsuitable slippers/shoes for walking (S4)" has a high average RAS for the net cage working area. Season-appropriate and non-slip shoes should be worn. In the port, falling loads (S31) can lead to tragic situations such as injury or death. One should not stand under the load being transported, and a helmet must be worn at all times. The dendrogram test revealed that academicians and trainees have similar risk perceptions, as do engineers and employees. For example, it is interesting to note that the net repair and washing unit, locker room, and package unit and chill store showed higher average RAS for academic staff and trainees compared to other occupational groups. This is related to professional experience and the perspective of employees, as risks may be overlooked by those with long-term experience in the same job (Pinder et al., 2016). Interviews with experienced personnel in aquaculture facilities support our study's conclusion that inexperience leads to increased anxiety and a heightened focus on safety (Thorvaldsen et al., 2020). Especially during the summer months, there is a noticeable increase in serious injuries due to the participation of young and inexperienced workers compared to the rest of the year (Holen et al., 2018a, 2018b).

Conclusions

The current study, incorporating the perspectives of engineers, trainees, and employees working in various marine cage aquaculture facilities, as well as academicians from different universities and departments, presents a comprehensive risk assessment for an integrated facility. The highest average risks were observed in net cage, port, and package unit and chill store among the 72 different case scenarios. Although no significant differences in average RAS were found among occupational groups regardless of the working area, variations were noted based on job experience and professional perspective. Based on the results of this study, it is recommended that occupational health and safety protocols in marine cage aquaculture facilities include regular training sessions, the integration of advanced risk assessment methods such as the L- type decision matrix, open communication channels, the provision of modern safety equipment, and regular inspections. The study's limitations include a small sample size, the inability to assess long-term effects, and the focus on a specific geographical region. Future research should focus on comparing different risk assessment methods, exploring employee awareness, examining the impact of new technologies, and comparing international practices to identify best approaches.

Ethical Statement

The author declare that the scientific ethical and legal responsibility of this article belongs to the author.

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Author Contribution

Mert Minaz: Conceptualization, Visualization, Writing - Original Draft, Data Curation.

Conflict of Interest

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SUPPLEMENTARY MATERIALS

Supplementary Table 1. Case scenarios, potential risks and recommended preventions

Working Place	Scenario No	Case Scenario	Risk	Prevention
Net Cage	S1	Falling into the sea	Drowning, illness	Walkways on the net cages should be non-slip, hydrophobic, and easy to walk on. The walkways should have railings that can support a person's weight. Personnel working on net cages should be able to swim and must also be trained in lifeguarding and first aid.
	S2	Gaps in the cage system	Injuries such as fractures, sprains	The platform should be made of materials suitable for walking, and there should be no gaps that could cause limbs to get caught.
	S3	Contact with fish during harvesting	Allergies, dermal diseases, etc.	Gloves should be worn during any task that involves contact with fish.
	S4	Using unsuitable slippers/shoes for walking	Injuries due to falling	Season-appropriate and non-slip shoes should be worn.
	S5	Missing equipment on the net cage	Drowning, death	Life jackets or rings, rescue ropes, and ladders to climb onto the platform should be present on the cage platform.
	S6	Working for long periods in cold weather	Illness	Appropriate clothing should be worn.
	S7	Divers diving far apart from each other	Drowning, death	Divers should dive in pairs and remain within each other's line of sight.
	S8	Working for long periods under the sun	Sunstroke, burns, fainting	Appropriate clothing and hats should be worn.
	S9	Exposure to dirty or chemically cleaned nets	Allergies, poisoning, dermal diseases, etc.	Suitable masks and gloves should be used.
Boat	S10	Personnel not knowing how to swim	Drowning, death	Ship personnel should be taught to swim and trained in lifeguarding and first aid.
	S11	Absence of or difficulty in accessing life jackets	Drowning, death	Ships should have life jackets readily available and accessible.
	S12	Ropes scattered on the deck	Falling and injury	Ropes on the deck should be neatly stowed.
	S13	Falling load while in motion	Injury, death	Before moving, loads (tanks, feed bags, etc.) should be secured.
	S14	Absence of a first aid cabinet/bag	Inability to respond in emergencies	Ships should have aid bag readily available and accessible.
	S15	Absence of or difficulty in accessing fire extinguishers	Fire	Ships should be equipped with fire extinguishers, which should be appropriately distributed in all areas.
Dining Hall	S16	Lack of air conditioning and/or heating system in the kitchen	Negative effects of the weather conditions and illness of the kitchen staff	It is necessary to establish ventilation and heating systems for the kitchen.
	S17	Disruption of the cleaning in the dining hall and kitchen	Sickness of employees eating in the dining hall	The dining room should be disinfected with chlorinated water every day. Around the garbage cans, pantry, refrigerator and cabinets should be cleaned regularly.
	S18	Failure of kitchen staff to undergo a health check	Sickness of employees eating in the dining hall	A first aid cabinet should be present on the ship, and its contents should be regularly checked and replenished as necessary.
	S19	Mistakes/deficiencies in the supply, storage and processing of food supplies	Sickness of employees eating in the dining hall	The products brought to the dining hall should be quickly taken to the refrigerator or cold storage. It should be used fresh and analyzed by sampling from food.
	S20	Lack of hygiene of kitchen and dining hall employees	Sickness of employees eating in the dining hall	All staff in the kitchen are required to wear clean bonnets and gloves
Feed Storage	S21	Inhalation of feed powders	Adverse effect on the respiratory tract	A high-security mask should be used in the feed store
	S22	Lack of necessary warning signs on forklifts	Health problems may occur due to usage errors	There should be signs containing warnings such as load amount and load type
	S23	Inhalation of medicated feed powders	Adverse effect on the respiratory tract	A high-security mask should be used in the feed store
	S24	Transportation of heavy feed sacks with manpower	Employees' back and waist discomfort	The weight of the material to be lifted; According to the physique and gender of the personnel who will carry it, it should not exceed 25 kg for men and 15 kg for women.

Working Place	Scenario No	Case Scenario	Risk	Prevention
	S25	Breakage of forklift chain rope	Injury/death of an employee in or near the forklift	Forklift lifting equipment should be tested at least once every 6 months
	S26	Shelves and cabinets not fixed to the wall	During an earthquake, cabinets can tip over and cause injury	All shelves and cabinets must be fixed to the wall
	S27	Insufficient lighting	Injury due to insufficient lighting	In parallel with the results of indoor illumination, the level of illumination should be determined and necessary improvements should be made according to the report result.
	S28	Insufficient durability of the storage roof	Negative impact on the employee in case of collapse	Roof should be checked yearly and repaired if it is resistless.
	S29	Eating and drinking in the feed storage area	Microbial disease	Employees should be informed that eating is not allowed in the feed storage area
	S30	Disorganized feed storage	Drop of employee	Feed storage should be tidy
Port	S31	Load falling	Injury, death	Do not stand under the load being transported; a helmet must be worn.
	S32	Crane falling	Injury, death	Ensure the load is within the crane's lifting capacity, and avoid standing near the crane.
	S33	Rope breaking during load transport	Injury, death	Use materials with appropriate strength for the weight when using ropes.
General	S34	Absence of insulating mat in front of the electrical panel	Injury-death by electric shock	A full insulating mat with a width of at least 50 cm must be kept in front of the electrical panels and constantly checked.
	S35	Emergency squads not determined according to hazard class of workplace	Material damage and/or injury-death as a result of failure to take appropriate action in emergency situations	The necessary training should be given to the emergency squads according to the hazard class of the workplace.
	S36	Material stack in front of the electrical panel	Fire, injury and material damage due to ignition of flammable materials	It is necessary to prevent material stack in front of electrical panels, to warn employees and to make continuous controls
	S37	Unlocked electrical panel covers	Electric shock, injury-death due to the intervention of unauthorized employee	Covers of electrical and control panels must be kept closed and locked at all times and checked with control forms
	S38	Absence of residual device relay in electrical panels	Injury-death as a result of leakage currents passing over the human body	There must be a 30 milliampere residual current relay in the electrical panels and its working condition should be tested periodically by a qualified electrician.
	S39	Absence of emergency lighting that should be activated in case of power cut in emergency situations	In the relevant situation, employees cannot go to safe zone	Emergency lighting showing the emergency exit must be activated in emergency situations and lightings must be active for minimum 2 hours.
	S40	Drivers working overtime	Having a traffic accident due to fatigue	If there is a situation that drivers need to work hard, a second driver should be present in the shuttle
	S41	Stacking material inside the electrical panel	Fire, injury and material damage due to ignition of flammable materials	It is necessary to prevent material stack inside of electrical panels, to warn employees and to make continuous controls
	S42	Lack of fire extinguisher in the facility	Inability to intervene in emergency situations such as possible fire or explosion	Fire extinguishers suitable for the fire class that may occur in each independent zone should be supplied. Fire extinguishers should be marked with a plate and periodically checked every 6 months.
	S43	Failure to prepare emergency plans	Injury and/or material damage as a result of failure to respond in an emergency	Emergency plans should be determined, communicated to the relevant people and controlled through exercises.
	S44	Not getting full-fledged medical reports when employees are hired	Late detection of possible diseases	Employees should have health checks while being recruited and should be repeated periodically. Health reports should be kept in the personal file.
Administrative Building	S45	Direct exposure to air conditioning	Health problems such as neck stiffness, flu etc., due to direct exposure of air conditioners to employees	Appropriate precautions (using directional materials, changing the position of office desks in front of them or changing the location of the air conditioner etc.) should be determined and taken to prevent the air conditioners from directly affecting the employees.
	S46	Lack of thermal comfort conditions	Illness, decrease in productivity, etc., due to inadequate thermal comfort conditions.	Thermal comfort conditions (e.g., temperature, humidity, air flow) should be measured. If there are any inadequacies, they should be addressed primarily at the source through control methods. If this is not possible or sufficient, appropriate PPE (Personal Protective Equipment) should be used according to standards.
	S47	Instructions not posted in the production area	Material damage and/or injury due to incorrect intervention by employees.	Safety instructions for the use of all electrical equipment should be prepared and posted in a visible and appropriate location near the equipment.

Working Place	Scenario No	Case Scenario	Risk	Prevention
	S48	Open ends of electrical outlets or cables	Injury due to electric shock caused by open ends of electrical outlets or cables.	Electrical outlets or cables should not be located in areas where people can come into close contact and should be properly insulated.
	S49	Working for extended periods	Eye discomfort.	Periodic eye examinations (at least once a year) should be conducted for employees. Training on working with display devices should be provided. After 1 hour of work, a 5-10 minute break should be given, and after 2 hours of work, a 15-20 minute break should be provided. These breaks should ideally involve dynamic movement away from the screen.
	S50	Fire extinguishers not mounted approximately 90 cm above the ground	Material damage and/or injury due to the inability to reach fire extinguishers in time because they are not mounted approximately 90 cm above the ground.	Fire extinguishers should be mounted approximately 90 cm above the ground.
	S51	Not placing fire extinguishers of the same type and capacity during periodic inspections	Failure to place the same type and capacity of extinguishers during periodic testing or refilling can lead to material damage and/or injury during a fire.	During periodic inspection and refilling of fire extinguishers, the company responsible for these services must place fire extinguishers of the same capacity and type in the designated locations.
	S52	Fire hose being made of fabric	A fabric fire hose may not open immediately and may lack durability, leading to failure in timely intervention during a fire, resulting in material damage and/or injury.	Fire hoses should be made of rubber. Note: Rubber hoses become usable more quickly during a fire compared to fabric hoses.
	S53	Lack of regular checks of fire detection systems	Failure to perform regular checks on fire detection systems can lead to delayed or failed detection of fire, resulting in delayed evacuations and potential injury and/or material damage.	Maintenance of fire detection systems should be carried out by a certified firm at regular intervals, and maintenance records should be kept in an occupational health and safety file.
	S54	Presence of materials on emergency staircases	The presence of materials on emergency staircases can lead to injuries, such as falls, during an emergency.	No materials should be stored on emergency exit staircases.
	S55	Absence of a first aid kit	Absence of a first aid kit can result in a worsening health condition due to the unavailability of necessary materials during a first aid situation.	A first aid kit must be available.
	S56	Failure to perform periodic checks of fire extinguishers	Failure to perform periodic checks of fire extinguishers can lead to an inability to intervene effectively during a fire, resulting in material damage and/or injury.	Fire extinguishers should be checked by an authorized firm every 6 months, and the inspection dates should be marked on the extinguishers.
	S57	Positioning of screens for electronic devices such as computers	Physical discomfort.	The computer screen should be positioned ergonomically to ensure that the user can view it from a comfortable angle (e.g., positioning the screen perpendicular to windows to minimize reflections).
	S58	Lack of grounding for building and its extensions	Losses due to natural phenomena such as lightning, fire, and fatal accidents.	All buildings and extensions within the facility should be properly grounded, and lightning rods should be installed. Annual inspections should be carried out, and records of these inspections should be maintained.
	S59	Failure to perform regular maintenance of air conditioning systems by certified firms	Failure to perform regular maintenance of air conditioning systems by certified firms can lead to unsuitable temperature conditions or the formation of a bacteriological air environment, resulting in health problems.	Maintenance of air conditioning systems should be carried out by a certified firm at regular intervals, and maintenance records should be kept in an occupational health and safety file.

Working Place	Scenario No	Case Scenario	Risk	Prevention
	S60	Absence of covers on fluorescent lamps	Absence of covers on fluorescent lamps can lead to injury if the lamps fall or cause a fire if they fall on flammable materials, resulting in material damage.	Fluorescent lamps should have covers, and if special lighting fixtures are required (e.g., ex-proof or watertight fixtures) due to the environmental conditions, these measures should be taken.
Package Unit and Chill Store	S61	Contact with fish during packaging	Allergies, dermal diseases, etc.	Gloves and masks should be worn during the packaging process.
	S62	Prolonged working hours	Musculoskeletal disorders	Personnel should not work for extended periods without rest; they should be given breaks at regular intervals.
	S63	Wet and slippery floors	Falls and injuries	Employees should work in non-slip boots, a sign should be placed for slippery floors, and the floor should be made of non-slip material.
	S64	Inappropriate clothing	Frostbite	Employees should wear clothing that protects against cold.
	S65	Icy warehouse floor	Slips and falls	Employees should wear non-slip boots.
Net Repair and Washing Unit	S66	Contact of personnel with nets	Allergies, poisoning, dermal diseases, etc.	Personnel should wear gloves and, if necessary, a mask while washing and repairing nets.
	S67	Uncovered belts and pulleys in the net washing machine	Injury or death due to clothing or a body part being caught in the moving parts	All moving parts of the machine should be covered, and warning signs should be placed in visible and appropriate locations.
Locker Rooms	S68	Inadequate cleaning of locker rooms according to hygiene standards	Spread of microbial diseases, illness	Locker rooms should be equipped with necessary cleaning supplies and should be cleaned regularly.
	S69	Lack of personal lockers in locker rooms	Potential financial loss for individuals, and the mingling of personal clothing can lead to the spread of microbial diseases	Each employee should have a personal locker.
	S70	Lack of ventilation and/or heating system in locker rooms	Adverse effects on personnel due to weather conditions, leading to illness	Ventilation and necessary heating systems should be installed in the locker room.
	S71	Insufficient lighting	Injury due to inadequate lighting	The lighting level should be determined in parallel with indoor measurements (lighting), and necessary improvements should be made based on the report findings.
	S72	Lockers without ventilation holes	Lack of oxygen circulation, leading to the spread of microbial diseases from stuffy clothing	Lockers should have ventilation holes to allow air circulation.