

Safety climate and compliance in the Norwegian aquaculture industry—employees' perceptions at different company levels

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ABSTRACT: The aquaculture industry is economically important in Norway, and the production is expected to increase in the future. Employees at the fish farms face a high risk of accidents compared to employees in other industries and the focus on safety from both industry and researchers has increased during the last decade. Adding to the knowledge on safety in aquaculture, the objective of this paper is to study employees' perception of safety climate, and whether aspects related to safety climate may predict employees' compliance. Findings from two surveys aimed at managers and employees in different companies are analysed. The first is a telephone survey targeting employees and managers at the fish farms. The second is a web-based survey involving the onshore management level. The results show that employees at all levels have a positive perception of the safety climate, but they also illustrate challenges related to work pressure, maintenance and employee participation. Furthermore, the analysis shows that work pressure affects compliance negatively while participation and competence have positive associations with compliance. These results give input to some practical measures for safety management in the industry.

1 INTRODUCTION

Norway is the second largest exporter of fish worldwide, and the largest producer of finfish (FAO, 2016). Since the 1970's aquaculture, and fish farming in particular, has become a significant contributor to the national value creation. In 2016, the total production in the aquaculture industry was 1,3 mill metric tons, equal to a value of 65 billion NOK (Norwegian Directorate of Fisheries, 2017). 93% of this was Atlantic salmon.

There are both large and small companies in the industry, and the structure of management levels depends on the size. Smaller companies may have personnel that serve different roles, combining the responsibility for safety with other areas such as quality management. Larger companies may have dedicated management working solely with health and safety. The lowest management level is the operational managers, who are responsible for biological production and personnel at one or two fish farms, typically manned by three to six employees (fish farmers).

There are typically six to 12 circular plastic collar net cages in one fish farm (Jensen et al., 2010,

Holen et al., 2017a). The fish farm also has a feeding barge for equipment and feed storage, the feeding system, as well as manager offices, meeting rooms and accommodation for shift workers.

Fish farmers are decreed to perform daily inspections to assess fish welfare and document that the net cages are in order. Fish farmers often use boats and cranes in their work, but increasingly rely on specialized service vessel crews to perform tasks such as mooring operations and delousing. The safety for fish, material assets and personnel is regulated by an extensive set of statutory requirements (Holmen et al., 2017b), which are audited by five different regulatory authorities (Holmen et al., 2017c).

The aquaculture production has the potential to increase in the future (Olafsen et al., 2012). Technology innovations aim to enable production at areas more exposed with respect to climate, wind and currents. This raises new challenges when it comes to fish welfare and operational safety (Bjelland et al., 2015).

The attention to occupational and operational safety in the aquaculture industry has increased during the last decade. Recent studies indicate that safety and risk management systems need to

be improved to maintain a sustainable food production and ensure a safe work environment at harsher locations (Størkersen, 2012, Holmen et al., 2017b, Holmen et al., 2017c).

Being a fish farmer is the 2nd most risk exposed occupation in Norway after being a fisherman, according to the rate of fatal accidents (McGuinness et al., 2013, Holen et al., 2017b). Fall, blow by object, entanglement/crush and cuts are the most common modes of injuries in the Norwegian aquaculture industry (Holen et al., 2017a). In a recent study among aquaculture workers, three out of four respondents reported to have knowledge of near accidents (Thorvaldsen et al., 2017). Organisational aspects and safety indicators have been the topic in several studies (Fenstad et al., 2009, Størkersen, 2012, Thorvaldsen et al., 2015, Holmen et al., 2017b). Looking back, Allred et al. (2005) found that many companies had implemented some systematic HSE work, although production often was given priority.

In this article we will explore the following problems: 1. How do fish farmers, operational managers and onshore management/staff perceive the safety climate? 2. To what extent can safety climate predict safety compliance?

1.1 *Safety climate*

Safety culture has been a defined area of research since the late 1970s, and there is still much research activity related to the issue. Up until 2015, 1789 research publications related to safety culture has been published (van Nunen et al., 2017). In the beginning it was applied as a construct related to causal analyses of major accidents, with Barry Turner's (1978) contribution as an important starting point. Later, the research interests spread over different topics, and involved different disciplines, including anthropology, psychology, sociology and the engineering sciences. Today it is considered a multi-dimensional and cross-disciplinary field of research (van Nunen et al., 2017)

The contributions from psychology is in particular related to *safety climate*, a construct which is in many instances used as synonymous to safety culture and defined in similar ways (Guldenmund, 2007). A much used definition of safety climate is provided by Zohar (2003), who sees it as shared perceptions about safety policies, procedures and practices in a work community. Questionnaire surveys are commonly used to measure safety climate in a work community, involving assessments of topics such as the safety system, work pressure, the safety competence and leadership/supervision (Flin et al., 2000).

Much research on safety climate has been related to identifying causal links between safety climate

as an independent variable and different safety outcomes, summed up in review studies (Clarke, 2006, Christian et al., 2009). This includes exploration of safety climate as an indicator (Kongsvik et al., 2010). The review studies also point to many studies that find a positive relationship between safety climate and safety compliance (adherence to safety instructions, rules, and procedures).

A general finding in the research is that the safety climate in a work community is associated with the work practices in the same community; a positive safety climate is related to compliance and participation in safety-promoting activities, and also mindful safety practices (Dahl and Kongsvik, 2018).

2 METHOD

2.1 *The surveys*

The results are based on two different surveys, that were later combined. The first included fish farmers, operational managers and service vessel crew members as well as some employees in other positions. Representatives at the management level in a selection of 40 companies were informed about the aim of the survey, and invited to share employees' phone numbers. A professional polling company conducted the survey, and a total of 447 out of 735 employees participated. Here, answers from 258 fish farmers and 110 operational managers are used.

The second survey included onshore management and staff. Companies were contacted and asked to provide e-mail addresses to their employees who then got an e-mail linking to the digital survey. Some companies distributed the link to their employees themselves, so the response rate cannot be estimated. A total of 135 persons responded. Here, the net sample includes 92 onshore managers or staff.

The questionnaires were developed on basis of earlier surveys, but were tailor made to the aquaculture industry. In both surveys, the respondents were asked to state their agreement to different statements related to safety climate, on a 5-point Likert scale, ranging from totally disagree to totally agree.

2.2 *Analyses*

Answers from both surveys were extracted and combined in one data file. Some items had divergent wording, mirroring their position.

The items common for the two samples were thematically sorted into four categories: Work pressure, Participation, Competence and resources and Compliance. The first three categories are directly related to the safety climate construct, while Compliance is related to safety practices and whether employees live up to requirements given by the companies.

The statistical analysis aimed at comparing the perceptions of three groups, involving comparing means related to the responses. One-way ANOVA was applied for comparing the means. The limit for statistical significance (P-value) was set to 1%.

We performed a multiple regression analysis to explore if compliance could be predicted by the safety climate factors. The analysis was restricted to the fish farmers (n = 258) to ensure homogeneity in the work situation for those included. A *Compliance scale* was constructed by combining three items: 1. I use the required protective equipment 2. If I see dangerous situations at work, I report them. 3. Safety has first priority when I do my job. The Cronbach's alpha for the scale was .71. The *Work pressure scale* consisted of three items: 1. Sometimes I feel a pressure to continue working, although safety can be compromised 2. In practice, consideration to production is prioritized at the expense of safety 3. Inadequate maintenance has reduced the safety level. The Cronbach's alpha for the scale was .67. The *Participation scale* also included three items: 1. I participate in making new procedures 2. I get involved when new procedures are to be introduced 3. My manager appreciates that the employees take up safety issues. The Cronbach's alpha for the scale was .70. The *Competence scale* included two items: 1. I have the necessary competence to handle my work tasks safely. 2. I have received the necessary training for handling critical or dangerous situations. The Cronbach's alpha for the scale was .60.

The independent variables in the regression analysis were introduced by forced entry. Missing values were excluded list wise. The variance inflation factor (VIF) varied between 1.141 and 1.276, and tolerance values varied between 0.783 and 0.876. This gives no indications of multicollinearity. To check the assumption of independent errors, the Durbin-Watson test was performed. This test shows there was no concern regarding autocorrelation, with a test statistic of 2.063 (Field, 2005).

3 RESULTS

Here, the mean values reported by the respondents of the surveys are compared. Results are presented by the three following groups: onshore management (M), operational managers (OM) and fish farmers (F).

3.1 Perceived safety climate

The safety climate can be expressed by the survey results about work pressure; competence and resources; and compliance.

3.1.1 Work pressure

Table 1 reports the results from three items considering work pressure.

The first item is phrased differently for operational and onshore personnel. Yet, all groups somewhat disagree that production pressure makes operational personnel break safety rules and continue unsafe work. Onshore management agree more than operational personnel that employees will compromise on safety because of production pressure.

On the next item, this controversy is partly reversed. On average, fish farmers neither agree nor disagree that production is prioritized over safety, while both types of managers disagree more. Still, analysis show that 22.9% of the fish farmers and 13.6% of the operational managers agree or totally agree that consideration to production is prioritized at the expense of safety.

All three groups' mean values show they somewhat disagree that inadequate maintenance has reduced the safety level. 19.8% of the fish farmers and 18.2% of the operational managers agree or totally agree that safety has been reduced due to inadequate maintenance.

3.1.2 Participation

Table 2 includes three items about employee participation.

All groups agree that managers appreciate employees' safety engagement. Onshore management appreciate that employees take up safety issues more than considered by the employees.

Table 1. Perceptions of Work pressure – means on a scale from 1 (totally disagree) to 5 (totally agree).

Items	Groups	Mean	P-value
F/OM: Sometimes I feel a pressure to continue working, although safety can be compromised	Fish farmers	2.02	0.000
	Operational managers	2.16	
	Onshore management	2.63	
M: Owing to the company's production demands, the employees sometimes have to break the safety rules			
In practice, consideration to production is prioritized at the expense of safety	Fish farmers	2.56	0.001
	Operational managers	2.09	
	Onshore management	2.19	
Inadequate maintenance has reduced the safety level	Fish farmers	2.40	0.609 (NS)
	Operational managers	2.30	
	Onshore management	2.47	

Table 2. Perceptions of Participation – means on a scale from 1 (totally disagree) to 5 (totally agree).

		Mean	P-value
F/OM: My manager appreciates that the employees take up safety issues	Fish farmers	4.20	0.000
	Operational managers	4.32	
	Onshore management	4.92	
M: As manager, I appreciate that the employees take up safety issues			
F/OM: I participate in making new procedures	Fish farmers	2.77	0.000
	Operational managers	3.54	
	On shore management	3.61	
M: The employees participate in making new procedures			
F/OM: I get involved when new procedures are to be introduced	Fish farmers	3.35	0.006
	Operational managers	3.73	
	On shore management	3.76	
M: The employees get involved when new procedures are to be introduced			

The mean results about employees' participation in development of new procedures lies around neither/nor. Fish farmers lean towards disagreement, while both management groups agree somewhat that employees (including the operational managers themselves) participate in making procedures.

Management agree that employees get involved in introduction of procedures, Analysis shows that 24.4% of the fish farmers disagree or totally disagree that they are involved when new procedures are introduced, compared to 19.1% of the operational managers.

3.1.3 Competence and resources

The three items considering Competence and resources are presented in Table 3.

All groups agree that the operational personnel have the competence to work safely and that manning is sufficient for safe work. It is 12.4% of the fish farmers and 12.7% of the operational managers that disagree or totally disagree that manning was sufficient.

There are larger differences regarding learning from unwanted events. Fish farmers and operational managers agree that information regarding unwanted events is utilized to prevent recurrence, while onshore management state neither/nor.

3.1.4 Compliance

All respondent groups' in average agree regarding the three items about compliance, but there are some differences (Table 4).

Table 3. Perceptions of Competence and resources – means on a scale from 1 (totally disagree) to 5 (totally agree).

		Mean	P-value
F/OM: I have the necessary competence to handle my work tasks safely	Fish farmers	4.49	0.578 (NS)
	Operational managers	4.56	
	Onshore management	4.47	
M: Our employees have the necessary competence to handle their work tasks safely.			
The manning is sufficient to maintain the safety	Fish farmers	3.70	0.235 (NS)
	Operational managers	3.62	
	Onshore management/ staff	3.87	
F/OM: Information regarding unwanted events is utilized adequately to prevent recurrence	Fish farmers	4.11	0.000
	Operational managers	4.13	
	Onshore management	2.91	
M: We utilize the information from reported unwanted events sufficiently in the preventive work			

The analysis displays no significant differences regarding perceptions of reporting of dangerous situations. However, 31.4% of the fish farmers answered that they agreed or totally agreed with the statement: *I think it is uncomfortable to point out lack of compliance to safety rules and procedures.* 16.4% of the operational managers said the same. Onshore management were not asked about this aspect, as it relates to the operational context and the everyday interaction between workers at the fish farms.

Regarding use of protective equipment operational personnel totally agree that they use it, while onshore staff only agree.

Operational personnel agree (4.30), while onshore management almost totally agree (4.71) that safety has the first priority.

3.2 Safety climate's relation to compliance

A linear regression analysis restricted to the fish farmers in the sample was performed. Work pressure, Participation and Competence were used to predict Compliance.

Work pressure, Participation and Competence explained 30.4% of the variance in Compliance ($p < 0.000$). Each of the predictor variables had a significant contribution to the model.

Table 4. Perceptions of Compliance – means on a scale from 1 (totally disagree) to 5 (totally agree).

		Mean	P-value
F/OM: If I see dangerous situations at work, I report them.	Fish farmers	4.38	0.209 (NS)
	Operational managers	4.54	
	Onshore management/ staff	4.32	
M: The employees use the reporting system adequately when it comes to personal injuries and other serious events.			
F/OM: I use the required protective equipment	Fish farmers	4.55	0.000
	Operational managers	4.72	
M: Our employees always use the required protective equipment	Onshore management	4.20	
Safety has first priority when I do my job	Fish farmers	4.30	0.000
	Operational managers	4.30	
	Onshore management	4.71	

Table 5. Linear regression analysis predicting ‘Compliance’: Beta-values (B), standard errors (SE B), standardised betas (β) and explained variance (Adjusted R^2) (N = 253).

	B	SE B	β	Adjusted R^2
Constant	2,086	0.301		0.304
Work pressure	-0.150	0.044	-0.197	
Participation	0.112	0.043	0.156	
Competence	0.366	0.054	0.381	

Work pressure had a negative association with Compliance, while Participation and Competence had a positive association. High perceived work pressure was thus associated with lower Compliance, while higher degrees of participation and Competence, was associated with higher Compliance.

4 DISCUSSION

Considering the results, variations in perceptions of safety climate related to the three different groups and company levels are discussed.

4.1 Regarding work pressure

All groups recognize some pressure to continue unsafe operations or violate rules and prioritize production over safety (two first items, Table 1).

Almost ¼ of the fish farmers agree that production sometimes trumps safety. Unsurprisingly, managers disagree more as they often have a more positive (Fenstad et al., 2009) or less realistic view of operations (Hale and Borys, 2013b, Hollnagel, 2011). When considering if *production pressure will make employees compromise on safety*, managers agree more than operational personnel do. One explanation may be that management have HSE as their area of expertise, and might have learned, in practice and theoretically, that operational personnel will feel pressured to work efficient and not thorough (Hollnagel, 2009) or prioritize production over protection (Reason, 1997) with a drift towards unsafe performance (Dekker, 2011, Vaughan, 1997, Rasmussen, 1997).

This resonates with earlier findings in Norwegian aquaculture. In Allred et al. (2005), 21% agreed that they were pressured to work in a way that could threaten safety. In addition, 27% agreed that the operational manager did not have the time to sufficiently manage employees’ HSE – meaning that they focused on production to make the ends meet (ibid). Priority of the biological product, the fish, is also qualitatively described (Fenstad et al., 2009, Størkersen, 2012).

A more recent study found that work pressure may be caused by poor planning of operations, insufficient staffing, time pressure and working long hours (Thorvaldsen et al. 2015). And even though their personal safety may be threatened, employees are very conscious about following up on their work responsibilities.

An increased efficiency pressure coincides with the statements about maintenance (Table 1). 1/5 of the fish farmers and operational managers think that inadequate maintenance has reduced the safety level. Maintenance on existing equipment might be postponed to times with less activity and potential earnings. It is shown that coastal vessels running for the prosperous aquaculture industry have tighter schedules and more stress than vessels operating in slower markets (Størkersen, 2017).

Economic priorities are relevant here, as it may affect maintenance of existing equipment at a given fish farm or vessel, but also limit investments in new technology (Thorvaldsen et al. 2015). A previous study also found that fish farmers experienced increased profit as more important than workers’ safety (Fenstad et al. 2009).

4.2 Regarding participation

Personnel on all levels agree that managers appreciate employees’ safety engagement. However, managers seem to appreciate employees taking up safety issues more than fish farmers think. The interaction between company levels as well as differences between formal and informal communica-

tion may be reflected here. Fish farmers may take up safety issues with the operational managers, who then decides whether and how to address a specific issue. In larger companies, formal reporting systems are also used. As operational managers give a higher score than fish farmers, fish farmers may think about day-to-day interaction when they disagree with the perception of the operational managers, or they may be thinking about the (lack of) response they get when they address safety issues through formal reporting systems.

Allred et al. (2005) found that 81% agreed that employees could influence the HSE conditions to a large degree. Still, a third of the respondents said they did not have the chance to participate in HSE strategies.

When it comes to new procedures, and employees' participation in developing them, the answers gave a neither/nor result. Fish farmers disagree more than the managers. Here, a likely explanation will be that the onshore managers involve the operational managers and some of the fish farmers when procedures are made. Even though not all fish farmers are involved in such processes the onshore managers do involve some of the employees.

The situation seems to be somewhat similar when it comes to new procedures. Almost 25% of the fish farmers and 19% of the operational managers disagree. As procedures are often sent to employees via computer-based systems, this answer may indicate that this is not seen as involvement, but rather as information.

4.3 *Regarding competence and resources*

Over all, the participants agree that operational personnel at the fish farms have the competence to work safely. Several companies also provide external safety courses for employees, and companies use internal procedures to document how operations should be performed. Experience is also highly valued at the fish farms (Holmen et al., 2017a, Thorvaldsen et al., 2015).

In 2005, 68% stated that employees got adequate safety training, but 41–44% wanted more training in sickness and injury preventing work and safety routines (Allred et al., 2005).

When it comes to staffing, about 12% of both fish farmers and operational managers disagree that manning is sufficient. Safety issues when workload is increased without additional personnel has been discussed in previous studies in aquaculture (Thorvaldsen et al. 2015) and maritime industries (Hetherington et al., 2006, Österman and Hult, 2016).

Fish farmers and operational managers agree that they use information from previous events for prevention, but onshore staff answers neither/nor. It may be that onshore management see more potential for learning and prevention both on their part and from the operational personnel.

Onshore management must follow up on non-compliance reports from many fish farms, and may lack time and resources do to this optimally. The operational personnel on the other hand, may answer more positively based on activities and measures on their specific fish farm, and not what comes from the onshore management. With more formalized systems for reporting, one might think that this was an area that had improved a lot during the last decade. Looking back, however, 72% of the participants in 2005 (Allred et al.) answered that information about accidents and unwanted events was actively used by the companies.

4.4 *Regarding compliance*

All groups agree they report dangerous situations (the first item, Table 5), but a third of the fish farmers also are uncomfortable pointing out non-compliance. Not every company meets deviance from rules with an understanding that most personnel follow rules, but that some rules can be difficult to follow because they are contradictory to other rules, the context, or resources (March, 1994). It may even be necessary to break a rule to get the job done (Reason, 1990). Thus, the safety literature has emphasized that safety is not attained by blind rule-following (Hollnagel et al., 2006, Hale and Borys, 2013b). Still, compliance might be the safest option if the rules can be followed. A literature review of quantitative studies indicates “a positive linear relationship between safety compliance and safety. That is, the more compliance the better for the state of safety” (Dahl, 2014: 31). In the study of Allred et al. (2005), the findings were at least as positive as in the current study: 65% stated that employees always reported safety issues and dangerous conditions, and $\frac{3}{4}$ meant operational manager encouraged employees to report such conditions.

Both the current and previous studies (Allred et al., 2005) find that protective equipment mostly is used.

All groups prioritize safety in most situations, the management respondents are most certain. This is related to the statement that the production is prioritized over safety in some operations, although management disagree that production is prioritized over safety (Table 1). Management is commonly looser coupled to the negotiations in the operations. A relevant point here, is that our survey has targeted management respondents with health and safety as their responsibility. Furthermore, as Allred et al. (2005) also discuss, we do not know if it is only the most positive representatives working in the most HSE focused companies who have answered the surveys (Hollnagel et al., 2006, Hale and Borys, 2013).

4.5 *Safety climate and compliance*

The regression analysis revealed that safety compliant behaviour was predicted by safety climate

measures among fish farmers. In our context, compliant behaviour involves adherence to safety rules, and procedures, such as the use of the required protective equipment, reporting of dangerous situations if they are observed, and prioritizing safety when they do their job.

Among the three safety climate factors, Competence was the most important predictor, followed by Work pressure and Participation. Competence and Participation were positively related to Compliance, while Work pressure was negatively related to Compliance.

Several studies have shown similar results, adding up to a quite robust relationship between safety climate and safety behaviour (Clarke, 2006, Christian et al., 2009). In general, this research shows that those who perceive safety as valued and prioritized in their work community, display a more positive safety behaviour, including compliant behaviour, than those who perceive safety as less valued (Dahl and Kongsvik, 2018).

This relationship has not been studied in the aquaculture industry previously. The results indicate that the relationship can be valid also in this context. This gives input to some practical measures for safety management in the industry. The competence scale included items on training, including training for emergencies. Providing such training might increase compliance through increased knowledge of the procedures. Further, avoiding work pressure that goes at the expense of safety might also increase compliance and reduce exhaustion for the individual employees. This may be a challenge, as there are some very labour-intensive periods related to delousing operations etc. Still, organizing these periods as to avoid long hours and heavy workloads might have a positive influence on compliance and safety climate. Lastly, involving employees in the construction of procedures, and having an 'open door' policy regarding safety issues can also have a positive influence on ownership, feeling of involvement and compliance.

Although safety compliance is one important aspect, it is also true that procedures and rules tend to be underspecified and cannot cover all eventualities in complex systems (Hollnagel, 2009). On the one hand, the work at fish farms include many routine tasks, where the applicability of clear procedures is evident. On the other hand, flexibility, situational awareness, practical experience, and problem-solving skills are also vital qualities in this context (Thorvaldsen et al. 2015). Consequently, rules and procedures should be dynamic, and involve sharp-end workers in formulating and evaluating them (Hale and Borys, 2013 a). So even if compliance in many instances is a basic foundation for many work operations in high-risk industries, performance variability is also a valuable asset that

might increase the resilience in a sociotechnical system (Hollnagel, 2009, Haavik et al., 2017).

The results give grounds for further exploring the relationship between safety climate and safety compliance in the aquaculture industry. Future research could include onshore personnel, and suitable measures for safety climate and safety behaviour. This could broaden the view on how accidents can be prevented in the industry. Also, the cause and effect relationship between climate and safety outcomes can be explored. Other studies indicate that this relationship might be reciprocal (Kongsvik et al., 2011).

5 CONCLUSION

This article explores perceptions of safety climate at different company levels based on two surveys amongst employees in the aquaculture industry. Over all, perceptions of the safety climate are positive at all levels. This may reflect an increased focus on workers' health and safety during the last decade. Still, there are challenges related to work pressure, maintenance and employee participation. While aspects related to compliance such as reporting, wearing protective equipment and prioritizing safety get a high score, many fish farmers are uncomfortable with pointing out colleagues' lack of compliance.

The analyses further reveal that fish farmers' compliance to safety requirements is predicted by safety climate, and in particular by competence. Training, including emergency exercises, will be valuable for increased safety. The same goes for reduced work pressure. Work pressure relates negatively to compliance, and almost one quarter of the fish farmers agree that production is prioritized over safety.

Differences between company levels reflect different points of view and responsibilities within the companies. It is important that fish farmers are involved when their work procedures are created and introduced. Fish farmers and operational managers who work at the sharp end are physically closest to the occupational hazards, and rely on the onshore management to get the necessary means to mitigate the risks.

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