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Safety culture, working conditions and personal injuries in Norwegian maritime transport

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Abstract

The aim of the study is to examine the influence of safety culture and working conditions on personal injuries and risk perception on vessels sailing along the coast of Norway (mostly bulk, well and general cargo). The study employs three methods: small-scale survey (N=180) to crewmembers, reference group meeting and qualitative interviews with sector experts (N=10). Results indicate that organizational safety culture, manning level on board, work pressure and demanding working conditions are closely related, and that these factors influence injuries and risk perception on the studied vessels. Analyses indicate that lower manning levels induce higher work pressure, which negatively influences safety culture. Respondents on vessels with lower manning levels (3-4 people) score lower on many of the key variables of the study: they experience more personal injuries, experience more stress, and rate the safety culture as lower than respondents on other vessels. It is not examined whether manning levels are too low. The safety challenges of vessels with lower manning levels are probably due to framework conditions (e.g. economy, com-petition). Future research should examine how to improve working conditions and safety culture on these vessels, given the current manning levels and framework conditions.

1. Introduction

1.1 Background and aims

Sea transport is central to world trade, as it carries about 90 % of internationally traded produce (Alderton & Winchester 2002). Sea transport dominates long distance goods transport in Norway, where it constitutes about 81 % of the import, measured in tonnes, including passenger ferries, and about 73 % of the export measured in tonnes, including ferries and excluding crude oil and natural gas (White paper no. 31 2003-2004).

According to Ek et al (2014), seafaring is still among the most hazardous of occupations, although mortality rates for seafaring have declined substantially over the course of the 20th century. Merchant shipping is known to have a high rate of fatalities caused by both occupational accidents on board vessels and shipping accidents, involving e.g. foundering, grounding (Ek et al 2014). According to Nævestad, Elvebakk, Phillips, Bye and Antonsen (2015), there were on average 15 killed and 424 injured annually on Norwegian ships, i.e. Norwegian Ordinary Ship Register (NOR) and Norwegian International Ship Register (NIS) in the period 2004-2013.

The present study focuses on occupational safety on vessels sailing along the coast of Norway. The Norwegian Maritime Authority (NMA) has previously identified challenges in the coastal cargo sector that may potentially affect safety, e.g. an ageing fleet, negative economic framework conditions, and sought more knowledge on manning levels, safety culture on board and working conditions (cf. Størkersen et al 2011). In their study, Størkersen et al (2011) especially point to the negative safety effects of fatigue, heavy workload and alienation, stressing that these factors may cause operational errors. Other studies have also underlined the importance of working conditions for occupational safety in the maritime sector, e.g. manning level, work load, fatigue and stress (Wadsworth et al. 2008; Phillips, Nævestad and Bjørnskau 2015; Lützhöft, Thorslund, Kircher, & Gillberg 2007; Allen et al. 2008; MAIB 2004).

Studies have also highlighted the importance of organisational safety culture for maritime safety, (cf. Håvold & Nesset 2009, Lu & Tsai 2010; Mearns, Whitaker, Flin, Gordon & O'Connor, 2000; Williamson et al. 1997; Hetherington et al 2006; Ek & Akselsson 2005). In spite of this, there are few studies of maritime safety culture compared to other sectors. In 2005, Håvold reported literature searches indicating that only a couple of studies about safety culture and climate recently had been done in shipping (Håvold 2005). A review conducted eight years later still found relatively few studies of safety culture at sea (Bjørnskau & Nævestad 2013). Organizational safety culture can be defined as "safety relevant aspects of culture in organizations" (Hale, 2000; Antonsen, 2009). In this study safety culture is specified as shared and safety relevant ways of thinking or acting that are (re)created through the joint negotiation of people in social settings (Nævestad, 2010). It may be useful to think of organizational safety culture as the informal aspects ("how things are actually done") of safety in organizations to distinguish it from the formal aspects ("how things should be done"), as described in procedures, routines and organizational charts etc. (Antonsen, 2009The latter is also referred to as safety management system (SMS), which typically include management policy, appointment of key safety personnel, reporting systems, hazard identification and risk mitigation, safety performance monitoring etc. (Thomas 2012).

The main safety prevention focus in the maritime sector is on safety management systems (SMS). This is due to the SMS requirement of the International Safety Management (ISM) code of the International Maritime Organization (IMO). IMO is the United Nations' specialized agency with responsibility for the safety and security of shipping and the prevention of marine pollution from ships. IMO made the ISM code statutory in 1998. The ISM code was developed after several severe maritime accidents were found to be caused by human error and insufficient safety management systems (Lappalainen et al 2012). IMO's primary goal with the ISM code was to gradually create a new safety culture in the maritime industry (Kongsvik et al 2016).

The regulations on manning levels (IMO 1047) is another key maritime safety regulation. The safety manning defines the minimum crew size and minimum qualifications required for sailing from A to B, not taking into consideration the operational tasks which also must be done on board ships while sailing, for instance related to preparing for loading/unloading, maintenance, administrative tasks and so forth. If vessels choose to only have a safety manning, it is likely that they will be understaffed when it comes to safety critical functions. The "operational manning" is the manning level chosen by the shipping companies, based on their considerations of the needs of their vessels, additional to sailing.

The aim of the present study is to examine the influence of safety culture and working conditions on personal injuries and risk perception on vessels sailing along the coast of Norway. Obtaining knowledge on the relationships between these factors is a prerequisite of implementing preventive measures to improve occupational safety on board vessels. In this study, occupational safety refers to personal injuries and risk perception. Working conditions refer to factors like manning level on board, work pressure, and demanding working conditions.

The data used in the present report was originally collected in another project, which is reported in Nævestad (2016a). The aims of the previous study were to study the relationship between organisational safety culture and safety on board vessels and to compare nationally flagged (NOR) vessels with vessels flying flags of convenience (FOC) when it comes to national safety culture, communication, working conditions, fatigue and implementation and enforcement of international rules (Nævestad 2016a). The present study looks closer at the sample of largely Norwegian respondents from NOR-registered vessels only (N=180), to be able to consider the effects of organisational factors on occupational safety without the confounding effects of flag or nationality. (Results are also reported in Nævestad 2016; Nævestad & Phillips 2017)

1.2 Previous research

1.2.1 Personal injuries and risk perception in maritime transport

Maritime safety generally refers to two categories of incidents: personal injuries due to work accidents on board (or ship accidents), and ship accidents (i.e. fire/explosion, grounding, severe weather damage, capsizing, collision, contact damage, leakage, breakdown of machinery, environmental damage/pollution, stability failure (without capsizing), missing/disappeared vessel and "other accident") (NMA 2016).[1] Norwegian statistics shows that most personal injuries (96 %) are due to work accidents on board, and that only four per cent are related to ship accidents in the period 1981-2013 (Nævestad et al 2015). The number of personal injuries on Norwegian flagged cargo vessels have been reduced in recent years (Figure 1).

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[1] Other examples of maritime safety indicators could be those used by the Paris Memorandum of Understanding (MOU) in port state controls (Nævestad 2016a). The focus in this paper is however on occupational safety, and the most basic and general measure of this is personal injuries, which therefore can be compared to results of previous research.

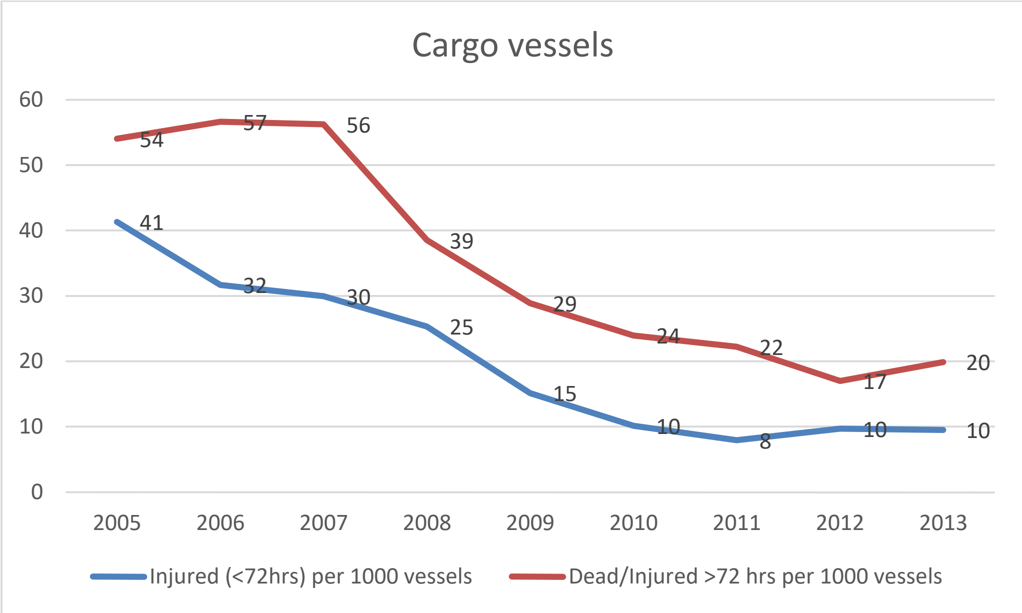


Figure 1 indicates that the number of injuries per 1000 vessels have been reduced substantially for both injury severities in the period. The risk for the most severe injuries has been reduced by 63 % in the period. In the same period, the number of NIS/NOR cargo vessels increased with 34 %, to 3470 ships in 2013 (Nævestad et al 2015). In a questionnaire study including 6461 participants in 11 countries, Jensen et al (2004) found that during the latest tour of duty, 9.1 % of all seafarers were injured and 4.3% had an injury with at least 1 day of incapacity. Hansen et al (2002) studied 1993 occupational accidents among crew aboard Danish merchant ships in the period 1993-1997. This study found that the mean risk of having an occupational accident was 6.4/100 years at sea and the risk of an accident causing a permanent disability of 5 % or more was 0.67/100 years aboard. Comparing the risk of occupational accidents on different vessel types, Hansen et al's (2002) study reports that Roll-on-roll-off vessels (2.85 per 10000 days) and passenger vessels (2.63) have the highest risk of occupational injuries of all severities, while gas tankers (0.86) have the lowest risk. Looking at the accidents causing permanent injuries or fatal accidents on the other hand, coastal cargo vessels are among those vessels with the highest risk, while passenger vessels have the lowest risk (Hansen et al 2002).[2]

1.2.2 Factors influencing personal injuries and risk perception

[2] The paradoxical difference between passenger and cargo vessels could be due to differences in safety culture, meaning that a more positive safety culture gives more reporting of all incidents, including the less serious incidents, but fewer serious incidents (Hansen et al 2002). The study of Nævestad et al (2017) comparing passenger vessels crews and cargo vessel crews supports this hypothesis, as it indicates higher safety culture scores among the studied passenger vessel respondents than the cargo vessel respondents.

Demographic factors. Hansen et al (2002) also found that foreigners have a considerably lower accident risk than Danish citizens, and that age was a major risk factor for accidents causing permanent disability, but younger seafarers had a higher risk. Jensen et al (2004) also found seafarers' age (<35 years) and nationality to predict occupational accidents. Nævestad et al (2017) also found seafarers age (<26 years) to predict occupational accidents in a questionnaire study including crewmembers on passenger vessels registered in the Norwegian Ship Register (NOR) (N=84) and NOR registered coastal cargo vessels (N=73).

Position/work activities: Jensen et al (2004) also found that position (i.e. rating) and work in engine room to be related to personal accident involvement. Hansen et al's (2002) study found that the most serious accidents happened on deck.

Situational factors. Other key findings from the study of Hansen et al (2002) is that change of ship and the first period aboard a ship were identified as risk factors Walking from one place to another aboard the ship caused serious accidents. Jensen et al (2004) also found tour lengths (<117 days) to be related to personal accident involvement.

Safety behavior. Jensen et al (2004) found lacking use of protective equipment to be related to personal accident involvement. Nævestad et al (2017) found that an index made up of four safety behaviour items predicted personal injuries. These were: "I violate procedures to get the job done", I refrain from using the required protection equipment in my work", "I accept small risks because the "situation demands it" (e.g. because of time pressure, bad weather)", "I work, even though I am so tired that safety may be compromised".

Risk perception. Finally, Jensen et al (2004) also found self-assessed occupational safety ("How is your occupational safety": 1=very bad, 5=very good) to be related to accident involvement. This may also be referred to as "occupational risk perception". Størkersen et al (2011) includes two items measuring this: "worry about work risk" and "rating of overall work situation safety level". They found that Norwegian seafarers were more worried about their work risk, but rated their occupational safety level as higher than foreign seafarers. Moreover, the Norwegian seafarers reported of less work pressure, fatigue, safety culture (1 item) and procedure violations than the foreign seafarers. Thus, although Størkersen et al (2011) sample is very small (N=74) and only report univariate results, one may perhaps assume, given these results, that respondents who experience better working conditions and safety culture rate their occupational safety as higher.

Organizational safety culture. Reviewing the field of safety climate research, Flin, et al (2000) conclude that the most studied and well-documented characteristic of a good safety climate is senior managers' commitment to safety (Flin et al. 2000). This is the prime factor in measurements of safety climate (Flin et al. 2000). It tends to influence all other safety-related aspects of organisations (Reason 1997). Other key aspects of safety culture highlighted in several studies are an informed, reporting and learning culture, continually reflecting upon practice (cf. Reason 1997; Pidgeon & O'Leary 2000). Studies also indicate the importance of employee involvement, safety communication, safety training and trust (e.g. Edkins et al 1998). These aspects are accounted for in the safety culture scale employed in the present study (cf. Chapter 2.3).

Research indicates a relationship between safety culture and safety performance (specified as safety behaviour) in the maritime sector, although this relationship is challenging to measure (Bjørnskau & Nævestad 2013). A systematic literature review from 2013 found only two studies examining the relationship between organisational safety culture and safety performance in the maritime sector (Bjørnskau and Nævestad (2013). These were the studies of Håvold and Nesset (2009) and Lu and Tsai (2010). Both studies found that safety culture influences safety performance. Håvold & Nesset (2009) include safety behaviour as a safety outcome variable in a large study containing 141 vessels and 2558 responses. Their study develops the safety culture concept further and defines "safety orientation" as an implementation of the safety culture concept. The authors conclude that the study confirms the usefulness of safety culture/climate factors as predictors of unsafe behaviour. The influence of safety culture on seafarers' safety behaviour is also investigated by Lu and Tsai (2010) by use of a safety culture survey combined with self-reported safety behaviour. This study also revealed a positive relationship between safety culture and safety behaviour. Studies focusing on the relationship between organizational safety culture and occupational injury risk have not been found, but Nævestad et al (2017) indicates that safety culture is related to safety behaviour, which in turn is related to personal injuries.

Manning level. This is the first of three working conditions focused on in the present study. According to Wadsworth et al. (2008), pressure to improve productivity and the introduction of new technology have resulted in reduced manning level, reduced port turnaround times and decreased layovers. In many branches of shipping there are long work weeks, nonstandard work days, extensive night operations, and periods of intense effort alternating with periods of monotony. Although it is difficult to find studies examining the relationship between manning level and occupational injury risk, previous research indicates that manning level may influence work pressure and fatigue (Phillips 2016). Phillips (2016) states for instance that understaffing will cause more problems during employee absences, more overtime, and more last-minute schedule changes, leading to a larger discrepancy between planned and actual schedules worked. Thus, understaffing may cause both fatigue and work pressure. It seems, however, that there are few empirical studies examining these relationships.

Fatigue. Seafarers share several important work characteristics influencing fatigue, for instance long working hours, sleep disturbances, due to for instance motion noise, and night work (Lützhöft, Thorslund, Kircher & Gillberg 2007; Allen et al., 2008). Fatigue seems to be related to occupational injury risk, although more research is needed on the mechanisms generating fatigue (Williamson et al 2011). Moreover, evidence is accumulating from international studies that fatigue is a problem for many watch keepers at sea. The Bridge Watch keeping Study of the Marine Accident Investigation Branch (MAIB) concludes a third of all the groundings involved a fatigued officer alone on the bridge at night (MAIB 2004).

Work pressure. In their study of ten coastal cargo vessels sailing along the coast of Norway. Størkersen et al. (2011) find that 33 % of the respondents reported that they put themselves in danger to get the job done, while about 40 % violate procedures to get the job done, especially because of efficiency demands. This indicates that work pressure influences safety behaviour, and research mentioned above (Jensen et al 2004; Nævestad et al 2017) indicates that safety behaviours influence occupational injury risk

To sum up, the following variables can be expected to influence personal injuries, based on previous research: 1) Age ("youngest" category), 2) Nationality (domestic) 3) Position/work activities (engine room, deck), 4) Situational factors (change of ship, first period on board), 5) Safety behaviours (e.g. violations, risk taking), 6) Risk perception, 7) Organizational safety culture (as it is related to behaviours), 8) Manning level (as it influences work pressure and fatigue), 9) Fatigue and 10) Work pressure (as it influences safety behaviour). Moreover, one may also expect that respondents who experience better working conditions and safety culture rate their occupational safety as higher (i.e have a low risk perception).

2. Methods

The study employs three methods: small-scale survey (N=180) to crewmembers, reference group meeting and qualitative interviews with sector experts (N=10).

2.1 Interviews and reference group meeting

We conducted qualitative interviews with 10 sector experts from employer organisations, employee organisations, authorities and other organisations involved in maritime safety. The interviews and the reference group meeting were conducted as part of the larger previous project reported in Nævestad (2016a-b) (cf. Chapter 1.1). The purpose of these interviews was therefore to gain knowledge on safety outcomes of increasing internationalisation, potential risk factors and relevant measures to increase maritime safety further. However, as the participants in the interviews and reference group meeting also provided rich and relevant information about safety culture, working conditions and occupational safety in the NOR fleet of coastal cargo vessels that is the focus of the present study, this information is also included in the present paper.[3] The interviews generally lasted for about 75 minutes. Useful information and viewpoints were also obtained in a reference group meeting held at the Institute of Transport Economics, March 27th, 2014, although the explicit focus of meeting was on the importance of flag state and crew nationality for safety. Results from this meeting are presented together with results from the interviews.

2.2 Small-scale survey

[3] Confer Nævestad (2016a-b) for the additional information from the reference group meeting and the interviews. A semi-structured interview guide was used, which contained questions on: organisational safety culture, national safety culture, communication, competence and training, economy, manning level and competition, long work periods and fatigue, technology and equipment and implementation and enforcement.

2.2.1 Recruitment of respondents

The respondents were recruited through an employer organisation for Norwegian based shipping companies, including more than 150 shipping companies and about 300 vessels. Thus, all the respondents work on ships that are operated from Norway, i.e. the shipping companies are located in Norway. Web links to the questionnaires were distributed by the employer organization to all its members along with an introductory text explaining the purpose of the survey, and stressing that the surveys were confidential. The shipping companies were asked to distribute the survey links to all employees working on ships.

2.2.2 Sample

Table 1 sums up the characteristics of the respondents and their vessels on key background variables.

Table 1: Characteristics of the 180 respondents and their vessels on key background variables. %.

	Age group	Position	Experience	Vessel type	Year the vessel was built	Vessel size
1	Younger than 31 years	Captain	Less than one year	Bulk	Before 1980	<500 DWT
	31 %	28 %	4 %	34 %	16 %	19 %
2	31-40	Deck officer	1-3 years	General cargo	1980-1985	500-3000 DWT
	17 %	24 %	9 %	14 %	8 %	79 %
3	41-50	Deck crew	4-10 years	Tank vessel	1986-1991	>3000 DWT
	23 %	20 %	24 %	4 %	3 %	2 %
4	51-60	Chief engineer	11-15 years	Well vessel	1992-1997	-
	23 %	7 %	7 %	34 %	16 %	-
5	Older than 60 years	Engine officer	More than 15 years	Stand by vessel	1998-2003	-
	6 %	1 %	56 %	2 %	14 %	-
7	-	Engine crew	-	Anchor handling vessel	2004-2009	-
	-	4 %	-	1 %	23 %	-
8	-	Catering	-	Fish farming vessel	2010-2015	-
	-	5 %	-	6 %	21 %	-
9	-	Apprentice	-	Other	Before 1980	-
	-	9 %	-	5 %	14 %	-
10	-	Other	-		-	-
	-	2	-		-	-
Total	100 %	100 %	100 %	100 %	100 %	100 %

The distribution of seafarers' gender is not shown, as there are only two female respondents in the sample. Neither is the distribution of seafarers' nationality, as only NOR vessels are studied. Seven % of the 180 respondents are from another Nordic country, 1 % are from another Western European country and 2 % are from a Central/Eastern European country.

2.2.3 Survey measures[4]

In this study, we examine the following variables:

1) Organisational safety culture
We made an organisational culture index, consisting of 18 questions from the GAIN-scale on organisational safety culture (Cronbach's Alpha=0.950). This scale has been used in previous research from different transport sectors (Bjørnskau & Longva 2009; Nævestad & Bjørnskau 2014). The GAIN-scale is presented in the "Operator's Safety Handbook" (GAIN 2001). Global Aviation Information Network (GAIN) is a voluntary association of airlines, manufacturers, trade unions, governments and other organisations in aviation. The purpose of GAIN is to produce and distribute relevant information to increase safety in aviation. GAIN was established in 1996 based on an idea that dissemination of experiences and knowledge of safety-related factors could improve aviation safety. The purpose of the GAIN manual is to help operators to start, improve and expand their internal safety programs. The 18 questions measure perceptions of culture; what one also may refer to as safety climate (cf. Flin et al 2000). The GAIN questionnaire which originally is developed for the aviation sector was chosen for five different reasons. First, it includes the most important elements of safety culture: e.g. management and employee commitment to safety (e.g. Flin et al 2000), a reporting and learning culture (e.g. Reason 1998), safety training and safety communication (Edkins et al 1995). Second, a previous literature review, conclude that this is one of very few universal safety culture surveys (Nævestad & Bjørnskau 2012). Third, this questionnaire has therefore been used to study and compare safety culture in different sectors like road, rail, helicopter and aviation (Bjørnskau & Longva 2009). Results from these sectors revealed safety culture scores that were in accordance with the known safety performances of these sectors (i.e. aviation/helicopter with the highest score, followed by rail and road). Four, it was applied to the maritime sector to facilitate comparison of scores with the road sector in the previous project (Nævestad 2016a). Fifth, the GAIN survey was chosen because the wording of each item can be adapted to different sectors without obviously altering the particular aspect of safety culture which that item measures. Thus the scale has the potential to be developed as a generic measure of safety culture.

[4] The original survey included a total of eighty questions on 11 themes, but the present study only focuses on the questions that may shed light on the study aims. See Nævestad (2016a-b) for a presentation of the other survey questions, themes and result. Many of the survey questions are from the study of Størkersen et al. (2011) and a questionnaire developed by Safetec for The Norwegian Maritime Authority (cf. Nævestad 2016a-b).

The GAIN-scale originally consists of 25 questions measuring five themes, but it has been reduced to 18 questions. Questions from all the five themes were kept when the number of questions in the GAIN-scale was reduced from 25 to 18. The reason is, as noted above, that the questions from the themes measure aspects of safety culture that have been found to be important in previous research. The concrete, specific questions were kept (cf. Chapter 2.4.3). The importance of all the five themes are not assessed in the present study, instead an index was made, summing up all the 18 questions. This is appropriate, as the factor analysis indicates that a one-factor solution is the most appropriate (cf. Chapter 2.4.3). The respondents answered all questions using a scale from 1 (disagree completely) to 5 (agree completely). The safety culture index is computed as the sum of the scores of the 18 questions. This gives a minimum score of 18 and a maximum score of 90.

In Appendix 1, each theme and the questions that each theme consist of are listed (the factor loadings of the one-factor solution are given in the right column in Appendix 1). Because seafarers relate to both the ship management on board and management and personnel in the shipping company ashore, the two first above mentioned questions are also asked about the shipping company.

2) Working conditions

The following questions about working conditions are included in the study: manning level, port calls, work pressure, demanding working conditions and safety compromising fatigue. These questions were included as previous research has showed differences between crews on Norwegian vessels on these factors, and as research indicates that these factors influence ship safety and occupational safety on board Norwegian vessels (Størkersen et al 2011).

2a) Manning level on vessels

- Please specify total manning on board the vessel

2b) Work pressure

- Sometimes I feel pressured to continue working, even if it is not perfectly safe

2c) Port calls

- Number of port calls per week

2d) Demanding working conditions. (index summing up 3 items). (Cronbach's Alpha=0.780)

How often do you think that the following events happen while you are at sea?

- Your shift change is delayed because of work operations, for instance port calls?
- You work more than 16 hours in the course of a 24 hour period?
- You are interrupted when you are off duty?

The respondents answered these three questions using a scale from 1 (never) to 7 (daily when I am at sea). The demanding working conditions index is computed as the sum of the scores of the 3 questions. This gives a minimum score of 3 and a maximum score of 21.

2e) Safety compromising fatigue

- Sometimes I am so tired during working hours that safety is compromised

2f) Safety management system

- Who participate in risk assessments of work operations on your vessels? (all on board the vessel participate=1, other scores=0)
- On this vessel we have job descriptions/procedures that describe the hazards of various risk assessments

3) Personal injuries occurring while at work:

- Have you been injured in your work on board in the course of the last two years?

4) Perception of risk related to work place hazards:

- To what extent do you worry about the risks associated with the work on board?

5) Other factors

The influence of other factors on occupational safety is also studied: Seafarers' position/line of work (1 item), Seafarers' age (1 item), Vessel type (1 item), Vessel age (1 item).

2.2.4 Analysis of quantitative data

2.2.4.1 Comparison of means

When comparing the mean scores of different groups, one-way Anova tests are used, which compare whether the mean scores are equal (the null hypothesis) or (significantly) different.

2.2.4.2 Regression analyses

Three regression analyses have been conducted to analyze the factors predicting respondents' answer on the dependent variables measuring personal injuries, worry about risk on board and safety culture. Logistic regression analysis was chosen in the first regression analyses, as the dependent variable has two values (yes=0, no=1). In this analysis, different independent variables were included in the analyses step-wise in order to be able to examine the isolated effect of the independent variables, i.e. when the other variables are held constant. B values are presented and they indicate whether the risk of personal injuries is reduced (negative B values) or increased (positive B values), when the independent variables increase with one value.

In the other analyses, hierarchical, linear regression analyses was used, where independent variables are included in successive steps. The most basic independent variables are included first, e.g. age, sex, vessel type, position. Then the other independent variables are included. It may be challenging to stick to the principle of presenting the most basic independent variables first when more conceptual independent variables (e.g. safety culture, work pressure) are included in the regression analyses. In this case, the order of variable inclusion is based on hypotheses derived from previous research, or other hypotheses about the primacy of some independent variable over others. Generally, factual variables (e.g. manning levels, number of port calls) are included before conceptual variables (e.g. safety culture). Of course, one cannot conclude about causality, as this is a cross-sectional and correlational study. Nevertheless, the term predict is used in the descriptions of the regression analyses.

2.2.4.3 Factor analysis

The GAIN-scale originally consists of 25 questions measuring five themes, but the scale was reduced to 18 questions. The reason is, as mentioned that the data in the present study is based on data collected in a larger survey used in the previous project (Nævestad 2016a). The survey in the previous project included a large number (eighty) of questions. Thus, when developing the survey for this previous project, seven questions were removed from the GAIN-scale to facilitate the inclusion of other questions, measuring other topics (cf. Nævestad 2016a). When choosing the 18 questions to keep in the GAIN-scale, questions that have generated statistically significant differences between companies in previous research were kept (e.g. Nævestad & Bjørnskau 2014). These are the most concrete questions, referring to specific functions and situations. Thus, one may assume that these concrete questions (e.g. "Management often praises crew members who work safely") are better suited to provide indications of concrete differences between companies than more general and abstract questions general questions (e.g. "Managers do all they can to prevent accidents"). The reason is that it seems easier for respondents to evaluate the concrete questions against their experiences and knowledge. Moreover, when removing questions, it was considered important to keep all the five themes, and not remove all questions from a theme, as the questions and the themes include the most important elements of safety culture: e.g. management and employee commitment to safety (e.g. Flin et al 2000), a reporting and learning culture (e.g. Reason 1998), safety training and safety communication (Edkins et al 1998).

An exploratory factor analysis (EFA) was conducted to examine the underlying factor structure of the 18 items in the sample. Tests indicated that the items and the data were suitable for factor analysis. Bartlett's test of sphericity (approx. Chi-square) was 2382,301 ($p < .001$). The Kaiser–Meyer–Olkin's measure of sampling adequacy showed a value of 0.939. A principal component analysis (PCA) with oblimin rotation was used. Results showed three components with initial Eigenvalues higher than 1, which explained a total of 68.4 % of the variance. The choice of the number of factors to retain was based on a combination of (a) inspecting the scree plot for a bending point and (b) inspecting the factor loadings in the component matrix. By inspecting the scree plot, a bend was most clearly identified at factor 1, and a less clear bend at factor 3, indicating either a one-factor or a three-factor solution. All the 18 items loaded on the first component with factor loading above .5. Three items loaded both on the first and second component. Four items loaded on both the first and third component. With one exception, the cross-loading items all had factor loadings below .40 on the second and third component. Matsunaga (2010) suggests that on a conventional liberal-to-conservative continuum, setting the cutoff value of factor loadings equal to or above .40 is perhaps the lowest acceptable threshold. It was also hard to identify the unique, underlying substantial or theoretical aspects measured by the items loading on either component 2 and 3 (in addition to component 1). They did not measure e.g. "reporting culture" or "training", as the original GAIN-scale factors. As a consequence, it was concluded that that a three-factor structure was unjustified, and that a one-factor structure including all the 18 items was appropriate. The factor loadings of each item is presented in the right column in Appendix 1. The one-factor solution explained a total of 56.2 % of the variance, i.e. about 12 % less than the three-factor solution. The Cronbach's Alpha value of the 18 questions was 0.950.

3. Results

3.1 Safety culture

The aim of the study is to examine the influence of safety culture and working conditions on personal injuries and risk perception on vessels sailing along the coast of Norway. In the following, the importance of organizational safety culture, and its relationship to other variables will be examined. The importance of organisational safety culture was highlighted several times in the reference group meeting, and in the interviews. Culture, attitudes, knowledge, skills and risk understanding are factors that are important when it comes to explaining safety behaviour among crew members on board ships and the ship accident risk of vessels. One interviewee stated that organisational safety culture clearly is the most important safety influencing factor in maritime transport, and that it "starts on the top"; in the shipping company and with the captain. Reference group members also stated that the revision of the ISM code in 2010 involved a stronger organisational focus on safety, although the revisions unfortunately focused more on bureaucracy and procedures than safety culture.

Table 2 shows the means on the organisational safety culture index for different groups. Captains are excluded from the means presented in Table 2, as five of the 18 questions in the index concern the ship management. The average organisational safety culture score is 77.7 points (min=18, max=90).

Table 2: Means on the organisational safety culture index for seven variables, excluding captains (N=130). The average organisational safety culture score is 77.7 points (minimum score: 18, maximum score: 90).

Value	Age group	Vessel type	Position	Work pressure	Fatigue	Manning level
1	Younger than 31 years	Bulk	Deck personnel	Totally disagree	Totally disagree:	1-2 people
Score	78.5	76.8	77	83.1	82	-
2	31-40	General cargo	Engine personnel	Disagree somewhat	Disagree somewhat:	3-4 people
Score	71.1	78.1	79	77.7	78.4	67.1
3	41-50	Tank vessel	Other	Neither/nor	Neither/nor:	5-6 people
Score	79.3	73.5	78.5	69.7	69.6	77.7
4	51-60	Well vessel	Captain	Agree Somewhat	Agree Somewhat:	7-8 people

Value	Age group	Vessel type	Position	Work pressure	Fatigue	Manning level
Score	76.8	78.1	79.9	69.4	75.1	79.6
5	Older than 60 years	Other		Totally agree	Totally agree:	9-10 people
Score	85.3	79.5		60.2	69.4	-
6						11-12 people
Score						83
P value	.027	.n.s.	.n.s.	.000	.000	.045

Table 2 indicates four variables with significant differences on the safety culture variable. First, respondents between 31-40 years rate the organisational safety culture level lower than other age groups. The table also indicates that the more respondents agree with the statements on work pressure and fatigue the lower safety culture levels they report. The table also indicates that higher manning levels gives higher safety culture scores. Respondents on vessels manned with 3-4 people report the lowest organisational safety culture scores.

3.2 Manning levels and port calls

Manning levels and port calls make up working conditions that may influence personal injuries and risk perception (cf. the study aim). Reference group members considered fatigue and manning level to be among the most important risk factors in maritime transport. They stated that the small Norwegian ships sailing along the coast of Norway have low manning levels, considerable work pressure and scarce time. In Norway, the NMA defines the "safety manning" of vessels based on the international rules regulating manning of vessels (e.g. the IMO 1047 principles for safe manning). The "operational manning" is the manning level chosen by the shipping companies, based on their considerations of the needs of their vessels. It is the responsibility of the shipping company to staff vessels properly, i.e. in a way that facilitates the execution of all functions on board. A general problem mentioned by interviewees, however, is that shipping companies may perceive the safety manning as the defined standard. As noted, the safe manning document describes the minimum crew size and minimum qualifications required for sailing from A to B, suggesting that vessels will be understaffed when it comes to safety critical functions, if they only have the safety manning.

Respondents in the survey were asked about the manning level on board their vessels. To avoid counting the same vessels several times, the data was filtered according to a unique vessel identity. The captains in the sample were used for this purpose. When only the means for the captains in the sample are compared, there are 50 vessels left. This sample is too little for comparison, as it is necessary to compare manning levels for different vessel types controlled for their size. Keeping in mind that numbers are small, it was found found that the average manning level on vessels less than 500 dwt was 4 people, while it is 6 people on vessels between 500 and 3000 dwt.

Interviewees underlined that small short sea cargo vessels often have many port calls. Thus, in the night when two people are supposed to be at the bridge; a navigator and a subordinate crew member, the subordinate crew member will typically be another place in the vessel performing operational tasks like cleaning the cargo hold, performing maintenance tasks and so on. Respondents were asked about the average number of port calls per week. Again, the data was filtered according to a unique vessel identity (i.e. 50 captains). Bearing in mind that the filtered sample is too little for comparison, the vessels' captains in average reported of 14 port calls per week, and there was little variation between the vessels.

3.3 Work pressure

Work pressure also make up an important working conditions that may influence personal injuries and risk perception (cf. the study aim). Respondents were asked to rate their agreement with the statement: "Sometimes I feel pressured to continue working, even if it is not perfectly safe". In Table 3, mean score for different groups on this variable are compared. The minimum value is 1 (totally disagree) and the maximum value is 5 (totally agree). The average score is 2.

Table 3: Means on the variable "Sometimes I feel pressured to continue working, even if it is not perfectly safe" The minimum value is 1 (totally disagree) and the maximum value is 5 (totally agree).

Value	Age group	Vessel type	Position/line of work	Port calls per week	Manning level	Organ. safety culture
1	Younger than 31 years	Bulk	Captain	1-3	1-2 people	>70
Score	2.2	2	2.1	1.9	-	<u>3.3</u>
2	31-40	General cargo	Deck personnel	4-6	3-4 people	70-75
Score	<u>2.5</u>	2.1	2.1	1.7	<u>3</u>	2.4
3	41-50	Tank vessel	Engine personnel	7-9	5-6 people	76-80
Score	1.9	<u>2.5</u>	1.8	2.1	1.9	2.2
4	51-60	Well vessel	Other	10-12	7-8 people	81-85
Score	1.7	1.9	1.9	2.2	1.9	1.7
5	Older than 60 years	Other	-	13-15	9-10 people	86-90
Score	1.7	1.8	-	1.8	-	1.3
6	-	-	-	>15	11-12 people	-
Score	-	-	-	<u>2.3</u>	-	-
P value	.052	.n.s.	.n.s.	.n.s.	.008	.000

Table 3 indicates significant differences between the work pressure on vessels with different manning levels: the lower manning levels, the more work pressure. The table also indicates an interesting and significant relationship between work pressure and organisational culture: seafarers with low safety culture scores report of higher levels of stress and pressure and vice versa.

3.4 Demanding working conditions

Finally, demanding working conditions also make up an important working condition that may influence personal injuries and risk perception. As noted in the methods section, a "Demanding working conditions index" was constructed of three questions, asking how often respondents' shift change is delayed because of work operations (e.g. port calls), respondents work more than 16 hours during a 24-hour period, or are interrupted when they are off duty. In Table 4 below, mean scores for different groups on this index are compared. The minimum value is 3 (never) and the maximum value is 21 (daily when I am at sea). The average score is 6.4 points.

Table 4: Means on the demanding working conditions index. The minimum value is 3 (never) and the maximum value is 21 (daily when I am at sea).

Value	Age group	Vessel type	Position/line of work	Port calls per week	Manning level	Org. safety culture
1	Younger than 31 years	Bulk	Captain	1-3	1-2 people	18-69
Score	6.5	5.9	7.3	6.2	-	8.6
2	31-40	General cargo	Deck personnel	4-6	3-4 people	70-75
Score	7.5	6.2	5.8	5.8	8.3	7.2
3	41-50	Tank vessel	Engine personnel	7-9	5-6 people	76-80
Score	5.9	7	6.2	7.4	6.4	6.5
4	51-60	Well vessel	Other	10-12	7-8 people	81-85
Score	6.2	6.8	6.4	6.4	5.5	6.3
5	Older than 60 years	Other	-	13-15	9-10 people	86-90
Score	4.3	6	-	6.7	-	4.9
6	-	-	-	>15	11-12 people	
Score	-	-	-	6.5	-	
P value	.054	n.s.	.084	.n.s.	.014	.000

Table 4 indicates significant differences between respondents with different scores on the organisational safety culture variable and on the manning level variable. Results indicate that respondents with low organisational safety culture scores experience the most demanding working conditions. The same applies to respondents working on vessels manned with 3-4 people. Finally, Table 4 also indicates significant differences (at the 10 %-level) between respondents with different age groups and positions/lines of work. Respondents between 31-40 years old and captains experience more demanding working conditions.

3.5 Personal injuries and risk perception

We asked respondents whether they had been injured in their work on board in the course of the last two years. A total of 30 respondents (17 %) answered that they had been injured in their work on board in the course of the last two years: 12 % answered that they had a little injury which did not require medical attention, 3 % had a little injury which required medical attention and 2 % had an injury which required medical attention and a period of work absence.

Respondents were also asked to what extent they worry about the risks associated with the work on board. A share of 15 % of the respondents report that they are worried about the risks associated with the work on board: 1 % were very worried and 14 % were somewhat worried. 10 % of the respondents answered neither/nor to this question, 37 % were seldom worried and 39 % were not worried.

3.6 Results from regression models

3.6.1 Personal injuries on board as the dependent variable

A logistic regression analysis was conducted with personal injuries as dependent variable, in order to find the variables predicting personal injury among the respondents (Table 5). In this analysis, the injury variable, which originally had four answer alternatives, was dichotomized, 0=no personal injury, 1=personal injury. B values are presented and they indicate whether the risk of personal injuries is reduced (negative B values) or increased (positive B values), when the independent variables increase with one value. Different independent variables are included step-wise in the analyses to be able to examine the isolated effect of the independent variables, i.e. when the other variables are held constant.

Table 5: Logistic regression. Dependent variable: Personal injuries on board in the last two years (dichotomized: 0: no personal injury, 1=personal injury). B values.

Variables	Step 1	Step 2	Step 3	Step 4	Step 5	Step 6	Step 7	Step 8	Step 9
Age group	**-.526*****	**-.423****	**-.451****	**-.488****	**-.451****	**-.439****	**-.452****	**-.458****	**-.459****
Position/line of work (Deck crew/apprentice=0, Other=1)		-.746	-.676	**-1.070****	**-1.075****	**-1.251*****	**-1.255****	**-1.230****	**-1.299****
Vessel type (Well vessel=0, Other=1)			**-.847***	**-.991****	**-1.039****	**-1.043****	**-1.007****	**-1.014****	**-1.075****
Manning level (coded with 7 values)				**-1.110*****	**.993*****	**-.970****	**-.936****	**-.931****	**-.984****
Sometimes I feel pressured to continue working, even if it is not perfectly safe					.274	.118	-.178	-.181	-.184
Sometimes I am so tired during working hours that safety is compromised						.313	.211	.193	.192
Organisational safety culture (coded with 5 values)							**-.439****	**-.439****	**-.464****
Risk analyses ("all on board participate"=0, Other answer=1)								.155	.184
Procedures describing hazards									.153
Nagelkerke R^2	.090	.115	.149	.234	.254	.272	.311	.312	.315

* p < 0.1 ** p < 0.05 *** p < 0.01

First, the three background variables contribute negatively and significantly at the 0.05 level: age, position/line of work and vessel type. The age group variable consists of five values, and results indicate that the older the seafarers are, the less likely they are to have been injured in the last two years. Position or line of work is the variable with the strongest effect on personal injuries. This variable was dichotomized, grouping deck crew/apprentice into one value (0) and all other groups into another value (1), based on the fact that deck crew/apprentice (30 %) had the highest shares of personal injuries compared to other groups (three times higher). Vessel type contributes negatively. This variable was dichotomized, grouping well vessel into one value (0) and all other groups into another value (1), as well vessels (25 %) had nearly twice the share of personal injuries compared to the other vessel types (13 %) (p=0.035).

In Step 4, the manning level variable was included, which contributes negatively and significantly to the risk of personal injuries at the 5 %-level. The higher manning level, the lower is the risk of personal injuries. This variable consists of seven values: 1) 1-2 people, 2) 3-4 people, 3) 5-6 people, 4) 7-8 people, 5) 9-10 people, 6) 11-12 people and 7) >12 people. This is the third strongest predictor of personal injuries in the model. Manning level could be related to work pressure or safety compromising fatigue, but neither of these variables contribute significantly.

In Step 7, the organisational safety culture index is included in the model, and it contributes negatively and significantly, which means that the better safety culture the respondents report, the less likely it is that they have had an injury in the last two years. The safety culture variable which is used in Step 7 is coded with 5 values: 1) >70 points, 2) 70-75 points, 3) 76-80 points, 4) 81-85 points and 5) 86-90 points. This coding is in accordance with those presented in the foregoing tables comparing mean scores on this index.

In Step 8 and 9 two variables measuring "Safety management system" are included, denoting risk analyses (which all on board take part in) and procedures describing hazards. Neither of the variables contribute significantly.

The Nagelkerke R^2 indicates the amount of variance in the dependent variable that is explained by the independent variables in the models. In step 8 in Table 5 the Nagelkerke R^2 is 0.315 which indicates that the independent variables explain 31.5 % of the variance in the dependent variable, personal injuries.

3.6.2 Worry about the risks on board as the dependent variable

Table 6 shows results from a hierarchical, linear regression analysis, where independent variables are included in successive steps to examine the variables predicting respondents' worry about the risks associated with the work on board. The table presents the standardized beta coefficients. The contributions of the different independent variables on the dependent variables can therefore be compared directly. The scores on the dependent variable vary between 1 (not worried) and 5 (very worried).

Table 6: Linear regression. Dependent variable: "To what extent do you worry about risk aboard?". Standardized beta coefficients.

Variables	Step 1	Step 2	Step 3	Step 4	Step 5	Step 6	Step 7
Age group	-.066	-.111	-.114	-.029	-.002	-.004	.002
Position/line of work (Captain, Deck officer, Chief engineer=2)		**.194****	**.194****	**.143***	**.123***	**.122***	.116
Vessel type (Other=2)			.033	.063	.061	.059	.057
Sometimes I feel pressured to continue working, even if it is not perfectly safe				**.373*****	**.255*****	**.156***	.106
Sometimes I am so tired during working hours that safety is compromised					**.250*****	**.228*****	**.192****
Organisational safety culture						**-.202****	**-.173****
Demanding working conditions index							**.174****
Adjusted R2	-.001	.029	.024	.152	.194	.218	.236

* $p < 0.1$** $p < 0.05$ *** $p < 0.01$

Table 6 indicates that respondents' experiences of safety-compromising fatigue, organisational safety culture, and experiences of demanding working conditions predict their worry about risk on board. The more safety-compromising fatigue respondents experience, the more worried they are. The Organisational safety culture index contributes negatively and significantly to respondents' worry about the risks on board. This means that the better safety culture the respondents report, the less likely it is that they worry about the risks on board. In Step, 7 the demanding working conditions index is included. This index contributes positively and significantly at the 10 %-level, indicating that the more often respondents experience demanding working conditions, the more worried they are.

The work pressure variable ceases to contribute significantly in Step 7, when the demanding working conditions index is included in the analysis, indicating that the latter is more important. The position/line of work variable contributes to respondents' (i.e. captain, deck officer, chief engineer) worry about the risks aboard in all steps, until Step 7, where the demanding working conditions index is included, indicating that senior crew members' working conditions could explain their worries. Vessel type (i.e. "other vessel") does not contribute significantly.

The Adjusted R2 indicates the amount of variance in the dependent variable that is explained by the independent variables in the model. In step 7 the Adjusted R2 is 0.236 which indicates that the independent variables explain about 24 % of the variance in the dependent variable.

3.6.3 Organisational safety culture as the dependent variable

Table 7 examines factors predicting respondents' organisational safety culture scores. Captains were excluded from the regression analysis as five of the 18 questions in the index concern the ship management.

Table 7 Linear regression. Dependent variable: Organisational safety culture. Standardized beta coefficients.

Variables	Step 1	Step 2	Step 3	Step 4	Step 5	Step 6
Age group (1=other, 2=31-40 years)	**-.262*** **	**-.263** **	**-.252** **	-,127	-,116	-,108
Vessel type (Other=1, General cargo=2)		.015	-.053	,030	,039	,039
Manning level			**.188** **	,123	,113	,107
Sometimes I feel pressured to continue working, even if it is not perfectly safe				**-,489*** **	**-,448*** **	**-,434*** **
Sometimes I am so tired during working hours that safety is compromised					-,069	-,079
Demanding working conditions						-,066
Adjusted R2	.061	.069	.102	.317	.324	.327

* p < 0.1** p < 0.05 *** p < 0.01

Table 7 indicates that the perceived "work pressure" variable is the only variable contributing significantly to organisational safety culture (at the 1 %-level). The negative effect of the variable indicates that higher levels of work pressure predict lower levels of safety culture. Neither safety compromising fatigue, nor demanding working conditions contribute significantly in the model, indicating the important relationship between work pressure and safety culture.

The manning level variable contributes significantly in Step 3, indicating that higher manning levels predicts higher safety culture scores, but manning level ceases to contribute significantly when the work pressure variable is included, indicating that the effect of manning level by and large was due to work pressure; i.e. that the work pressure is greater on vessels with lower manning levels. Respondents' age (i.e. between 31-40 years) contributes significantly and negatively to respondents' assessment of organisational safety culture in the first three steps, until the work pressure variable is included in the analysis in Step 4, indicating that the age effect of respondents between 31-40 years old could be due to their work pressure. The age variable was dichotomized as comparison of means indicated that respondents between 31-40 years rated the safety culture lowest. The adjusted R2 value is .321, indicating that the model explains 32 % of the variation in the organisational safety culture variable.

4. Discussion

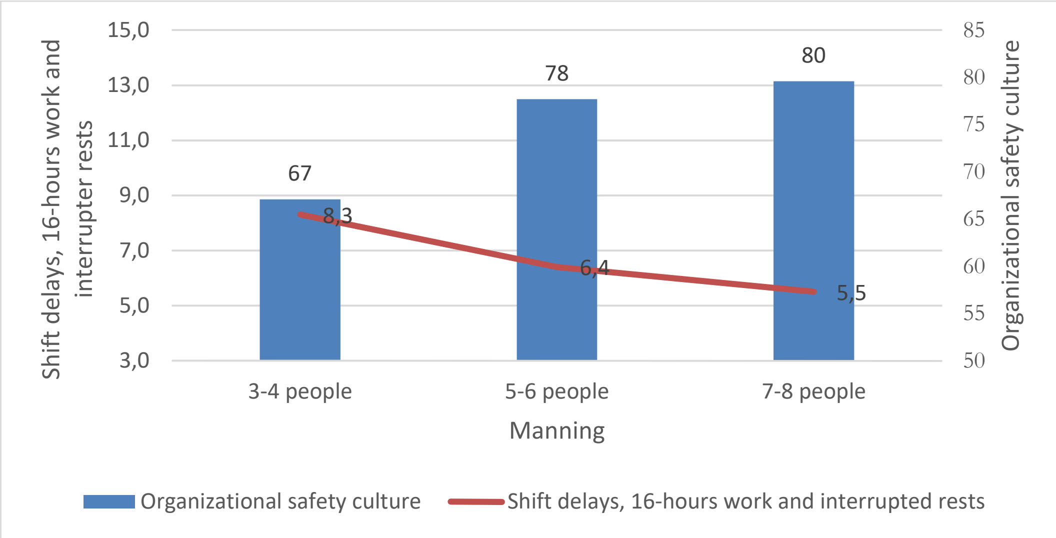
4.1 Main results

The aim of the study was to examine the influence of safety culture and working conditions on personal injuries and risk perception on vessels sailing along the coast of Norway.

The first main result of the study is that organisational safety culture on board influence personal injuries on the studied vessels. Previous research indicates that organizational safety culture influences seafarers' safety behaviours (Håvold & Nesset 2009; Lu and Tsai 2010), but a previous review (Bjørnskau & Nævestad 2013) did not find studies demonstrating a relationship between safety culture and accidents. Based on a more recent study in maritime cargo and passenger transport, Nævestad et al (2017) found that safety culture is related to safety behaviour, which in turn is related to personal injuries. Thus, one can assume that the link between safety culture and injuries is safety behaviours. The present study has not measured this. Thus, more research is needed on this issue, examining the mediating role of safety behaviours.

The second main result of the study is that manning level on board influences personal injuries on the studied vessels. It seems difficult to find studies examining the relationship between manning level and occupational injury risk. Thus, the study contributes to the research literature on occupational safety in the maritime sector. It may, however, be difficult to explain the observed relationship between manning level and injuries. It seems likely that this relationship is mediated by work pressure and fatigue, meaning that lower manning levels give higher work pressure, higher fatigue and subsequently more injuries. However, the regression analyses which indicate a relationship between manning level and injuries also control for work pressure and fatigue (cf. Table 5). Thus, perhaps the effect on manning level on injuries is due to some unmeasured variables. On the other hand, the other regression analyses indicate that lower manning levels seem to induce higher work pressure (Table 7), which negatively influences safety culture, and as mentioned, the study indicates that safety culture is closely related to personal injuries (Table 5). More research is needed.

The third main result is that respondents on vessels with lower manning levels (3-4 people) experience more personal injuries, more stress, and rate their organisational safety culture as lower. Although differences between the shares are not statistically significant, vessels manned by 3-4 people had the highest share of crew members who had been injured in the last two years (26 %). The corresponding numbers for vessels manned by 5-6 people was 20 %, while it was 7 % for vessels manned by 7-8 people. The vessels with lower manning (3-4 people) score lower on many of the variables measuring occupational safety and working conditions. They rated their organisational safety culture as lower than other respondents and experienced more often demanding working conditions. This main result is illustrated in Figure 2



Respondents on vessels with lower manning also reported of higher levels of safety-compromising fatigue, more pressure to work even though it is not perfectly safe and they were more worried about risks in their work. These results must be interpreted with caution, as numbers are small in the sample of vessels manned by 3-4 people (N=19). Results indicate, however, a tendency of more positive scores with increasing values on the manning level variable indicating the importance of manning level for occupational safety and working conditions. Thus, future research should examine the importance of manning level for occupational safety and organisational factors. It is important to note that the study does not examine whether manning levels are too low on these vessels, it merely compares occupational safety and organisational factors.

The fourth main result is that organisational safety culture, safety compromising fatigue and demanding working conditions is closely related to risk perception among respondents. Previous research indicates that occupational risk perception influences occupational injury risk (Jensen et al 2004). This may indicate that occupational risk perception provides a good predictor or injury risk, or that seafarers who have been injured rate their safety as lower. The present study indicates that occupational risk perception provides a predictor or injury risk, as it indicates a close relationship between risk perception, safety culture and fatigue. This supports the univariate results of Størkersen et al (2011), that were based on a very small sample.

The fifth main result of the study is that demographic factors (e.g. young age) are important for the occupational safety of the seafarers in the sample. This is in line with previous research (Hansen et al 2002; Jensen et al 2004; Nævestad et al 2017). The study also concludes that position and work activities (deck crew/apprentices) are associated with injury risk. This has also been found in previous research (Hansen et al 2002; Jensen et al 2004). In line with Hansen et al (2002) the present study also find that vessel type influences the risk of occupational injuries. Regression analyses indicate that "other" cargo vessels predict respondents' injuries on board, controlled for other factors. This is difficult to explain, given that the analyses also control for organizational safety culture, manning level, work pressure, fatigue, demanding working conditions, risk analyses and procedures describing hazards. Perhaps work activities on the "other vessels" could shed light on this, or other unmeasured variables.

4.2. Implications for future research

Previous research (Størkersen et al 2011) indicate that the safety challenges of vessels with lower manning levels could be due to framework conditions (e.g. economy, competition). As noted, the importance of negative framework conditions in coastal cargo transport was also highlighted by the NMA. Moreover, the interviewees and references group members suggested that the small vessels transporting goods along the coast of Norway have low manning, considerable work pressure and scarce time, resulting in negative safety outcomes. Future research should therefore examine the importance of framework conditions for maritime safety. This research should focus on the consequences of different individual framework conditions, examining the combined effect of various framework conditions (e.g. economy, competition, regulator focus on safety, charterer focus on safety, required safety documentation) in different sub-sectors. Størkersen (2017) provides such a nuanced discussion, indicating that charterers focusing on safety in some cases could make up a challenging framework conditions for vessel crews, as this may require a lot of paper work and less time to focus on navigational activities. Bulk and general cargo vessels, on the other hand, may have tight economic margins, but low attention from regulators and charterers (Størkersen 2017). Although the regulator and charterer focus on safety is deemed to be positive for safety, it may require a lot of paper-work on board, which could divert attention and time from sailing and navigational activities (Størkersen 2017). The respondents in the present paper, work on vessels operating in different subsectors, with different framework conditions. Nearly half of the sample includes bulk (34 %) and general cargo vessels (14 %), The sample also includes a considerable share of well vessels (34 %) transporting live fish. In this sector, the charterers (fish farming industry) are more profitable. Thus, the rates are higher, the vessels are newer and the crews have more safety resources (Størkersen 2017). Additionally, the sample includes stand by vessels (2 %) and tank vessels (4 %), which are included in the comprehensive safety regulatory regime of the petroleum industry.

4.3 Practical implications

The challenging framework conditions in the coastal cargo sector may in some cases favour economical concerns over safety concerns (Størkersen et al 2011). When such goal conflicts between safety and economy are unresolved at a higher level, they may trickle down to the level of the people on board, who are forced to deal with them (Mostad 2011), and perhaps they sometimes may have to prioritise economy over safety. Our results on respondents' experienced work pressure ("Sometimes I feel pressured to continue working, even though it is not perfectly safe") indicate this. Thus, the observed relationships between challenging working conditions, low safety culture scores and personal injuries could indicate respondents' way of dealing with unresolved goal conflicts. Such goal conflicts may be a source of stress, and the way they are handled at all levels are key to safety (Perrow 1999; Reason 1997). If these goal conflicts are a result of challenging framework conditions, a first practical implication of the study could be to change the framework conditions. If low manning level is a risk factor, rules for the safety manning could be changed, requiring more people on board. This could lead to higher prices for transport, and thus alter the competitive conditions. Moreover, other rules regulating competition (e.g. price, contracts, cargo owners' responsibility for safety) could be introduced. However, the maritime sector is international, regulated by international rules with international competition, and framework conditions may be difficult to alter.

Thus, a second practical implication of the present study could be to improve how these goals conflicts are dealt with in the shipping companies. Research indicates that the premises for safety to a great extent are set by shipping companies and owners of the cargo (Mostad 2011). Shipping companies may influence the amount of activities that vessel crews are asked to perform while at dock or while sailing, the resources they are provided with, manning on board and so forth. The extent to which shipping companies se the premises for safety is related to safety culture, and the present study includes two items measuring shipping company focus on safety culture. One important recommendation, suggested by Størkersen (2017) is to reduce administration and paper-work on board, to let crewmembers focus more on their primary tasks.

A third practical implication of the present study concerns how captains and vessels crews can deal with goal conflicts. The vessel crew represents the "sharp end" when dealing with goal conflict. Although they may have little influence over their market, their pay, manning level and so on, our results indicate important differences between safety culture levels and working conditions. This could indicate that the captain and the crew may develop positive safety cultures, which may counter-balance negative framework conditions. Understanding the importance of goal conflicts, talking openly about them and finding ways to tackle them seem to be important aspects of a positive safety culture (Mostad 2011). Future research should develop knowledge on how to improve safety culture and working conditions, although there are economical, manning and other constraints.

5. Conclusion

The main conclusion of the study is that organisational safety culture, and working conditions (e.g. manning level on board, work pressure and demanding working conditions) are closely related, and that these factors influence injuries and risk perception on the studied vessels. It is, however, difficult to conclude about causality, as this is a cross-sectional and correlational study. Results indicate that safety culture influences working conditions and vice versa. Future research should develop more knowledge on the relationships between these factors. Additionally, a main challenge for future research is to develop knowledge on the extent to which the observed correlations between safety culture, working conditions and occupational safety are generated by the framework conditions of the coastal cargo sector. Such analyses should focus on the combined contribution of different individual framework contributions. A second main challenge for future research, and not least for safety practitioners in the maritime sector, is to develop practical knowledge on how to deal with goal conflicts between safety and economy. I have discussed how these can be dealt with at three different analytical levels: at the level of framework conditions, shipping companies and on board vessels.

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Appendix 1 Themes questions in the GAIN-scale on organisational safety culture

Themes	Questions	Factor loadings
Ship management commitment to safety	Ship management regards safety to be a very important part of all work activities	.841
	Ship management is aware of the most important safety problems that we have on board	.804
	Ship management stops unsafe operations and activities	.756
	Ship management detects crew members who work unsafely	.687
	Ship management often praises crew members who work safely	.636
Shipping company commitment to safety	The shipping company regards safety to be a very important part of all work activities	.751
	The shipping company is aware of the most important safety problems that we have on board	.690
Employee commitment to safety	My colleagues on board usually report all safety problems and unsafe situations that they experience in their work	.794
	My colleagues on board do all they can to prevent accidents and unwanted incidents	.768
Reporting culture	There are routines (procedures) on board for reporting safety problems	.721
	All defects or hazards that are reported are corrected promptly	.778
	After an accident has occurred, appropriate actions are usually taken to reduce the chance of reoccurrence	.787
	Everyone has sufficient opportunity to make suggestions regarding safety	.739
Safety training	All crew members on board receive adequate training to work in a safe way	.770
	All newly employed are provided with sufficient training for their work activities	.762

Themes	Questions	Factor loadings
	Everyone on board is kept informed of any changes which may affect safety	.821
General safety questions	Safety on board is generally well controlled	.796
	Safety on board this vessel is better than on other vessels	.534

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