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Fish protection during fish production. Organizational conditions for fish welfare



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ABSTRACT

Too many salmon die during production at Norwegian fish farms. Earlier research shows that most farmed salmon die in operations partly related to protection of the wild salmon (from salmon lice), but it is not known how this relates to other conditions positive or negative for fish welfare. Fish farm personnel are experts on the organizational conditions during production. This is thus a study of what fish farm personnel consider contributing to fish welfare. Data are gathered through interviews, observation, and a small-scale survey. The results suggest that the personnel stand in a multiple protection dilemma, where fish welfare loses in a battle with objectives of profitable production, and protection of wild salmon. In this context of conditions emphasizing other objectives, the personnel act as a buffer for farmed fish welfare. In particular, the study indicates that fish health personnel perceive themselves and are perceived as advocates for fish welfare. This important role, and the multiple protection dilemma that comes from the conflict between product and environment, are not earlier described in organizational literature. Multiple protection dilemmas can be relevant for all production in open environment, so personnel and organizations should be structured to reduce and handle it.

1. Introduction

Good fish welfare is not sufficiently achieved in Norwegian salmon farming; 16% of the salmon set into sea cages are registered dead during the production process [9]. Good fish welfare is mandatory [4], and the biological knowledge is already in hand [23,31,37,49]. Yet, it remains unclear how fish welfare can be realized among other organizational conditions at Norwegian fish farms.

Major contributors to mortality among the farmed salmon, are operations to protect the farmed and wild salmon from salmon lice [36]: Farmed fish are routinely checked for salmon lice [24]. If a certain degree of lice is found, and the company management wish to continue production, the fish farm personnel must delouse the fish to prevent lice spreading to wild salmon. Lice counting and delousing are harmful for the farmed salmon [36].

Between these operations for the sake of production or to protect wild salmon, fish farm personnel are instructed to protect the farmed fish. It makes them central in balancing the objectives of the company

and several regulations [25,29,52,58].

This study investigates the fish farm personnel's views on negative and positive conditions for fish welfare. Fish welfare is seen as the quality of life as perceived by the fish itself [49]. Empirical data is gathered through interviews with 22 primary and fish health personnel at sea-based fish farms, and a survey that received responses from 49 more primary and fish health personnel.

Through six sections, this article explores the organizational conditions contributing to fish welfare. Section 2 introduces Norwegian fish farming, regulation and research, and Section 3 builds on the theoretical framework of production and protection dilemmas. In Section 4, methods and limitations are described. The findings are introduced in Section 6 and discussed in Section 7. Results show that positive contributors to fish welfare are daily tending tasks and educating others. In addition, the personnel experience dilemmas of competing objectives: protection for the farmed fish, protection of the wild fish, and production demands. One key dilemma is that *production* goals can contribute negatively to protection, as is consistent with the theoretical framework;

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Surprisingly, however, personnel also commonly experience a dilemma between *protecting farmed fish* and *protecting wild fish*.

2. About fish farming

In Norway, salmon are commonly produced in open sea-based net cages. Along the coast there are 300–400 million fish at any time [12], most of which are salmonids. The welfare of these individuals is important for ethical, environmental, and economic reasons, in addition to legal requirements [16].

The work and monitoring at fish farms is done by primary personnel (often technicians, including operational managers) and fish health personnel (often veterinarians). *Primary personnel* are trained to feed the fish, ensure cleanliness, and maintain equipment. They are responsible for the production at the fish farm, and to comply with regulations. Studies have showed that they prioritize actions to protect the fish, even when facing risk of personal injury [52,61]. *Fish health personnel* are veterinarians or fish biologists who have formal authority to protect fish health and welfare through regular health visits [6]. They prescribe preventive actions and treatments [17].

2.1. Regulations – production, protection of farmed fish, and protection of wild fish

The fish farming industry in Norway is governed by many regulations (for thorough examples, see [16]). Fundamental is the Norwegian Aquaculture Act [5] that aims to enhance industry profit, competition, and coastal trade within the frames of sustainable development.

Important for all husbandry and animal production, is the Norwegian Animal Welfare Act [4]. It is a functional regulation promoting animal welfare, health and respect for animals: All animals should be treated well and be protected from unnecessary strains. The rule text does not include specific requirement in how to achieve these goals, but is supported by other structures, such as specific regulations: In Norway, fish farming companies need a license to produce a certain amount of biomass (fish) and a discharge permit specifying the biomass allowed at each fish farm. The maximum number of fish in each net cage is 200, 000, with a maximum density of 25 kg/m³ per traditional net cage [6]. This governs low fish density, which is generally positive for fish welfare in sea cages [31].

Another influential regulation is addressing the problem of salmon lice. Low lice numbers are essential for both the farmed and the wild salmon, as numerous lice would cause wounds and anemia [36]. Many lice on the numerous farmed salmon, lead to increased pressure of lice on the wild salmon living in the nearby waters. This is the background for the regulation to combat salmon lice. The Norwegian Lice Regulation [24] provides detailed requirements for how and when to count lice on farmed fish. This counting procedure involves crowding a representative sample of salmon, dip netting of individual salmon into an anesthesia bath, handling fish out of water, and returning them to a recovery tank and then to the sea cage (see a review of different practices in Thorvaldsen, Frank, and Sunde [56]). Lice counting is stressful for and potentially harmful to the fish, even when done correctly. Mortality risk increases after such handling, especially in cold weather [31]. If the counting shows too many lice, taking actions like delousing or slaughter is mandatory. Common delousing methods involve the fish being pumped into a seawater bath of 28–34 °C for 30 s or using seawater flushing systems before fish return to the net cage. Such temperatures can risk the salmon's welfare and life and is also questionable when it comes to pain, as salmonids have pain receptors that respond to heat [7,8,14,30,31,36]. Protective methods against salmon lice are currently suboptimal. For example, lice skirts used around cages to prevent sea lice from reaching farmed salmon can reduce water oxygenation [17]. Cleaner fish or fresh water coming in due to the season are rarely effective in the short term [10,46] for remaining below the upper lice limits stipulated in the regulations [50]. To employ cleaner fish as a measure also introduces

welfare problems for those cleaner fish [2,29,50,54].

One can see a contradiction between the Norwegian Animal Welfare Act [4] and the Norwegian Lice Regulation [24]. The Lice Regulation aims to reduce the spread of salmon lice but also leads to operations that can harm farmed fish [15,36]. In addition, the lice-related operations can potentially cause personnel injuries, the escape of farmed fish, and increased costs [19,31,57,58].

In total, it is not straightforward to comply with the sheer number of objectives the regulations contain ([16]; 2017; [34,40,47]). Aquaculture companies must meet regulations even when compliance with one regulation implies violating others.

2.2. Company compliance with regulations

Most industries face conflicting objectives, and Norway's fish farming operations are susceptible to many such issues, as the fish are produced in open sea-based net cages, where the production is part of an organic environment inside an ecological habitat with other (wild) species. Still, what makes fish farming special is the raising of fish: Production in fish farming involves living animals that require continuous care, in contrast to industries where the product is inanimate [13, 52].

In practice, it is fish farm personnel that must balance fish welfare, environmental issues, accident prevention, and cost savings [13,16,19, 21,44,51,52,58].

Several studies have described how fish farm personnel find it impossible to follow all regulations, since compliance with some results in violating others; compliance may even be technically or practically impossible [15,16,18,21]. They implement welfare measures beyond what is mandatory, as the husbandry situation in itself can evoke affective sentiments and practices of care ([25] p. 146–147; [29]). There are not earlier studies of how fish farm personnel solve the goal of fish welfare in this complex context. Studies of primary personnel or veterinarians (or others tending to live animals) commonly focus on either organizational conditions or the live animal. Fifteen years ago, 21% of fish farmers reported being pressured to work so as to threaten personnel safety [1]. In 2017, 23% of fish farmers surveyed agreed that production goals sometimes trump safety, and 36% agreed that their company practices make employees violate regulations [61].

3. Theoretical basis of conditions for protection and production

Organization theory can help explore the organizational conditions relevant for fish welfare. This study is based on the idea that work takes place in an organizational context (e.g. [38,42]). The personnel have what also can be called framework conditions or environmental conditions. These organizational conditions can be divided into five dimensions: Structure, materiality, culture, interaction, and social relations (see the pentagon model in Fig. 1; [45]). Each dimension is

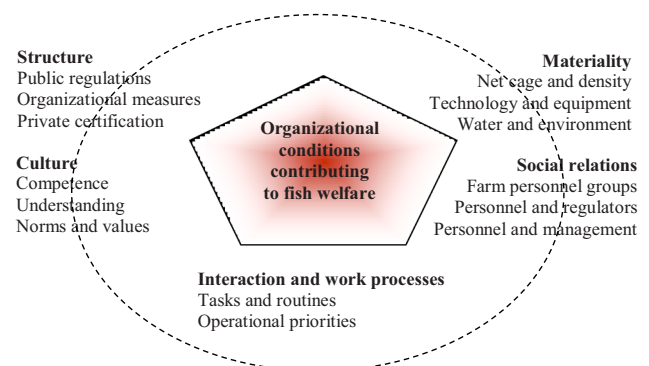


Fig. 1. The pentagon model for qualitative analysis [45] with empirical findings from Section 6.

different to the next, but one can say that two are about tangible or “hard” conditions (structure and materiality), while the other three have a softer nature. The decisions of personnel on a fish farm are influenced by for example regulation (structure), available resources (materiality), values (culture), how tasks are performed (interaction), their informal network (social relations), etc. All these dimensions play together and are intertwined [45]. They influence the personnel’s discretionary space, incentives, and power and the decisions they are able to make [43]. To understand work decisions, one must consider all dimensions of the organizational context.

All organizations must handle several aims, since they have production demands while they simultaneously need to meet the expectations of regulators, market, etc. At the core, conflicting objectives of protection and production are present in all organizations [39]. In the organizational literature, *production* aims generally refers to profit, product quality, and efficiency, while the aim of *protection* is to avoid negative outcomes by production ([39], pp. 3–4). Ideally, operations should balance production and protection, but in practice one is usually favored. The dilemma of production and protection is illustrated in Fig. 1 [22]. (Fig. 2).

Organizations meet conflicting objectives on several tiers since the personnel on different levels have different roles [43]. Decisions at each level influence the others. When studying (fish farm) personnel, decisions by regulators and managers must also be understood, since these decisions will constitute framework conditions for the personnel.

For regulatory authorities, achieving protection through oversight is central. Regulations may aim to protect one objective without taking others into account [27]. In many industries including aquaculture, regulators must enforce their regulations as if they did not conflict with other regulations or practical objectives [33,41,53].

Managers are to ensure that their company achieves efficient productions while complying with regulations. An essential objective is often short-term production, since “production creates the resources that make protection possible” ([39], p. 4). Managers have to translate regulations into operational procedures and facilitate the personnel’s execution of efficient operations [38,43]. However, when the objectives of regulations conflict, work procedures can also become conflicting [53]. Middle managers must ensure that upper management’s decisions are implemented. At many Norwegian fish farms, the middle managers are fish farm personnel who are responsible for operational execution and reaching production goals, and there is considerable delegation of responsibility to the sharp end personnel [25,48].

Most personnel want to conduct thorough rule-complying operations, but this is not always possible, so they must balance efficiency and thoroughness [20]. Over time, competing objectives can shift work

practices away from formal procedures [38,59]. Conflicting objectives are often handled by personnel rather than managers because such conflicts often arise during practical operations and are less visible to top management. When rules conflict with one another, personnel have to use their experience to prioritize which ones to follow [11]. In aquaculture, like in many other industries, it is common for procedures to diverge from actual work tasks [55]. Yet, compliance with some regulations is paramount for profit and public image [35], even when fish suffer.

4. Methods

The organizational conditions that contribute to fish welfare are explored through qualitative and quantitative data from personnel at Norwegian fish farms. We collected data in line with research ethics standards. The Norwegian Social Science Data Services has approved the study.

4.1. Interviews

The interview data in this study consists of interviews with 22 persons – 17 of primary personnel and 5 of fish health personnel working for different employers at a total of six fish farms.

In 2018, we visited four fish farms in two pairs with similar organizational conditions. Each pair had the same owner and fish health personnel, were situated in the same geographical area, and had similar organizational structures, but each farm differed as to natural conditions and production results. Before our visits, company managers and farm personnel received oral and written information and consented to participating in the study. One or two researchers spent approximately one day on each site, observing operations and interviewing personnel. An operational manager was present on two of the fish farms. At the farm visits, we interviewed 16 people, of whom 2 were fish health and 14 primary personnel. Some interviews were group interviews. We also had supplementary telephone interviews with the two fish health personnel and two operational managers before and after our visits and conducted telephone interviews with six further people: three primary personnel on a fish farm at a third aquaculture company and three fish health personnel.

All 22 interviews were semi-structured research interviews conducted by one or two researchers. We documented the interviews through real-time notes taken by one researcher or subsequent transcriptions of recordings.

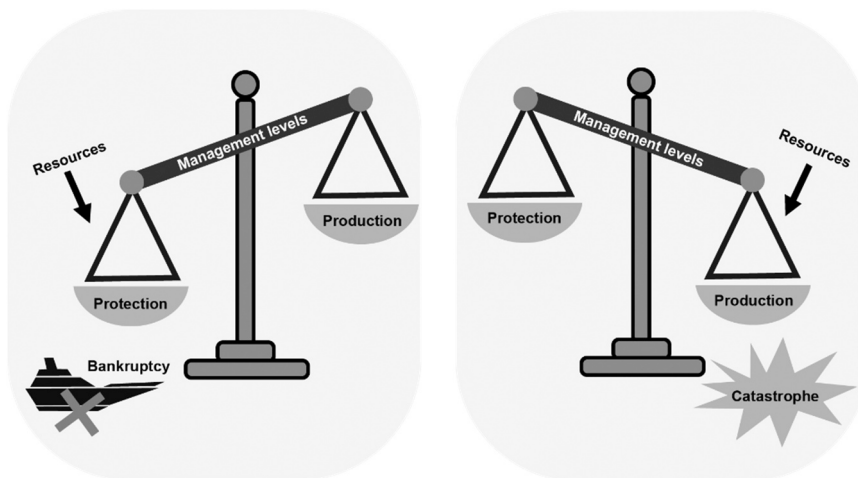


Fig. 2. Catastrophes related to fish welfare can be serious illness, mass deaths or escape of salmon. Production and protection should be balanced to avoid coming too close to bankruptcy or catastrophe (source: [22]).

4.2. Survey

The survey responses from 49 operational and fish health personnel at fish farms are part of a larger survey about fish welfare governance. As to respondents, we targeted primary and fish health personnel at aquaculture firms and third-party companies and regulators working with fish welfare. To recruit respondents, we phoned aquaculture companies and regulators and asked them to participate. They then received an e-mail with information and a link to the digital survey. Many recipients distributed the link to their networks or employees, so a response rate cannot be estimated. A total of 119 people responded, of whom 49 self-identified as primary or fish health personnel and are thus included in this study (see Table 1).

The survey questionnaire was developed by a multidisciplinary group of researchers and used topics from earlier research, including fish health and welfare, regulations, salmon lice and other diseases, competence and collaboration, and priorities in planning production and during operations.

The survey included one open-ended question per topic, enabling the participants to write their opinions freely. The answers varied in length and reflected on similar questions as in the interviews. In Section 6, we analyze the open-ended survey answers and the interviews together. These two data sources are similar, although the data were gathered using different methods.

In most items, the participants reported their agreement with different statements related to fish welfare on a five-point Likert scale. “Don’t know” was also an alternative but is not included in the results. Due to the small number of study participants, the survey data analysis is descriptive. We mainly report the mean values and standard errors of the means (SEMs) of the set of answers from each personnel group.

4.3. Methodological considerations and limitations

4.3.1. Focus and respondents

The topic of the study is the welfare of farmed salmon (rather than, for example, cleaner fish or wild fish). “Fish welfare” implies the quality of life as perceived by the fish itself [31,49]. Welfare thus can be measured at scale level or defined as positive or negative. Norwegian fish farming’s most used welfare statistics is *mortality* which is at the most negative end of the scale. Although a line of biological welfare indicators exists [31,49], this study relies completely on the perspectives of the personnel. In this study, the importance is not the fish welfare status, but how the personnel perceive that fish welfare is affected by e. g. regulations, tasks or competence.

Organizational conditions for fish welfare could have been studied on different levels. If the study objects were managers, one could have sought information from an office about strategical decision-making. It could be useful to discuss why delousing are performed instead of slaughtering, or why fish is farmed in areas with high risk of salmon lice, although one expects economical rationality plays a major role. When fish farm personnel are in focus, however, one gets data from the persons working closely with the fish and watching the fish (from the surface or through cameras) all day in all operations. Fish farm personnel have experienced a range of conditions that they can evaluate related to fish welfare. This is knowledge sought for by policymakers, company owners, as well as fish farm personnel.

Table 1
Respondents.

	Frequency	Percent
Primary personnel (technicians and operational managers at fish farm sites)	32	65.3
Fish health personnel (veterinarians and fish health biologists at fish farm sites)	17	34.7
Total	49	100.0

Among the fish farm personnel data, this study divides between primary personnel and fish health personnel. This is not a comparison between them, but it is useful to explore potential differences. The results show that the two groups usually have the same perception of the conditions, but fish health personnel in general are more skeptical to if any conditions positively to fish welfare.

It is important to acknowledge the potential bias toward fish welfare that respondents may have. Survey respondents may have volunteered to participate because they are especially interested in the topic of fish welfare. However, the participants interviewed at the fish farms participated only because they worked on the selected farms and may therefore not have this bias.

The findings of this study should be read within a societal context. In Norway, aquaculture is a major industry (mainly salmon farming) that has generated large profits in the last two decades. In recent years, fish welfare and mortality rates of farmed salmon have received intensified media attention, illustrating an increased emphasis on fish welfare among the public and the industry.

4.4. Technical considerations

The empirical data are both qualitative and quantitative; combining the two sources strengthens the results, which is useful because of the relatively low number of participants. Interviews and surveys provide different types of data. The survey displays in number how the respondents value a certain topic, while in the interviews, the personnel can explain and give details on survey topics. Also survey comments have the same elaborative function. The survey showed how the respondents ranged certain measures related to fish welfare, and the interviews and comments contributes to shed light on the same measures from different perspectives. The results from a survey this size do not have much value without support.

On the same strand, mean scores cannot be interpreted as direct numbers when the alternatives are on an ordinal level and can thus hide details in the results, but means can still convey useful information that helps understand the results (Rosenthal & Rosenthal, 2011). Additionally, in small samples, mean values combined with SEMs can contribute to revealing certain differences: the mean values display an overview of the differences between groups (like this study’s personnel groups) and between questions in the same survey.

Still, Fig. 3 must be discussed. On these items, respondents reported their views on the degree to which fish welfare is improved by certain measures (“To a small degree,” “To some degree,” “Neither/nor,” “To a considerable degree,” “To a great degree”). All alternatives were on the positive side, since the purpose was to find how each measure contributed to fish welfare. The alternatives were listed, as in other questions, with “neither/nor” in the middle, although that could be interpreted as the most negative alternative. We still see it as likely that the respondents interpreted the alternative in the middle as part of a continuum.

4.5. Analysis

To analyze the qualitative and quantitative results, the research team have performed a descriptive and qualitative pattern analysis of organizational conditions relevant for fish welfare. To find patterns and analyze all relevant parts of the organization, the pentagon model is employed (Fig. 1). Data is categorized into five organizational conditions—*structure*, *materiality*, *culture*, *interactions*, and *relations*—to understand how the different conditions, separately and together, contribute to fish welfare.

5. Empirical data

This section presents the findings from the data material, sorted under the pentagon model categories (see Fig. 1). First, a description of

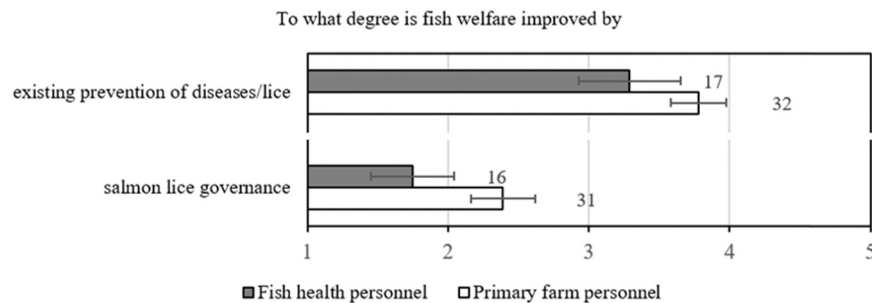


Fig. 3. Improvement in fish welfare. Two questions with alternatives ranging from 1 (“to a small degree”) to 5 (“to a great degree”): means of the results from operation and fish health personnel at Norwegian fish farms. Originally, this item had six questions, but four are removed since they are relevant only to a few respondents.

conditions that the respondents see as important for *fish welfare*. Their answers indicate that welfare involves a natural life and freedom from diseases, hunger, or suffering. Many emphasize low mortality and adequate growth and relate this to environmental conditions like water quality and oxygen, enough room to move, protection against predators, and few salmon lice:

A healthy fish lives in an environment it can handle without problems. This involves good water quality, sufficient space, and a unit designed not to harm the fish or decrease its natural behavior and movement: as little handling and stress as possible. Fish health personnel, survey comment.

Plenty of current, feed, cleaner fish, and clean nets. As few operations as possible that stress and pressure the fish. Primary personnel, survey comment.

One can see that many of these needs can be more or less fulfilled, depending on the organizational conditions. For example, it is important with good localities and routines that do not stress the fish.

The subsequent sections introduce survey data and respondents’ comments (from the survey and interviews) about organizational conditions contributing to fish welfare. The figures display the mean results, standard error of the means, and number of respondents in the personnel groups.

5.1. Structure

The organizational dimension of structure includes topics like regulations, procedures, and organizational structure. Fig. 3 shows how the participating primary and fish health personnel experience structural conditions that contribute to the welfare of their farmed fish.

Fig. 3 shows two items that are clearly differently assessed by the respondents. *The existing prevention of diseases and salmon lice* is highly rated at improving fish welfare. Existing prevention includes good-quality sites (see Section 6.2) and personnel tasks (see Section 5.4). The Lice Regulation and its specific requirements for fish farm operations is described in Section 2.1. This current *governance of salmon lice* was considered by both groups to improve fish welfare the least;

The respondents explained why in the survey comments and interviews.

When it comes to how the personnel’s own tasks contribute to fish welfare, at least two perspectives appeared in the results. The respondents emphasized that their daily tasks contribute positively to fish welfare. They strive to meet as many of the farmed fish’ needs as possible but acknowledge that production animals must endure some handling:

The fish should be fine, get as much food as it wants, and thus develop to be a fantastic product, without suffering. He’d experience minimal stress in some operations but not more than we experience at an examination. Fish health personnel, survey comment

On the other hand, the personnel reported having to perform tasks that harm fish welfare and occasions where they could protect their fish; harmful tasks include weekly counting of salmon lice and irregular delousing. The respondents emphasized that related operations stress the fish more than what is healthy, increase mortality, and run counter to the animal welfare they strive to achieve:

It’s not good for the fish. Like in salmon lice counting and such ... scrabbling around in the net cages. That’s not good fish welfare, to sweep around with the landing net. Primary personnel, interview

At times it feels like the focus is more on lice than fish welfare. [...] It’s not allowed to have lice above the limit, but it’s allowed to kill/hurt lots of fish through delousing. Primary personnel, survey comment

The respondents expressed further frustration regarding the regulators’ handling of these conflicting objectives of animal welfare and lice combating. The fish farm personnel were puzzled that they were ordered to improve fish welfare in one occasion, and in the next performing harmful operations.

It’s a problem that the Food Safety Authority focus on only one problem at a time. One moment they impose decisions regarding poor welfare, and the next [...] they order delousing despite very low temperatures and low lice levels, which is very poor welfare. Fish health personnel, survey comment

Overall, primary personnel tended to respond more positively than fish health personnel in most survey items (comparison of means by paired-test: 3.03 vs. 2.67, $p = 0.002$). The fish health personnel appeared reluctant to consider any structural instruments as contributing positively to fish welfare. Data from the interviews substantiate this tendency: fish health personnel in general appear to have significant knowledge about fish welfare and thus high expectations for the welfare of the fish they protect. Concurrent with high mortality rates and frequent diseases in some regions, many fish health personnel have a negative perception of the current state of farmed fish welfare and the instruments intended to achieve it.

5.2. Materiality

In aquaculture, the category of materiality includes water, net cages, feed, feeding equipment, vessels, cranes, and other operational infrastructure.

The survey had two questions about the number of fish in the cages (Fig. 4). Low fish density is generally desirable. Many survey participants found that their companies aim to balance fish welfare and production in their decisions about density rather than optimizing either welfare or production. On the question about choosing maximum fish density, the fish health personnel reported that their organizations rarely or sometimes choose to achieve maximum fish density, while primary farm personnel reported that they choose that option

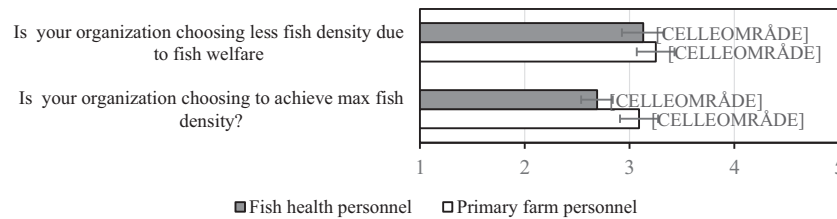


Fig. 4. Maximum fish density. The Aquaculture Operations Regulation specifies the maximum density of fish per production unit. Is your organization choosing. (1–5: “Never,” “Rarely,” “Sometimes,” “Often,” “Always”).

sometimes.

In addition to adequate space, the fish need the correct water environment. Few of the interviewed personnel, however, discussed their ability to influence the farm’s location: Instead, they regarded it as given. In one interview, a group of primary personnel reported being “lucky” with their site, because salmon lice usually bypass it, but “unlucky” since the water is sometimes colder than salmon prefer. The primary personnel care for the farmed fish but are realistic about how much they can influence welfare:

The fish is in a cage. He’s in a net, and he can’t swim where he wants to. Whether it’s raining or windy or the snow melts or whatever, he is where he is. If he were in nature, he most certainly would swim far away and wouldn’t be here all year. But that’s how it is. Primary personnel, interview

The respondents reported using delousing equipment that raises fish mortality because the method is harmful to fish. Some primary personnel admitted taking part in hazardous testing of equipment and methods. The fish health personnel emphasized that all technology and methods should be developed with their input:

Fish health personnel have only fish welfare and health in mind. This is a necessary opposite to the technology providers, who know most about the equipment and its efficiency. Fish health personnel, survey comment

5.3. Culture and competence

The category of culture and competence includes knowledge, understanding, norms, and values. Fig. 5 shows that primary personnel stated that they know the regulations, while fish health personnel reported being very familiar with the regulations.

Knowledge of regulations is important to fish farm personnel, since both regular and large operations are done to comply with regulations (more about regulations in Section 2.1). Fish health personnel have responsibility for fish welfare on the farms, and to comply with related regulations, so they need to know the regulations well. Primary personnel have more production related tasks, and therefore are oriented more towards company procedures. Both groups are familiar with the routines required by the Lice Regulation and have voiced strong opinions about that, and see the requirements as rigid and operations as negative for fish welfare:

There is a never-ending discussion about salmon lice regulation. We often disagree with it. [...] One needs regulations but also discretionary space. It’s too rigid. There should’ve been room for judgement and practical experience. This goes for all regulation: not to generalize but open up for considerations. Primary personnel, interview

Some personnel doubt the knowledge on which the regulations are based, weakening their overall trust in the regulations. This is closely related to the trust they have in the regulator representatives. This fish health personnel believe that incompetence has led to functional rules that are difficult to comply with:

I often see that guidelines are written by people with little or no experience of [fish farm operations]. Very often, it’s opinions that are not possible to achieve or don’t match with reality. Fish health personnel, survey comment

Yet, several fish health personnel underline that the lice limits contribute positively to fish welfare.

Treatment against salmon lice results in lots of poor fish welfare. [...] The government is criticized for strict lice limits, but it wouldn’t improve fish welfare to remove or lower the limits. Fish health personnel, survey comment

Even though the regulations are not regarded as preventing fish mortality, governance in general is viewed as a potential positive contributor to fish welfare. Several respondents noted that, if high fish mortality barred aquaculture companies from producing fish the next season/generation,

this would make the fish farmer institute measures to obtain the best potential salmon survival. Then, biology would overrule profit. Primary personnel, interview

The suggestion for new regulation goes as follows; companies with low fish mortality could produce fish next generation, while the companies with high mortality could not. The respondents implied that this would make companies invest more in research and measures that would positively contribute to fish welfare.

5.4. Interaction and work processes

This category involves how personnel perform and reflect on their tasks and routines, like the interaction between welfare and production,

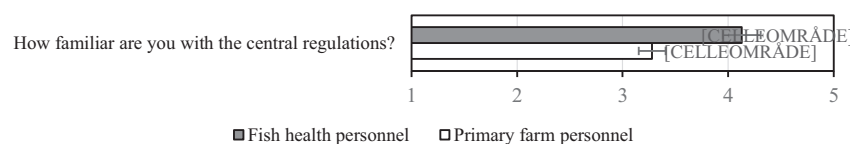


Fig. 5. Familiarity with central regulations. Three questions combined—one each for The Aquaculture Operations Regulation, the Animal Welfare Act, and Internal Control Regulation of Aquaculture—regarding degree of familiarity, ranked 1–5 (“Poor,” “Fair,” “Good,” “Very Good,” “Excellent”).

managers' priorities in operations, and tasks related to wild salmon.

Fig. 6 shows that fish health personnel found fish welfare trumped by profitability in daily operations more often than primary personnel. Indeed, 64% of the overall personnel agreed that production supersede fish welfare sometimes, often, or always. See Section 6.1 for interview comments about how some daily tasks can reduce fish welfare.

Fig. 7 shows that most respondents felt that fish farm personnel prioritize fish welfare more than their administrative managers do. Yet, almost half of the primary personnel said that fish farm personnel and managers prioritize fish welfare equally.

In the survey and interviews, the personnel described situations where their managers neglected fish welfare to optimize profit. Again, the lice situation is the example: Managers may order harmful delousing instead of slaughtering lice-infested fish, since the surviving fish will reach a more profitable weight a few weeks later. To the personnel, this indicates that "profit is the driver" (as several for the interviewed persons said). Even though one now experiences large profits, the personnel is concerned that cost-cutting is prioritized. This person tries to understand why managers are so eager to maximize profit when times are good:

The envelope is pushed in production to maximize profit; I think we push it a bit too far because production's profitable either way. If we were in a recession and feared job losses and the stakes were that high, it would be [right to balance costs], but when the profit's great either way... Fish health personnel, survey comment

5.5. Social relations

The personnel's ability to maintain fish welfare also depends on relationships within the company and with regulators. This section includes the results of two survey items and comments about regulators, managers, and fish health personnel. Despite harsh descriptions of regulations and its practical implications in Section 6.1, the relations with the authorities are more positively valued.

Fig. 8 shows that the groups have different perspectives on cooperation with public authorities. *Siting* (position and farm layout) is governed by several public authorities; and the fish farm personnel rate this collaboration as neutral. As described, siting is important for fish welfare, but it is also seen as a given condition, something presented before the personnel and salmon arrives. The site is thus seen as the foundation for their work with fish welfare. *Salmon lice* are governed by Norway's Food Safety Authority, this collaboration is valued more positively by primary than by fish health personnel. See below for comments that describe reasons why.

Also, the comments revealed good collaboration with the Food Safety Authority. The fish health personnel were satisfied that certain regulators listen and are open to their arguments. The primary personnel reported maintaining a close relationship with regulators to reach a shared understanding; one said, "the Food Safety Authority can answer almost everything." Still, as seen in Section 6.1., many respondents were skeptical about how much practical knowledge the authorities have, given their limited industry experience. Several expressed that both relationship and competence improve when regulators visit fish farms:

They don't know enough about aquaculture, so when they get out on the sites, they learn something about fish farming and see that their profession and their rules have to adapt to the world. Then the flexibility enters; they see they can't be totally rigid. Primary personnel, interview

Another group important to the fish farm personnel are their office-based administrative managers. Company managers are rarely involved in operations, but most respondents were satisfied with the available resources. The current good economy in aquaculture makes it possible to invest in protecting both employees and fish. Protection of employees would include investment in personal safety to prevent injuries. Still, a few respondents expect that their managers want them to take chances and cut corners. For example, in delousing operations, they feel pressured to try risky methods and equipment (as described in Section 6.2). Many respondents emphasized that managers fail to see that welfare can equal profit, since healthy salmon can be sold for a higher price. They believe that managers could more easily consider factors other than direct costs if they had operational or fish health competence instead of only business expertise. This person states what many other discussed, namely that welfare should be a valued decision criterion, not only for fish farm personnel, but also managers:

Business management is about dollars and cents, but decisions should be about more than this. Primary personnel, interview

The relationships between fish health personnel and other groups at the companies arose often during the interviews. Fish health personnel are known to advocate for fish welfare and contribute to improved competence in and attention to fish welfare. The primary personnel described a close relationship with their site's fish health personnel, who teach them about biology and diseases, explain regulations, and speak up for them—and the fish—to management. The primary personnel below even see their farm's fish health person as a caregiver to both humans and fish, since the fish health personnel often educate the primary personnel in good methods, and express their concerns to management:

She cares for us. Primary personnel, interview

In the study, we saw examples of fish health personnel convincing management to make fish welfare-related investments and convincing primary personnel to change routines based on fish welfare research. Through coaching primary personnel and managers, they set the standards for fish welfare.

5.6. Summary of results

- Structure: Daily tasks were considered as the most positive contributor to fish welfare.
- Materiality: Material conditions and site can contribute whichever direction depending on the site.
- Culture: The fish health and primary personnel's roles were reflected in their different knowledge: Primary personnel are oriented at getting tasks done, while fish health personnel are responsible for fish health and welfare.
- Interaction: In operations, farmed fish considerations can be superseded by goals to achieve profitable production or wild salmon considerations.

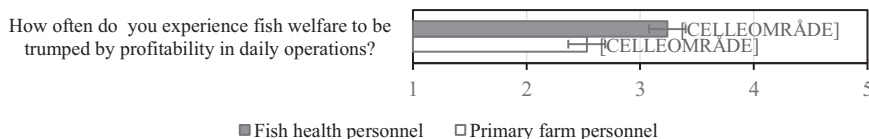


Fig. 6. Fish welfare versus profitability". How often do you experience fish welfare to be trumped by profitability in daily operations? (1-5: "Never," "Rarely," "Sometimes," "Often," "Always").

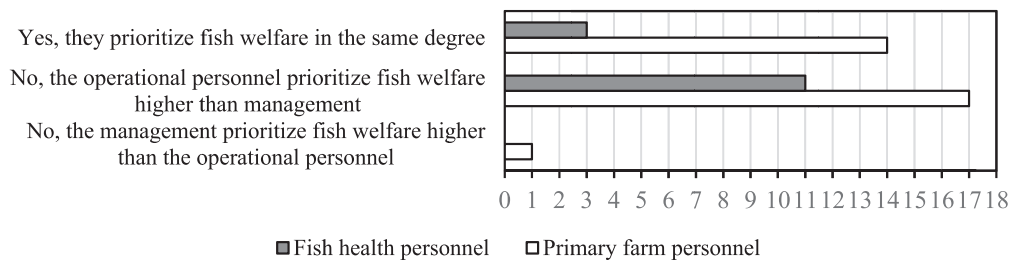


Fig. 7. Managerial priorities, fish welfare, and profitability. Sometimes there can be a trade-off between fish welfare and profitability. In such situations, do you experience that fish farm personnel have the same priorities as managers regarding fish welfare? Number of answers.

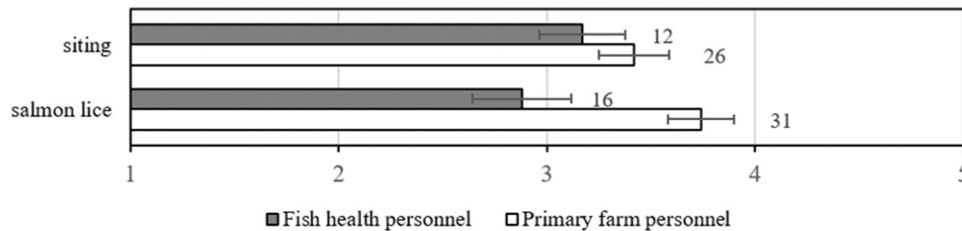


Fig. 8. Cooperation between industry and regulators. How do you rate the cooperation between the industry actors and the public regulators in cases related to...? ranked 1–5 (“Very poor,” “Poor,” “Neither/nor,” “Good,” “Very good”).

- Social relations: The personnel wanted to coach regulators and managers in maintaining fish welfare. Fish health personnel were particularly valued as advocates for fish welfare.

6. Conditions for fish welfare

This study has described organizational conditions that fish farm personnel consider affect fish welfare, positively and negatively. This section discusses the negative and positive contributors (see Fig. 9). The fish farm personnel see themselves as safeguarding fish welfare, in a context of structural conditions prioritizing increased profit in production on one hand, and protection of wild salmon on the other. The result is a multiple protection dilemma, that should be further addressed in fish farming and industries with open production.

6.1. Negative contributors to fish welfare – structural conditions focus on production and protection of wild salmon

The data show that many fish farm personnel are dissatisfied with how the industry facilitates for fish welfare. They were asked about what they do to protect the fish, but argued that the most important contributors are the structural conditions made by regulators and industry managements. Organizational theory emphasizes that management should facilitate for personnel to attain operational objectives (like fish welfare), but that there also will be other objectives in an organization [28,43]. Conflicting objectives are widely studied in the organizational safety literature, especially the choice between production and protection [39]; This conflict is also highlighted in aquaculture regulations [16].

Many of the respondents in this study indicate that managers’ decisions negatively affect fish welfare. If lice levels are too high, management tends to choose delousing to enable continued production (salmon who survive delousing can grow into the most profitable and budgeted weight, and thus increasing profits), while fish health personnel may argue that slaughtering entails less suffering for the fish. Managers are known to emphasize short term production [39]. Kongsvik et al. [61] reported that 23% of fish farm personnel agreed that managerial decisions about production sometimes trumps protection of

personnel. That figure is alarming enough, but our study found 64%—more than twice that level—of personnel reporting that production sometimes trumps protecting the fish. They suggest that all aquaculture company managers and directors should attend fish welfare courses to increase focus on fish welfare.

Among the governing instruments, the Animal Welfare Act is not found to contribute much to fish welfare in this study, while the Lice regulation contributes heavily. The regulatory contributions emphasized by the personnel were mostly related to the Norwegian Lice Regulation [24], which have specific requirements that are strictly enforced. It is designed to protect salmon (and especially wild salmon) from salmon lice. The Animal Welfare Act makes fish welfare a foundational requirement, but according to the respondents in this study, fish welfare is only rarely enforced by the regulators. One reason may be that the Animal Welfare Act does not have specific requirements, but goal-based regulations which leave room for many interpretations and solutions, and which ultimately creates insecurity for both companies and regulators [26,55]. Regulators commonly experience a risk-risk tradeoff, where they need to enforce only a narrow part of the wide body of regulations [27].

Some respondents in this study reported that regulators know too little about fish farming and fish welfare and should spend more time at fish farms to improve their competence. This is supported by earlier research [32,51,60]. The current study’s fish farm personnel suggested that knowledgeable regulators would know how to regulate to reach the right goal. Several of the respondents suggested a rule that could work: If high fish mortality led to fewer fish the next season, companies would prioritize fish welfare more. They would slaughter fish that have lice instead of making them go through harmful delousing. Lice above a certain limit give the management a choice between delousing or slaughtering. Today, managements choose to maximize profit even though delousing harms many fish. With the additional rule of fewer fish next season, many would choose slaughtering – or maybe produce less fish in environments with high densities of sea lice.

These examples show that production can conflict with protection, but they also show that conditions contributing negatively to farmed fish welfare are related to wild fish, indicating an underlying conflict between protection of the farmed and wild salmon, which is further

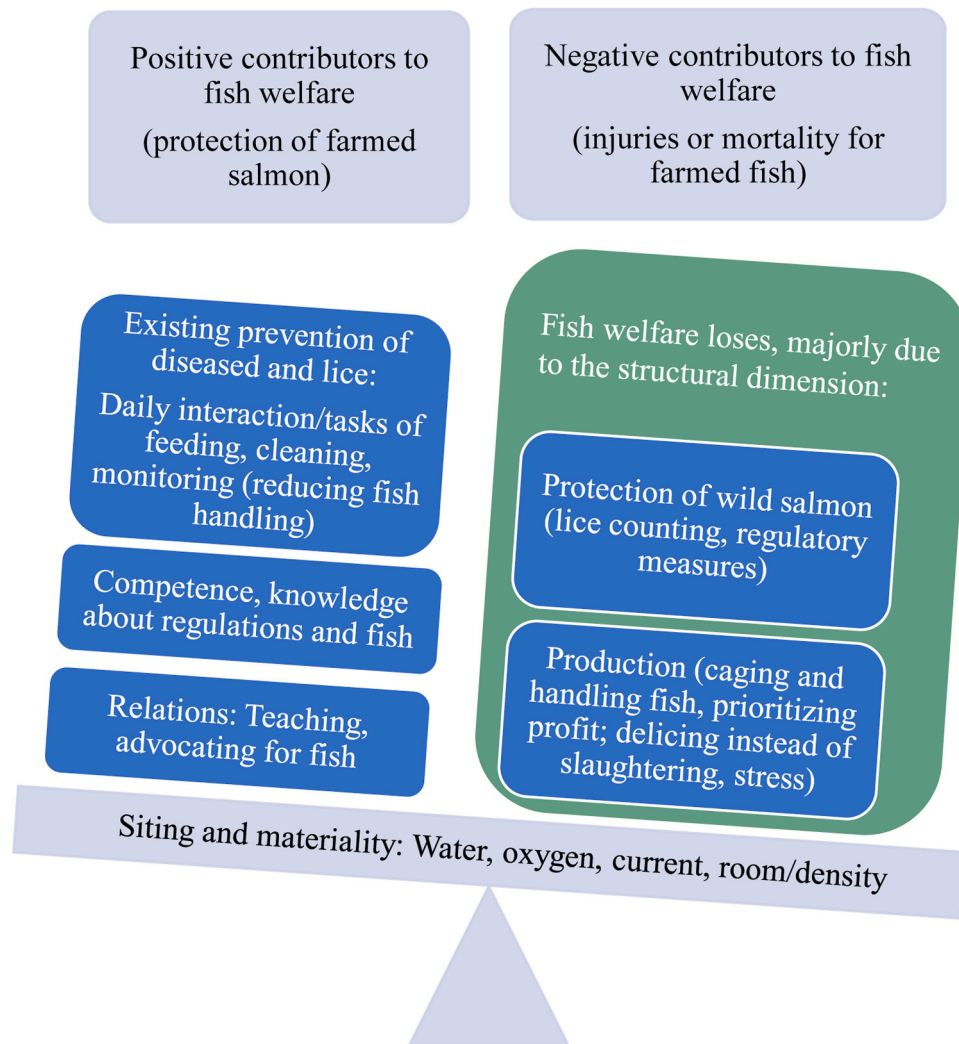


Fig. 9. Positive and negative contributors to fish welfare. The dilemma is how to protect farmed fish under the weight of structural conditions of wild salmon protection and production.

explored below.

6.2. Positive contributors to welfare of the farmed fish – competence, relations, and interactions at the fish farm

In the described context of strong conditions negative for fish welfare, the personnel see themselves as important positive contributors to fish welfare. The data in Section 6 indicates that the personnel strive for fish protection even when regulatory and managerial conditions impede it. The respondents in the current study try to influence regulators and management to prioritize fish welfare.

Primary personnel are employed to run operations and tend to the fish. They are required to attend fish welfare courses but said they learn mostly by experience and from fish health personnel. They also reported that they work as loyal employees but have significant leverage and perform operations with fish welfare in mind. This is in line with Holen et al. [19]; Størkersen [52], that also found that primary personnel have significant responsibilities in the operations, and that operations for the sake of the fish were prioritized over personnel safety.

Fish health personnel are biologists or veterinarians who have studied and pledged to protect the animals they work with [3]. A majority of the fish health personnel in this study reported being included in managerial decision-making about fish health and welfare, but they often find their influence insufficient. Still, they paint a picture of

managements acknowledging their competence and employing them for advice on developing knowledge and routines to maintain fish welfare; in effect, fish health personnel speak for the fish in managerial decisions. They go a long way to influence and change rule enforcement, management, and operations at fish farms. To some extent, they influence the organization—in both directions—through conversations, training, and operations with management and primary personnel. These results suggest that fish health personnel are crucial for preserving fish welfare.

The personnel see their leverage as genuinely positive for fish welfare, but wish they could have more authority to make strategic decisions. Both personnel groups enjoy much discretionary space and an open communication with management. This accords with general findings of work relations in Norway, especially Norwegian fish farming, as being based on relations of trust rather than hierarchical authority and substantial delegation of responsibility to farm personnel ([25], p. 45; [52]). In the present study, personnel saw themselves as able to “speak back” to management in cases important for fish welfare, as frontline personnel are ideally situated to notice welfare challenges as they unfold. Still, the personnel expressed concerns about their real potential to contribute to fish welfare. Their competence, relations and interaction may be appreciated, but regulators still demand operations like lice counting, and management still choose profit over fish welfare in many regards. The organizational conditions thus hamper the possibilities for personnel to ensure welfare to a greater degree. The

personnel's positive contribution to fish welfare is beyond doubt, but how much they can contribute to fish welfare during a production process under these circumstances remains unclear.

6.3. Farmed versus wild salmon: The multiple protection dilemma in open biological production

In the eyes of the fish farm personnel, their protection of the farmed fish is contradicted by regulators' enforcement of the Lice Regulation (and not the Animal Welfare Act), and managers' chasing of profit. The personnel experience tensions between protection and production.

They describe that fish welfare of the farmed fish is hampered by operations that seek to protect the wild fish. This study is the first study of how the personnel experience this dilemma. The findings show conflicts between farmed fish welfare; regulations connected to protecting wild fish; and management decisions for improving profit. Regulations state that operations should protect farmed fish and wild fish, along with employees and investments [16]. Previous studies of Norwegian aquaculture have touched upon the conflicting objectives of fish mortality, production demands, protecting personnel, salmon lice, diseases, and escaping fish (e.g., Holen et al. [19]; Størkersen [52]; T[57]. This current study is in line with the earlier findings, showing that complete protection is not possible, so priorities between objectives must be set by farm personnel, and some regulations are not met.

Yet, this study shows that the conflict between *production* and *protection* is even more difficult in aquaculture as in the industries examined by Reason [39]. In this type of production concerning living beings, production demands like profit and efficiency are inextricably connected to the protection of those beings [25,52]. Protection of the production animal is said to potentially be profitable, since thriving animals increase sales value. Even if fish welfare and profit are not conflicting in principle, in practice they are perceived as opposites. For example, when management choose to delouse instead of slaughter, or insert more fish in a cage when they are small, so they need to be moved when they are older. Achieving both objectives simultaneously, which the studied fish farm personnel insist is possible, offers a solution to the common production/protection dilemma for animal production.

Some objectives will suffer if others are prioritized. Thus, it is time to label and openly handle the multiple protection dilemma. Fish welfare is difficult to maintain without a fundamental change in aquaculture conditions that reduces either the protection of wild salmon or profit. Today, personnel act as a buffer for farmed fish welfare when regulations and management emphasize other objectives. This study demonstrates the urgent need to find instruments to maintain fish welfare for both farmed and wild fish under current conditions, or to change some of the conditions in how the salmon is produced.

7. Conclusion: Finding room for fish welfare

This study has shown that fish farm personnel experience that they contribute positively to fish welfare in a context where structural conditions contribute negatively. On the negative side, a few structural contributors dominate. Lice counting and delousing are executed because of a mix of regulations and managerial decisions, even when they are harmful for the farmed salmon. Due to such structures, many fish farm personnel experience that fish welfare is not prioritized in law enforcement and company decisions, leading Norwegian fish farming to regularly conflict with the *Animal Welfare Act*. On the positive side, the influence on fish welfare comes from all organizational dimensions jointly, and particularly competence, interaction and social relations. The fish farm personnel act as buffers and advocates for fish welfare. They strive for fish welfare through their daily tasks and aim to influence each other, management, and regulators to prioritize fish welfare. In essence, the personnel tries to find room to positively influence on fish welfare, but they continuously experience a *multiple protection dilemma*.

Through describing such a dilemma, this study expands on earlier

research into production and protection. The *multiple protection dilemma* is an addition to the dilemma of protection and production [39]. Production of living beings in open environments has specific conditions not common in other industries. To continue open sea-cage fish farming, it is imperative to improve the conditions that protect the living beings involved in and affected by the production.

Fish farm personnel play an essential role in their companies, where they share knowledge and develop and execute routines to protect farmed fish. There is a need for further studies of the policymaking and the managerial decision-making, but also the role of the health personnel in particular, and the impact these factors have on safeguarding fish welfare. Fish welfare has an improvement potential, and is determined by organizational conditions.

Data Availability Statement

The authors confirm that the data supporting the findings of this study are available within the article. Raw data are not publicly available due to data protection.

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