Occupational Safety in Norwegian Maritime Transport: a Study of Respondents from Cargo and Passenger Vessels

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Abstract

Seafaring is among the most hazardous occupations, and more knowledge is needed to inform preventive measures. One way of developing such knowledge is to compare different sub-sectors, to shed light on factors influencing occupational safety. Previous research has indicated a higher risk of serious occupational injuries in coastal cargo transport compared to passenger transport, hypothesizing that this could be due to the safety culture in coastal cargo transport. The aims of the present paper are to: 1) Compare organizational safety culture and working conditions in Norwegian cargo and passenger transport at sea and 2) Examine safety outcomes (safety behaviours and crewmember accidents) of safety culture and working conditions in the two sectors. The study is based on a small-scale survey to crewmembers on passenger vessels registered in the Norwegian Ship Register (NOR) (N=84) and NOR registered coastal cargo vessels (N=73). Results indicate that crew members in the coastal cargo sector experience more work pressure and that they rate their organizational safety culture as lower than respondents in the passenger transport sector. Moreover, results indicate that work pressure and poor organizational safety culture are closely related to unsafe working behaviours (violations, risk taking/acceptance), which in turn is associated with personal injuries on board. However, as a positive organizational safety culture is related to safer working behaviours, future research should examine how organizational safety culture can be employed to reduce the impact of negative framework conditions in maritime transport on occupational safety.

Keywords: *Safety culture, maritime transport, cargo, passenger, Norway*

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 (St. melding nr. 31 2003-2004).

According to Ek et al (2014), seafaring is still among the most hazardous 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 et al (2015), there were on average 15 fatalitites and 424 injuries annually on Norwegian ships (NOR and NIS) in the period 2004-2013.

In the present study we focus on two types of maritime transport in Norway, operating under different framework conditions: coastal cargo transport and border crossing passenger transport. The former is also referred to as coasters (i.e. smaller cargo vessels) (Hansen et al, 2002), while the latter can be referred to as ROPAX (roll-on/roll-off passenger), or cruise ferries, which often is used to describe passenger ferries with facilities for more than 500 passengers.

These two sectors are chosen because of an interesting paradox: previous research indicates that passenger vessel crews have a higher risk than coaster crews of all occupational accidents, but a substantially lower risk of serious injury and fatal accidents (Hansen et al, 2002). It is suggested that the lower risk of coaster crews of all occupational accidents could indicate under-reporting and poorer organizational safety culture on board coaster vessels than on other vessels (Hansen et al, 2002). Subsequently, we could perhaps hypothesize that the higher levels of reporting and lower risk of serious occupational injuries on board passenger vessels, could indicate that these vessels have a better organizational safety culture.

The aims of the study are therefore: 1) to compare organizational safety culture and working conditions in Norwegian cargo and passenger transport at sea, 2) examine safety outcomes (safety behaviours and crewmember accidents) of safety culture and working conditions in the two sectors and 3) discuss how safety culture and working conditions are influenced by the framework conditions of the two sectors.

Working conditions refer to factors like manning level on board, work pressure, and demanding working conditions. Organizational safety culture is measured by means of a 10-item survey based on the Global Aviation Information Network (GAIN) questionnaire (GAIN, 2001).

The data in this project have been collected as part of a research project titled "Safety culture in private and professional transport: examining its influence on behaviours and implications for interventions - SafeCulture".

1.2 Previous Research

1.2.1 Occupational safety in the maritime sector

Hansen et al (2002) studied 1993 occupational accidents among crew aboard Danish merchant ships in the period 1993-1997. This study finds the above mentioned difference in occupational accident risk (occupational accidents per days at sea) between coasters and passenger vessels. Additionally, this study finds that: 1) Foreigners had a considerably lower accident risk than Danish citizens, 2) Age was a major risk factor for accidents causing permanent disability, but younger seafarers had a higher risk 3) Change of ship and the first period aboard a ship were identified as risk factors, 4) Walking from one place to another

aboard the ship caused serious accidents, and 5) The most serious accidents happened on deck. It should also be mentioned that Hansen et al (2002) found that personal accident patterns on passenger ships differed substantially from cargo ships. A later study by Jensen et al (2004), including 6461 seafarers from 11 countries, finds the following factors to be related to personal accident involvement: 1) Seafarers' age (<35 years), 2) Tour lengths (<117 days), 3) Position, i.e. rating, 4) Work in engine room, 5) Nationality, 6) Self-assessed occupational safety ("How is your occupational safety": 1=very bad, 5=very good) and 7) Use of protective equipment.

1.2.2 Organizational safety culture

Organizational safety culture can generally be defined as "safety relevant aspects of culture in organizations" (Hale, 2000; Antonsen, 2009; Nævestad, 2010). In the present study, we define safety culture specifically as safety relevant ways of thinking or acting that are (re)created through the joint negotiation of people in social settings (Nævestad, 2010). Although work on organizational safety must address both formal and informal aspects of safety, it may be useful to think of organizational safety culture as the informal aspects of safety in organizations to distinguish it from the formal aspects, specified as rules, procedures and so forth (Antonsen, 2009). We may also refer to the latter aspect as safety structure or safety management system (SMS), comprised of risk analyses, work descriptions and training.

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 had been recently completed in shipping (Håvold, 2005). Four years later, Håvold and Nesset (2009) maintained that there still were few studies of safety culture at sea (Ek & Akselsson, 2005; Hetherington et al, 2006). The number of studies of safety culture in maritime transport sector has, however, increased in recent years (e.g. Håvold 2005; Håvold & Nesset 2009, Lu & Tsai 2010; Mearns et al, 2000; Williamson et al. 1997). A systematic literature review from 2013 found, however, 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 find 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.

1.2.3 Working conditions

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. Størkersen (2017) underlines the importance of framework conditions for working conditions in Norwegian coastal cargo transport. In the daily conflict between protection and production, the latter often wins in this sector. Størkersen et al (2011) found that a third 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. Maritime accident investigations and studies show that leading bridge officers and other crew members must constantly balance considerations related to economy and safety, and that the premises for safety to a great extent are set by shipping companies and owners of the cargo (Mostad, 2009). 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). Finally, research also indicates the importance of fatigue as a key safety challenge in the maritime sector (MAIB, 2004; Phillips, 2014). 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 et al, 2007; Allen et al., 2008).

2. Method

2.1 The SafeCulture Project

The data in this project have been collected as part of the SafeCulture project, which is funded by the Norwegian Research Council, and undertaken by the Institute of Transport Economics - TØI (Norway) and the National Technical University of Athens - NTUA (Greece). The project is exploring safety culture in land and sea based, professional and private transport in Norway and Greece. The main aims of the project are to examine safety culture and behaviour in road and sea transport, and to clarify implications for safety intervention strategies. The SafeCulture project focuses on three research questions: 1) How much does membership in different sociocultural units (e.g. nation, region, peer-groups, sector, organizations) influence individual transport safety behaviour in professional and private road and sea transport? 2) How much does transport safety culture influence safety behaviour and outcomes relative to known risk factors like sex, age, experience, technology and infrastructure? 3) How can the knowledge on group membership influencing TSC and the relative importance of TSC as a predictor of transport safety behaviour and safety outcomes be used to increase transport safety?

Although the survey that we have used includes several questions measuring national culture, we only compare two sectors in Norwegian maritime transport in the present study. We also report results on these, however, to test the hypothesis that we will not find substantial differences between the two sectors on national transport safety culture.

2.2 Recruitment of Respondents

The respondents were recruited through the Norwegian researchers' contact with Norwegian shipping companies. 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 shipping companies to all employees working on board vessels, along with an introductory text explaining the purpose of the survey, and stressing that the surveys were confidential.

2.3 Sample

Table 1 sums up the characteristics of the respondents and their vessels on key background variables. A share of 47% of the respondent worked in cargo transport, while the rest worked in passenger transport. Among the 74 respondents on board cargo vessels, 16% worked on

bulk vessels, 22% general cargo, 18% tank vessels, 41% well vessels transport live fish and 4% other vessels. The 84 respondents in the maritime passenger transport were distributed on six different vessels travelling to three different countries. Due to small numbers of respondents on the vessels, we divide these 84 respondents on three different lines, each operated by two vessels.

Table 1: *Characteristics of the 157 respondents and their vessels on key background variables*

	Age group	Position	Experience	Shipping company	Vessel type	Avg. manning level on board	Port calls per week
1	Younger than 26 years	Captain	0-5 years	1 Cargo	Bulk vessel	Bulk vessel	Bulk vessel
	11%	10%	13%	12	8%	7	15
2	26-35	Deck officer	6-10 years	2 Cargo	General cargo	General cargo	General cargo
	22%	21%	18%	13	10%	7	16
3	36-45	Deck crew	11-15 years	3 Cargo	Tank vessel	Tank vessel	Tank vessel
	23%	20%	15%	27	8%	5	10
4	46-55	Chief engineer	16-20 years	4 cargo	Live fish carrier	Live fish carrier	Live fish carrier
	32%	3%	18%	4	19%	6	6
5	Older than 56 years	Engine officer	More than 20 years	5 cargo	Other cargo	Other cargo	Other cargo
	13%	15%	36%	17	2%	6	9
6	-	Engine crew	-	6 Passenger	Passenger line 1	Passenger line 1	Passenger line 1
	-	8%	-	84	26%	270	7
7	-	Catering	-	-	Passenger line 2	Passenger line 2	Passenger line 2
	-	17%	-	-	12%	97	25
8	-	Apprentice	-	-	Passenger line 3	Passenger line 77	Passenger line 3
	-	4%	-	-	15,3%	-	28
9	-	Other	-	-	-	-	-
	-	15%	-	-	-	-	-
Total	100%	100%	100%	157	157	157	157

Eight per cent of the 157 respondents are women. Ninety-one per cent are Norwegian, 6% are from another Nordic country, while 3% are from other countries, mainly Western European.

2.4 Survey Measures

1) Background variables (15 questions): sex, nationality, age group, seafarer experience, position/area of work, employment status, vessel type, vessel size, manning on board, ship register, year vessel was built, days on board and days off, work schedule, number (and share) of nationalities on board, number of employees in the shipping company.

2) Safety performance (5 questions):

2a) Safety behaviours: (4 questions) the survey originally included seven questions on safety behaviours, but we removed four items and made an index with three questions after a stepwise "Scale if item deleted" analysis, where we removed items until removing items did not lead to a higher Cronbach's Alpha. The index is composed of the following questions (Cronbach's Alpha: .855). How often do you think the following events tend to occur for every 100 working days/nights on board?:

- 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

(Answer alternatives: 1) Never, 2) 1-2 times, 3) 3-5 times, 4) 6-10 times, 5) 11-15 times, 6) 16-20 times 7) More than 20 times, 8) Do not know/not relevant).

2b) Work place safety assessment: "All in all, how do you assess the safety of your work place situation (applies both to personal injuries and ship accidents)?" Answer provided in a scale 1-10 where very bad=1 and very good=10

2c) Safety compromising fatigue: "Sometimes I am so tired during working hours that safety is compromised" (Answer alternatives: 1=totally agree - 5=totally disagree, 6=Do not know/not relevant)

2d) Work accidents: "Have you been injured in your work on board in the course of the last two years?" (Answer alternatives: 1) No 2) Yes, a little injury which did not require medical attention, 3) Yes, a little injury which required medical attention, 4) Yes, an injury which required medical attention and a period of sick leave).

3) Working conditions: (4 questions): How often do you think the following events tend to occur for every 100 working days/nights on board:

- 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

(Answer alternatives: 1) Never, 2) 1-2 times, 3) 3-5 times, 4) 6-10 times, 5) 11-15 times, 6) 16-20 times 7) More than 20 times, 8) Do not know/not relevant)

We removed the eight answer alternative and made a "Demanding working conditions index" of these three questions (Cronbach's Alpha: .738). The survey also included a question on work pressure:

- Sometimes I feel pressured to continue working, even if it is not perfectly safe (Answer alternatives: 1=totally disagree - 5=totally agree, 6=Do not know/not relevant).

4) Organisational safety culture (10 questions): We made an organisational culture index, consisting of 10 questions from the GAIN-scale on organisational safety culture (Cronbach's Alpha=0.882). We have used this scale 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).

The GAIN-scale originally consists of 25 questions measuring five themes, but we have reduced the scale to 10 questions:

- Ship management regards safety to be a very important part of all work activities.
- The shipping company regards safety to be a very important part of all work activities.
- Ship management detects crew members who work unsafely.
- Ship management often praises crew members who work safely.
- My colleagues on board usually report all safety problems and unsafe situations that they experience in their work.
- My colleagues on board do all they can to prevent accidents and unwanted incidents.
- There are routines (procedures) on board for reporting safety problems.

3. Analysis of quantitative data

3.1 Comparison of Means

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

3.2 Regression analyses

We have also conducted three regression analyses to analyze the factors predicting respondents' answer on the dependent variables measuring personal injuries, the unsafe behaviours index and the organizational safety culture index. We chose logistic regression analysis in the first regression analyses, as the dependent variable has two values (no=1, yes=2). In this analysis we include different independent variables 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 two other analyses, we use hierarchical, linear regression analyses, where independent variables are included in successive steps. The most basic independent variables are included first, e.g. age, position, then the other independent variables are included. Of course, we cannot conclude about causality, as this is a cross-sectional and correlational study. We nevertheless use the term predict when we describe the regression analyses.

4. Results

4.1 Organisational Safety Culture

Table 2 shows the means on the organisational safety culture index for different groups. The average organisational safety culture score is 43.3 points (min=5, max=50).

Table 2: *Means on the organisational safety culture index for seven variables (N=157). The average organisational safety culture score is points (minimum score: 5, maximum score: 50)*

	Age group	**Position**	**Shipping company**	**Vessel type**	**Safety compromising fatigue**	**Work pressure**
1	Younger than 26 years	Captain	1 Cargo	Bulk vessel	Totally disagree:	Totally disagree:
	41.3	44.8	44	40.1	45	44.8
2	26-35 years	Deck officer	2 Cargo	General cargo	Disagree somewhat:	Disagree somewhat:
	42.1	42.6	41.2	44.3	42.2	42.2
3	36-45 years	Deck crew	3 Cargo	Tank vessel	Neither/nor:	Neither/nor:
	43.5	43.6	44.2	36.5	41.6	38.8
4	46-55 years	Chief engineer	4 cargo	Live fish carrier	Agree Somewhat:	Agree Somewhat:
	43.4	45.5	42	44.4	37.5	41.3
5	Older than 56 years	Engine officer	5 cargo	Other cargo	Totally agree:	Totally agree:
	46.7	42.6	38.1	40	38.3	29.7
6	-	Engine crew	6 Passenger	Passenger line 1	-	-
	-	40.1	44.4	43.3	-	-
7	-	Catering	-	Passenger line 2	-	-
	-	45.2	-	44.4	-	-
8	-	Apprentice	-	Passenger line 3	-	-
	-	41.5	-	46.5	-	-
9	-	Other	-	-	-	-
	-	43.2	-	-	-	-
P value	.039	.437	.001	.000	0.000	0.00

Table 2 indicates four variables with significant differences on the safety culture variable. First, we see that respondents younger than 26 years rate the organisational safety culture level lower than other age groups. We also see that the organizational safety culture score is slightly higher in the passenger shipping company than in the third cargo shipping company. Moreover, the organizational safety culture scores are generally higher on the three passenger lines, especially line 3, and lowest among the tank vessel respondents. We also see that the more respondents agree with the statements on work pressure and fatigue the lower safety culture levels they report.

4.2 Demanding Working Conditions

As noted in the methods section, we made a "Demanding working conditions index" 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 in the course of a 24-hour period, or

are interrupted when they are off duty. In Table 3 below, we compare mean scores for different groups on this index. The minimum value is 3 (never) and the maximum value is 21 (daily when I am at sea). The average score is 6.5 points.

Table 3: *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)*

	Age group	**Position**	**Shipping company**	**Vessel type**	**Safety compromising fatigue**	**Work pressure**
1	Younger than 26 years	Captain	1 Cargo	Bulk vessel	Totally disagree:	Totally disagree:
	6.8	8.1	7.2	7.3	6.2	5.7
2	26-35 years	Deck officer	2 Cargo	General cargo	Disagree somewhat:	Disagree somewhat:
	6.1	6	6.7	6.9	6	7
3	36-45 years	Deck crew	3 Cargo	Tank vessel	Neither/nor:	Neither/nor:
	6.3	5.4	7.6	7.3	7.8	8.5
4	46-55 years	Chief engineer	4 cargo	Live fish carrier	Agree Somewhat:	Agree Somewhat:
	6.5	7.3	8.8	7.7	6.9	10.2
5	Older than 56 years	Engine officer	5 cargo	Other cargo	Totally agree:	Totally agree:
	6.8	7.1	7.6	8.3	7.5	11.5
6	-	Engine crew	6 Passenger	Passenger line 1	-	-
	-	7.3	5.6	5.9	-	-
7	-	Catering	-	Passenger line 2	-	-
	-	6	-	5.5	-	-
8	-	Apprentice	-	Passenger line 3	-	-
	-	7.2	-	5.2	-	-
9	-	Other	-	-	-	-
	-	5.7	-	-	-	-
P value	.947	.256	.018	.061	.332	.000

Table 3 indicates significant differences between respondents in different shipping companies. The shipping company involved in passenger transport has the lowest score, indicating the least demanding working conditions. Moreover, we see unsurprisingly, that respondents who report higher levels of safety compromising work pressure, experience more demanding working conditions. Results also indicate significant differences between sub-sectors on the 10 %-level. Other cargo has the highest score, indicating the most demanding

working conditions, while passenger line 3 has the lowest score. Among the non-significant findings, we see that captain report the most demanding working conditions.

4.3 Safety Outcomes

4.3.1 Safety Behaviours

We made an index measuring unsafe behaviours (violations/risk taking) consisting of four items. In Table 4, we compare mean score for different groups on this variable. The minimum value is 4 (never) and the maximum value is 28 (more than 20 every 100 working days/nights on board). The average score is 8.

Table 4: *Means on the index measuring unsafe behaviours (violations/risk taking) consisting of four items. The minimum value is 4 (never) and the maximum value is 28 (more than 20 every 100 working days/nights on board).*

	Age group	**Position**	**Shipping company**	**Vessel type**	**Demanding working conditions**	**Work pressure**
1	Younger than 26 years	Captain	1 Cargo	Bulk vessel	3-7 points	Totally disagree:
	9.8	7.7	8.3	8.7	7.2	6.9
2	26-35 years	Deck officer	2 Cargo	General cargo	8-12 points	Disagree somewhat:
	9.3	9.3	8.8	8.3	9.3	8.7
3	36-45 years	Deck crew	3 Cargo	Tank vessel	13-21 points	Neither/nor:
	8.6	7.2	8.7	11.8	11.7	9.8
4	46-55 years	Chief engineer	4 cargo	Live fish carrier	-	Agree Somewhat:
	6.8	5.3	12.5	9.2	-	13.7
5	Older than 56 years	Engine officer	5 cargo	Other cargo	-	Totally agree:
	5.6	9	11.4	10.7	-	17.3
6	-	Engine crew	6 Passenger	Passenger line 1	-	-
	-	7.5	6.6	6.9	-	-
7	-	Catering	-	Passenger line 2	-	-
	-	6.5	-	6.1	-	-
8	-	Apprentice	-	Passenger line 3	-	-
	-	11.7	-	6.6	-	-

	Age group	Position	Shipping company	Vessel type	Demanding working conditions	Work pressure
9	-	Other	-	-	-	-
	-	6.7	-	-	-	-
P value	.004	.077	.000	.002	.004	.000

Table 4 indicates significant differences on the safety behaviour index between respondents from different age groups: the younger respondents are, the less safe are their behaviours. We also see significant differences between the shipping companies; the respondents from the shipping company involved in passenger transport have the safest behaviours. We see that the tank vessel respondents have the highest score on the unsafe behaviour index. Additionally, we see that the more demanding working conditions the respondents experience, the more unsafe behaviours they are involved in. Work pressure seems to be particularly closely related to unsafe behaviours.

4.3.2 Personal Injuries

We asked respondents whether they had been injured in their work on board in the course of the last two years. A total of 42 of the respondents (27%) answered yes (Figure 1). The figure also shows mean scores on the unsafe behaviours index for each value on the personal injury variable.

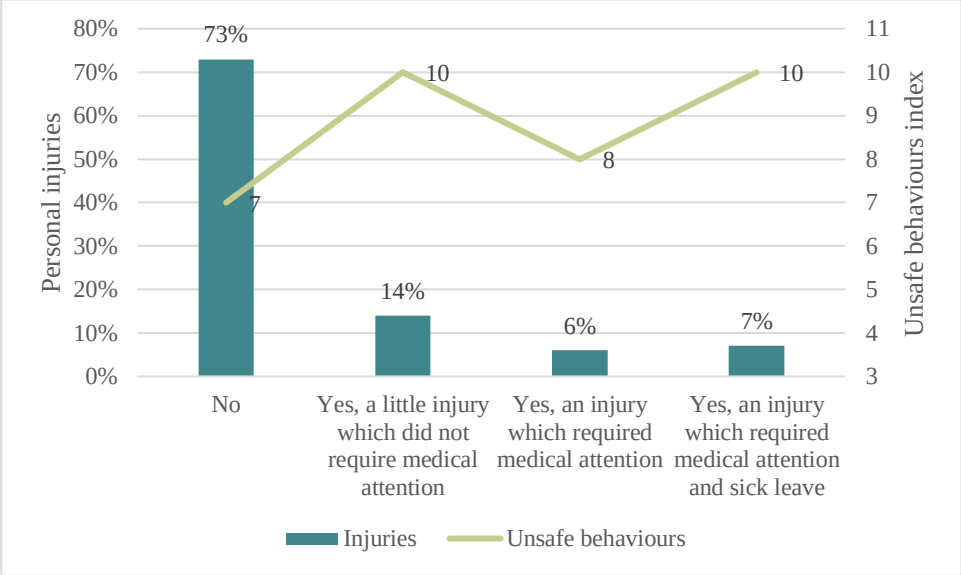

Figure 1: *Respondents' response to the question: "Have you been injured in your work on board in the course of the last two years?" % (left y axis) and mean scores on the unsafe behaviours index for each value on the personal injury variable (right y axis) (N=157).*

Figure 1 indicates a relationship between personal injuries and unsafe behaviours. An Anova comparison of means indicates that the differences between the mean scores on the unsafe behaviours index for each value on the personal injury variable are statistically significant at the 5%-level (p=0.018).

4.4 Results from Regression Models

4.4.1 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 our respondents (Table 5). In this analysis, the injury variable, which originally had four answer alternatives (Figure 1), 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. We include different independent variables 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
Age group (>26 years=0, other=1)	**-2,226*** **	**-2,106*** **	**-2,072*** **	**-2,086*** **	**-2,038*** **	**-2,051*** **	**-2,051*** **	**-2,120*** **
Position/line of work (Apprentice=0, other =1)		-,418	-,145	-,174	-,256	-,259	-,261	-,204
Unsafe behaviours index			**,098** **	**,100** **	**,102** **	**,097** **	**,096***	**,115***
Sector (passenger=0, cargo=1)				-,085	-,318	-,364	-,364	-,328
Sub-sector (Live fish carrier=0, other=1)					-,508	-,491	-,491	-,391
Demanding working conditions index						,032	,031	,030
Sometimes I feel pressured to continue working, even if it is not perfectly safe							,002	,048
Organisational safety culture								,033
Nagelkerke R^2	.158	.159	.201	.201	.208	.210	.210	.214

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

Table 5 indicates two important results. The first is that age group contributes negatively and significantly to the risk of having a personal injury, when we control for the other variables in the model. We dichotomized this variable, as results indicated that the youngest group of respondents (<26 years old) had a substantially higher share of personal injuries (65%) in the last two years compared with the other age groups (22%). The regression model in Step 8 indicates that this effect prevails when we control for other variables, including unsafe behaviours. Thus, the effect of age group on personal injuries is also due to other unmeasured factors.

The other main finding in Table 5 is that the unsafe behaviours index contributes positively and significantly to personal injuries, although it only contributes at the 10%-level in Step 8. Unsafe behaviours contributed significantly at the 5%-level in Step 6, but the effect only became significant at the 10% level in Step 7, when work pressure was included in the model. This indicates the close association between work pressure and unsafe working behaviours on board the studied vessels.

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 0.214 which indicates that the independent variables explain 21.4% of the variance in the dependent variable, personal injuries.

4.4.2 Unsafe Behaviours Index as the Dependent Variable

We saw above that the unsafe behaviours index predicted personal injuries in the last two years (although it was only significant at the 10% level). In Table 6 we show results from a hierarchical, linear regression analysis, where independent variables are included in successive steps to examine the variables predicting respondents' unsafe behaviours. 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 4 (never) and 28 (more than 20 every 100 working days/nights on board). As noted, this index measures violations and risk taking/ acceptance. The average score is 8.

Table 6: *Linear regression. Dependent variable: unsafe behaviours index. Standardized beta coefficients.*

Variables	Step 1	Step 2	Step 3	Step 4	Step 5	Step 6	Step 7
Age group (>26 years=2)	**.158***	.090	,059	.085	.089	.081	.026
Position/line of work (Apprentice=2)		.140	,094	.065	.065	.113	.122
Sector (cargo=1, passenger=2)			**-,280*****	**-.238*****	**-.178****	**-.159***	**-.160****
Sub-sector (Tank=2)				.139	.142*	.145*	.021
Demanding working conditions index					.212**	.064	.079
Sometimes I feel pressured to continue working, even if it is not perfectly safe						**.381*****	**.219*****
Organisational safety culture							**-.385*****
Adjusted R^2	.018	.026	.095	.105	.142	.261	.367

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

Table 6 provides three main results. The first is that sector contributes negatively and significantly to unsafe behaviours. This indicates that, controlled for the other variables in the model, respondents in the passenger transport sector in average have safer behaviours, with fewer violations, risk taking/acceptance.

The second main result is that safety compromising work pressure contributes positively and significantly to unsafe behaviours, controlled for the other variables (including sector and sub-sector). This indicates that the more work pressure the respondents experience, the more likely they are to be involved in unsafe behaviours. For each increasing value on this variables, respondents' score on the unsafe behaviours index increases.

The third main result is that organizational safety culture contributes negatively and significantly to unsafe behaviours. This is the variable in the model with the strongest contribution. This indicates that the higher organizational safety culture scores the respondents report, the less unsafe are their behaviours. This result is interesting and important, as it indicates that organizational safety culture to some extent may reduce the negative impact of for instance sector (i.e. working in cargo transport).

The Adjusted R^2 indicates the amount of variance in the dependent variable that is explained by the independent variables in the model. In Step 7 the Adjusted R^2 is 0.367 which indicates that the independent variables explain about 37 % of the variance in the dependent variable.

4.4.3 Organisational Safety Culture Index as the Dependent Variable

We saw above that the organizational safety culture index was the strongest predictor of respondents' unsafe behaviours. In Table 7 we show results from a hierarchical, linear regression analysis, where independent variables are included in successive steps to examine the variables predicting organizational safety culture. Table 7 presents the standardized beta coefficients. The scores on the dependent variable vary between 5 and 50.

Table 7: *Linear regression. Dependent variable: unsafe behaviours index. Standardized beta coefficients.*

Variables	Step 1	Step 2	Step 3	Step 4	Step 5	Step 6
Age group (>56 years=2)	**.195****	**.192****	**.171****	**.187****	**.196****	**.164****
Position/line of work (Chief engineer=2)		.046	.079	.078	.076	.100
Sector (cargo=1, passenger=2)			**.181****	.103	.068	.066
Sub-sector (Passenger line 3=2)				**.195****	**.188****	**.168****
Demanding working conditions index					-.128	.021
Sometimes I feel pressured to continue working, even if it is not perfectly safe						**-.368*****
Adjusted R^2	.032	.027	.053	.079	.088	.196

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

Table 7 provides three main results. The first is that age group contributes positively and significantly to organisational safety culture. This indicates that respondents over 56 years old in average rate their organizational safety culture higher than other respondent, when we control for the other variables in the model, e.g. position/line of work, sector, working conditions. We dichotomized the age group variable, when we saw that respondents over 56 years old rated their organizational safety culture considerably higher than other groups, although the variables measurement level did not indicate that dichotomization was necessary.

The second main result is that sub-sector contributes positively and significantly to organizational safety culture. We made the dichotomous sub-sector variable on the basis of the fact that Passenger line 3, was the sub-sector with the highest score on the organizational safety culture index. Table 7 indicates that working in this sub-sector is likely to contribute to a relatively high organizational safety culture level, when we control for other variables, e.g. age group. Thus, the high average of Passenger line 3, is not due to a sampling effect like age, or (our measurement of) demanding working conditions, which we also control for in the model.

The third main result is that safety compromising work pressure contributes negatively to organizational safety culture. This means that the organizational safety culture score decreases for each increasing value on the safety compromising work pressure variable. This is the variable with the strongest contribution in the model.

The Adjusted R^2 indicates the amount of variance in the dependent variable that is explained by the independent variables in the model. In Step 7 the Adjusted R^2 is 0.196 which indicates that the independent variables explain about 20% of the variance in the dependent variable.

5. Concluding discussion

5.1 Working Conditions, Safety Culture and Safety Outcomes

This study is partly motivated by a paradox reported by Hansen et al (2002), indicating that passenger vessel crews have a higher risk than coaster crews of all occupational accidents, but a substantially lower risk of serious injury and fatal accidents. Although our numbers have been too small to corroborate this result, our data can be used to evaluate Hansen et al's (2002) possible explanation to this paradox: the lower risk of coaster crews of all occupational accidents could indicate under-reporting and poorer organizational safety culture on coaster vessels. The results of the present study support this assertion, as it indicates that crew members in the coastal cargo sector rate their organizational safety culture as lower than respondents in the passenger (ROPAX) transport sector. Our study also indicates that safety culture is closely related to working conditions.

In accordance with previous research (Hansen et al, 2002; Jensen et al, 2004), we also found young age (<26) to be associated with occupational accident risk on board. Previous research (Jensen et al 2004) has found self-assessed occupational safety to be related to occupational accidents, using a relative simple measure: "How is your occupational safety". Our study contributes to this research as our results indicate that work pressure and poor organizational safety culture are closely related to unsafe working behaviours (violations, risk taking/acceptance), which in turn is associated with personal injuries on board.

5.2 How important are framework conditions for safety culture and working conditions in the two

One of the main results is that sector predicts safety behaviour and that sub-sector predicts organizational safety culture. In this study, we chose to compare the coastal cargo and ROPAX sector, as we assumed that framework conditions (e.g. economy, competition, regulation) are different in these sectors. 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 (Størkersen et al, 2011). Previous research indicates that framework conditions influence the organizational safety cultures and the safety levels of different transport sectors (Bjørnskau & Longva, 2009), and between sub-sectors in maritime transport (Størkersen 2017). An important framework condition is type of transport, suggesting that people are more "valuable" than goods, and that requirements (and thus the safety level) therefore are stricter in passenger than goods transport (Nævestad & Phillips, 2013). Our study complements this previous research indicating the importance of sector, as it suggests how the influence of framework conditions on safety behaviour and occupational accident involvement is mediated by organizational safety culture and working conditions. Figure 2 illustrates the relationships indicated by the regression analyses in the present study.

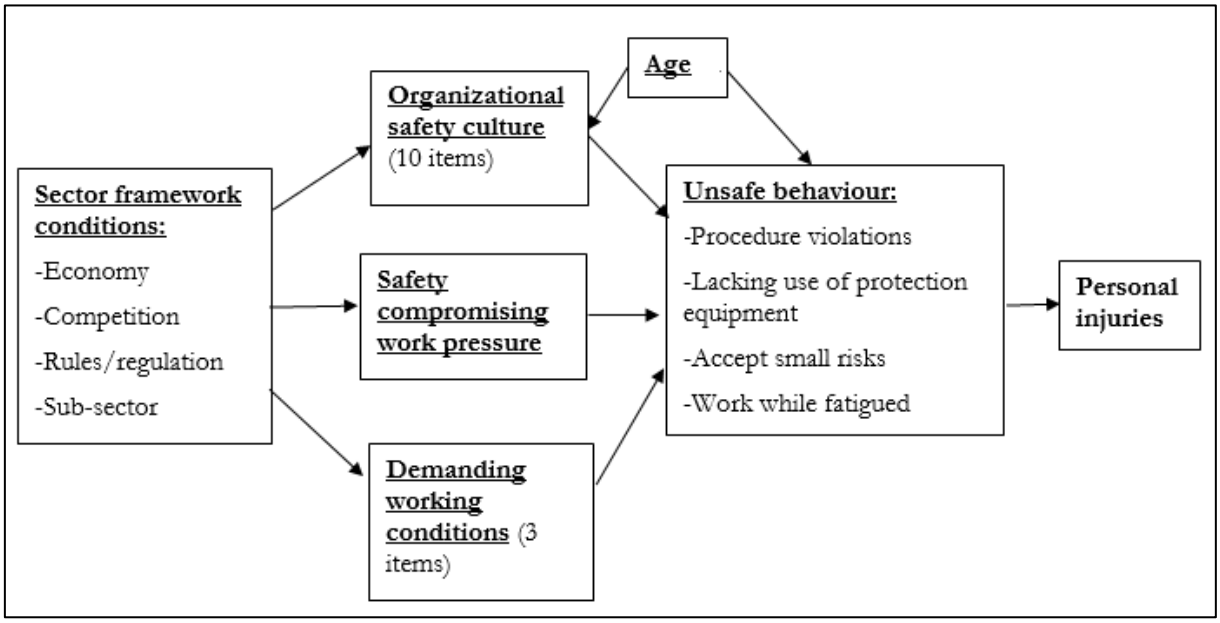

Figure 2: *Illustration of relationships between risk factors related to framework conditions, safety culture, work pressure, demanding working conditions, and risk factors related to safety*

Størkersen (2017) underlines the importance of framework conditions for working conditions in Norwegian coastal cargo transport. In the daily conflict between protection and production, the latter often wins in this sector. Størkersen et al (2011) found that a third 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.

5.3 Methodological Limitations and Suggestions for Further Research

As a positive organizational safety culture is related to safer working behaviours, future research should examine how organizational safety culture can be employed to reduce the

impact of negative framework conditions in maritime transport on occupational safety. Nevertheless, our results must be interpreted with caution, as they are based on a relatively limited sample, and low numbers. First, it is important to remember that it only includes one passenger vessel shipping company. Thus, we compare one passenger shipping company with several cargo shipping company, although several different vessels/lines are included. Second, we include many vessels that we should assume have different cultures (Håvold, 2005), although they belong to the same shipping companies, but the numbers are too low on these to compare. Third, although we see a higher share of injuries in coastal cargo, we do not have exposure measures, or a measure of risk. Fourth, we could have looked more closely at the different work processes leading to injuries on board cargo and passenger vessels. Hansen et al (2002) states, for instance, that these are very different; a point that we have been unable to follow up in the present study.

Fifth, we have not actually measured the influence of the different framework conditions in the present study, but rather based our assumptions about these on previous research. We should have looked more closely at the framework conditions in passenger transport, for instance, and the importance of these (and perhaps additional factors) must be assessed in future studies. It should however be noted that the present study includes survey measures focusing on sector culture and sector focus on safety, to be used in the SafeCulture project. Table 8 indicates significant differences between respondents from the two sectors on the two key first statements. These seem to represent fairly robust measures of framework conditions, and they are in accordance with the line of argumentation that has been pursued above. Differences are not significant on the other statements. Thus, these are either inappropriate when it comes to measuring framework conditions, or they indicate less important framework conditions. The first may apply to three of the statements, which are somewhat ambiguous but not the statement about strong competition. This statement does not ambiguous, and results may indicate that competition not is an important framework conditions when it comes to explaining the observed differences between the sectors. More research is needed.

Table 8: *Mean scores on statements measuring sector culture/focus on safety*

Statements measuring sector culture/focus on safety	Cargo	Passenger	P-value
On a "safety level scale" ranging from 1 to 10, where 10 equals the safety level in international commercial aviation, how would you rate your sector (i.e. sea transport of goods or passenger)?	**6.56**	**7.63**	**.002**
Safety is more important than deadlines to our customers	**3.78**	**4.26**	**.014**
Safety is more important than price to our customers	**3.73**	**3.76**	**.867**
Strong competition between companies impedes safety in my sector	**2.74**	**2.57**	**.434**
I don't expect safety improvements in my sector in the next 10 years	**2.14**	**2.06**	**.686**
Society accepts the current level of accidents that we have in my sector	**2.74**	**2.50**	**.245**

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