Assessment on the Impact of Pilot Nationality to Safety Performance

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Abstract

The purpose of the present study was to assess the impact of pilot nationality to safety performance of the bridge team under pilotage operations. In order to address this, a simulation experiment was conducted to compare homogeneous teams and heterogeneous teams. The main task of the bridge team was to safely navigate the vessel. In addition, a proposed safety assessment framework based on safety performance indicators was formulated as a tool for the assessment. The result showed that heterogeneous teams performed better than homogeneous teams. Nevertheless, this did not necessarily indicate that heterogeneous teams performed the task in a safer manner than homogeneous teams. Furthermore, the impact of nationality to safety performance of the bridge team was inconclusive. Therefore, further research is needed.

Keywords: nationality, pilotage, assessment, safety performance, safety performance indicators, sociotechnical systems, simulation, and teamwork

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Introduction

Maritime Shipping and Maritime Safety

Over several years, the shipping industry has evolved into an industry characterized as international, technology focused and highly multicultural, driven with the strong demand for economic efficiency and profitability (Berg, Storgård & Lappalainen, 2013). In today's world, globalization has been a major determining factor for economic growth, both domestically and internationally. The maritime industry, particularly the shipping and logistics sector acts as the backbone of economic growth (Manuel, 2011). It has been generally accepted that as much as 85-90% of the world trade of commodities and goods uses maritime shipping transportation at one point in time. Ships have been a key element in almost all aspects of multimodal transportations of goods worldwide. If it is not for the shipping industry, the global economy could not have functioned properly (IMO, 2012). However, the vast amount of flow of goods, peoples and infrastructures, together with stiff market competitions as well as the quest for maximum commercial gains often result in shipping companies undermining maritime safety. When maritime safety is not given attention, the risks of maritime accidents may potentially increase as a consequence.

According to the International Maritime Organization (IMO), the maritime shipping industry is perhaps the most international among the world industries it has been generally accepted that the maritime shipping industry considered among the most dangerous industries (IMO, 2002), from an operational perspective in particular (Drever, 1995; Li, 2002). In addition, many argue that the best way to improve safety is through additional rules and regulations together with the implementation of best practices based on accident reports (Gander et al., 2011; Kristiansen, 2013). However, this may not always be the case.

It is appropriate to keep in mind that maritime shipping, just like all the other high-risk industries, functions within the confines of a complex socio-technical system (Koester, 2007). Moreover, its dynamic nature as well as the international character of the commercial shipping industry added to the difficulties and challenges (Grech, Horberry & Koester, 2008). According to Pyne and Koester (2005), breakdowns within the socio-technical system in the maritime domain are often the underlying cause of the majority of incidents and accidents. This is supported by a number of accident studies conducted (Baylon & Santos, 2011; Mårtensson, 2006; Rothblum, 2000). The studies also showed that among the risk factors of maritime safety, ship crew ranked as the highest pointing to human error, at least in part, as the cause of as high as 90% of the maritime casualties (Berg et al., 2013). For decades, human factors have since been embedded in navigation and ship operations and remain a critical feature (Pyne & Koester, 2005). Numerous accident reports from the aviation industry, in particular, argue that human error is not confined to the incompetence of the operators alone and that there is a need to shift our attention to find methods of how to minimize human error. As for the maritime industry, focusing and understanding the factors that contribute to human error is significantly important if we aim towards decreasing maritime accidents (Rothblum, 2000).

Team and team performance. There has been numerous studies and research done regarding important factors that affect teams and their team performance such as teamwork, communication, situation awareness (SA) and distributed situation awareness (DSA) (Endsley, 1995; Flin, O'Connor & Crichton, 2008; Nazir, Colombo & Manca, 2012; Sorensen and Stanton, 2013). Salas, Dickinson, Converse and Tannenbaum (1992) argued that by improving the interactions between members in a team, team effectiveness could be enhanced due to the interdependency nature of teams. In line to this, the impact of communication to teams has been widely studied. Communication is generally defined as an information exchange, verbal or nonverbal, between two or more individuals (McIntyre & Salas, 1995; Salas & Cannon-Bowers, 2000). It is a given that a team cannot simply perform a task, let alone perform it in a safe manner, without the aid of communication. As the given task, situation and environment becomes more complex, the importance of communication significantly increases. A study was conducted by Øvergård, Nielsen, Nazir and Sorensen (2015) regarding the relevance of communication in assessing navigational teamwork. The findings interestingly showed that there is no relationship between the relevance of communication and the navigational performance of the team. Furthermore, the research argued that situational correctness of information should be given more focus rather than the relevance of communication alone.

Recently, researchers have recognized the importance of teamwork effectiveness to maintain or increase the level in a work environment (Awad et al., 2005; Flin et al., 2008; Turner & Parker, 2004). It is also worth noted that although a majority of the studies were conducted for teams under other high-risk industries (i.e. nuclear, process, aviation and healthcare) but few under the maritime shipping domain. Another aspect that was given less focus was the effect of national culture in within teams composed of multinationals.

Nationality and national culture. It is a given fact that nationality and culture have been one of the most researched topics across various industries. It is a widely accepted notion that national culture influences the behavior, beliefs and values across nations and nationalities. For example, a survey conducted by a European consulting firm concluded that the difference in culture is among the leading source of challenges and difficulties in terms of company acquisitions (Schneider & Barsoux, 1997). However, the most notable culture research was done by Hofstede (1991), from which most of the subsequent research were somewhat based upon. The present study will limit the discussion of nationality and national culture within the scope of maritime shipping and its impact on safety and team performance.

According to Horck (2005), there has been a significant increase in the crew composition in the global merchant fleet. Crew compositions on board vessels have become more multilingual and multicultural in the last few decades. The study stated that approximately two-thirds of the world fleet sail with several crew nationalities. It further stated that in the past decades, the impact of human relations was not taken into account in maritime accident investigations. On a lighter note, Horck (2005) emphasized in his conclusion the advantages of multi-cultural crews.

On the other hand, notable researches have touched the aspect of nationality and culture as well as its impact to safety (Benton, 2005; Berg et al., 2013; Hetherington, Flin & Mearns, 2006; Håvold & Nesset, 2013). Hetherington et al. (2006) pinpointed distinctive factors that played a role in accidents. They therefore concluded that cultural issues and language definitely influence maritime safety, particularly from communication failures and team misunderstandings. There seems to be a necessity to articulate a methodology that clearly differentiates between language and culture.

However, most research has been mostly focused within the organizational context of safety culture. A study conducted by Håvold (2007) focused on the relationship between national culture and safety orientation of seafarers on board Norwegian-owned ships. It conducted a survey using Hofstede's Value survey model 94. The findings showed that there was a significant difference in attitude among nationalities towards safety issues. Håvold (2007) further concluded that there has been little research done about maritime safety in relation to national culture on board vessels and pushed for more investigation within this construct.

Although several studies has been done focusing on the impact of cultural differences towards team performance, further investigation is necessary before we can fully comprehend the effects of these differences. According to Strauch (2010), culturally heterogeneous teams will more likely to perform errors than the culturally homogeneous teams under abnormal situations. In addition, the study argued that there are methodological and interpretative deficiencies in most research on cultural factors that limits their general applicability.

Pilotage operations and maritime safety. One specific area of maritime operation where the dynamic complexity of a socio-technical system is clearly present, by which few research has been thoroughly done about the impact of national cultures in a team, is during navigations and maneuvers of vessels under pilotage operations. A pilotage operation can simply be defined as the process of guiding the vessel movement from one place to the other, in most cases in within high-risk navigational areas such as berthing and mooring (Jensen, 2015). With the maritime industry becoming more reliant on the advancement of modern navigational aids such as Radio Detection and Ranging (RADAR), Electronic Chart Display System (ECDIS), autopilot capabilities, the elements of human factors are often neglected.

Moreover, multinationalization of seafarers on board today's vessels has been the popular trend recently. This creates potential challenges on how safety should be perceived and achieved (Berg, 2013). This has been a recognized problem during pilotage operations as well yet literature suggests that little research has been done to address this issue. A vessel under pilotage operation require a team of mariners that are highly skilled and competent to maneuver the vessel safely into port since the risk of accidents such as collisions and allisions increases significantly compared to high seas navigations (Larjo, Loveson & Lehtosalo, 2010). What adds to the seriousness of the situation is when a vessel navigates in areas where compulsory pilotage are mandatory, i.e. narrow channels, shallow ports and berths, rivers, congested ports. The technical and navigational skills of the seafarers, in this case the bridge crew, are extremely necessary for such operations that require precision (Drouin & Heath, 2009). However, what are equally important in conjunction to the required technical skills of the crew are their non-technical skills as well. Non-technical skills are skills that often involve both the cognitive and interpersonal aspect of individuals or a team which underpin its effectiveness. Interpersonal skills such as leadership, decision-making, situation awareness, teamwork and communication are some of the non-technical skill pointed out by Flin et al. (2008). Operating a vessel under pilotage is not an individual task. It involves a coordinated team often composed of a master, officer of the watch (OOW), navigator, lookout, and helmsman and in almost every case at least a local marine pilot as illustrated in *Figure 1*.

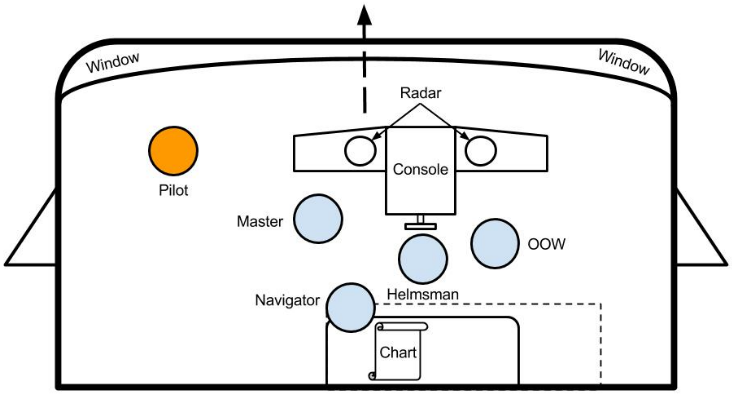

Figure 1. Basic layout of a ship's bridge deck under pilotage operations.

One of the key resources for a bridge crew to perform a safe approach to and out from harbors, ports and narrow channels is the pilot. A pilot is generally a seafarer and a professional vessel handler with a detailed knowledge of a local port, harbor areas or dangerous navigational waters. It is a general knowledge in the maritime industry that pilots are in the service of the public interest and is licensed by the Port State Authority. The pilot utilizes his/her in-depth local knowledge of the area to make sure that the vessel under pilotage performs a safe passage through the pilotage area. According to most maritime regulations and Pilotage Acts of different countries, the responsibilities of a marine pilot are clearly defined (Falkanger, Bull & Brautaset, 2011). However, there seems to be no definite consensus regarding the inclusion of the pilot as part of the bridge team. Some literatures claim that a pilot is not a member of the team by definition (Bowditch, 1995). However, IMO regulations as well as conventions emphasized the vital role of the pilot. Thus, the present study identified the pilot as part of the bridge team.

The Bridge Resource Management (BRM) as well as Bridge Team Management (BTM) are approaches widely used to study the resources and assets (which includes humans) available in the bridge and to exploit them in order to conduct safe and efficient voyages. There seems to be no specific guidelines on how BRM/ BTM should be conducted since this is up to the shipping companies themselves. In addition, the implementation of such management varies according to the vessel size, the voyage type, the crew, shore-based management, funding and other numerous factors (Bowditch, 1995). BRM and BTM consist of electronics, equipment on board and human assets except the pilot. As already discussed, the pilot is directly employed by the port state and not by the shipping companies. Therefore, the present study argued that there is a need to develop an assessment framework based on an objective approach that will address specific issues and challenges concerning maritime safety in the context of pilotage operations. In order to attain that, it is necessary to look into and try to identify specific safety performance indicators that may be general in nature but are present during pilotage operations.

Safety Performance Indicators

Safety performance measurements are necessary to achieve effective safety management in any industry. According to a 2010 report from the Safety Management International Collaboration Group (SMICG), the strategy of measurement should deliver a set of well-defined measures and safety performance indicators. When performing an analysis on such measurements, determining the number of safety performance indicators to be used is crucial to avoid discrepancies, overlapping and redundancies with similar indicators.

When selecting safety performance indicators (SPIs), the purpose, the reliability and the effectiveness should be considered. Wreathall (2009) defines safety indicators as, "*proxy* *measures for items identified as important in the underlying model(s) of safety*." Wreathall (2009) further argued that SPIs are necessary in order to monitor the current state of safety in high-risk industries. Hale (2009) added that the selection process of SPIs should "*be soundly based on an underlying model of safety and the precursor forces that lead to the failures of concern (Wreathall, 2008)*." Furthermore, Hale (2009) stated that there is a need for clear classification of the chosen SPIs whether they are related to occupational safety indicators or process safety indicators. Because of the different nature among safety- critical industries (e.g. aviation, process, nuclear and maritime), the identification and classification of the different types of safety performance indicators is an important factor to consider. Moreover, Korvers and Sonnemans (2008) emphasized the importance of safety indicators in identifying where to redirect resources in order to promote and develop safety.

The literature suggest that maritime shipping in general still lags behind in the identification and development of well-defined safety performance indicators in comparison to other industries (Jalonen & Salmi, 2009) despite the fact that it is the most regulated of all the industries and that safety regimes are in place (Knapp, 2007). One reason for this is that maritime shipping is a multi- clustered and multi- segmented industry in itself. The maritime shipping segments differ in operations, goals and structures. However, commonalities also exist. A commonality among different segments is the presence of vessels and seafarers, which may form the fundamental argument when identifying and selecting safety performance indicators. Statistical data and methods compiled and developed by various maritime institutions provide valuable information. One notable example is the DAMA database from Det Norske Veritas (DNV), the Norwegian Coast Administration and the Norwegian Directorate of Shipping and Navigation. Contained in the DAMA database is the complete recording of all the maritime shipping related incidents in the Norwegian waters from 1991- 1996. However, the weakness of employing such database as a sole basis in formulating safety performance indicators is that they may seem to be lagging in nature. The challenge with such safety performance indicators is that they are reactive rather than proactive.

Primary Safety Performance Indicators

For the purpose of this study, the author identified three primary safety performance indicators- communication, navigational effectiveness and navigational incidents. However, the author acknowledged that there are more safety performance indicators that can be used for future studies.

Communication. The importance of communication in any task that involves a team has been discussed. In fact, clear and precise communication acts as the glue that holds the bridge team together and make sure that safe navigation is fulfilled particularly in high stress situations (Bowditch, 1995). To illustrate, many serious accidents and groundings could have been avoided through a simple information exchange between the bridge team (master, crew and pilot). Therefore, communication is widely accepted as a key safety performance indicator for the maritime domain supported by numerous studies (Hetherington et al., 2006; Winbow, 2002; Øvergård et al., 2015).

Navigational effectiveness. Navigating comprised of different levels of processes, which involves different individuals with different interests working together for a common aim, to safely perform the maneuver without resulting to maritime accidents. The term navigational effectiveness, which will be later implied in this research, involves among others navigational skill of the seafarers or the bridge team to effectively perform the navigational tasks. There are specific roles regulated by the IMO's Safety of Life at Sea (SOLAS) as well as Standards of Training, Certification and Watchkeeping (STCW) 2010 Manila Amendments outlining sets of criteria for evaluating competence for seafarers (Yabuki, 2011). How the bridge team effectively navigates a vessel in a safe manner depends on different sets of technical and non-technical skills required as already discussed. Navigational effectiveness involves many aspects of navigations such as the proper use navigational tools (e.g. charts, ECDIS, Radar, gyrocompass, parallel index lines, VTS, conning, lookout). When it comes to pilotage, IMO recognized the importance of qualified pilots in order to effectively navigate safely as discussed in the Assembly resolution A. 159 (ES. IV) in 1968. Thereafter, the IMO Assembly adopted additional resolutions (e.g. A. 960(23), A. 668 (16), A. 710 (17), A. 827 (19)) with the aim of further promoting maritime safety in pilotage operations. When the bridge crew is unfamiliar with the area, the pilot's role as the navigator becomes significantly crucial on how the team perform effectively. The present study therefore argued that navigational effectiveness is a key safety performance indicator in assessing safety performance in pilotage operations.

Navigational incidents. Accidents as well as incidents have been widely used as a measurement for safety performance in the maritime domain (Darbra & Casal, 2004). However, Celik, Lavasani and Wang (2010) argued that due to different viewpoints as well as different methods of analysis and accident investigations, experts and professionals have not yet reached a certain consensus in terms of statistical distribution with regards to the causes of navigational accidents. With respect to pilotage, a study focused on the analysis of incidents reports during pilotage from 2004 to 2014 conducted by Johansson and Solver (2014) highlighted that navigational incidents which includes near-miss and deviations from intended turning points, can be used as a key performance indicator in pilotage operations. The study also found out that 23.4% of incidents during pilotage was largely due to allisions.

Safety Assessment Framework

This thesis proposes a two-level safety assessment framework (*Figure 2*) based on safety performance indicators to deliver a safety performance score of a bridge team. The two-level illustrates the different levels of the safety structure analysis. In both of these levels, the individual significance of each safety performance indicators was determined by using a pairwise comparison matrix to calculate the standardized weight of each other. There is a vertical interaction among the safety indicators, which in turn has an impact on the overall safety performance of the team.

Level 1. Level 1 consists of sub- safety performance indicators that are grouped together according to their categories and descriptions. In the framework, there are 9 sub- safety performance indicators (SI01- SI09), which are divided into groups of three based on their description and the type of indicator. Empirical parameters from the simulator and other measuring tools such as Noldus© provided a score for each of the nine sub- safety performance indicators. The sub- safety performance indicators will be further discussed in the methodology section.

Level 2. Level 2 consists of the main safety performance indicators in which the sub- safety performance indicators in level 1 are grouped into. These are navigational effectiveness, navigational incidents and communication. Through the main safety performance indicators, an overall score of the safety performance of a team is derived.

Pairwise comparison and weighting. A pairwise comparison matrix was utilized to generate the weightings for each safety performance indicators in the framework. This was done in order to determine the relative importance of each safety performance indicator and its significance, rather than simply listing and subjectively ranking the level of importance of each. The concept of the application of a pairwise comparison and weighting technique for the safety performance framework was patterned from the Analytic Hierarchy Process (AHP) tool, a multi- criteria decision-making tool developed by Saaty (1980; 1990). For the framework presented, a survey was conducted to collect expert subjective opinions from subject matter experts to form the source for the weighting (*see* Appendix B).

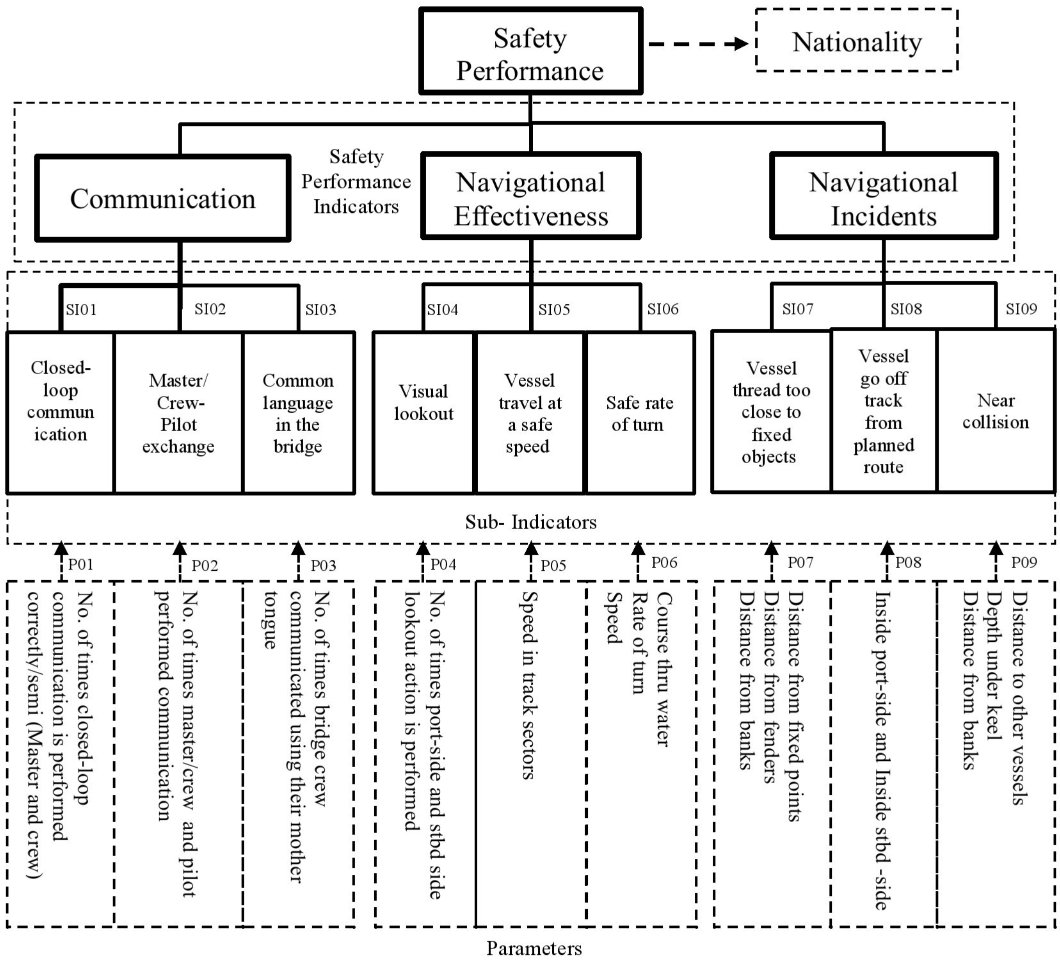

Figure 2. The Safety Assessment Framework.

Validation

Safety Assessment Framework. The literature provided the primary foundation for the construction of the proposed Safety Assessment Framework from which the safety performance indicators were derived from (*Figure 3*). Moreover, common features between maritime shipping in general and pilotage operations were looked into (*Figure 4*). Based on the comparisons, the author identified commonalities. The presence of a team of seafarers on the bridge, standard safety rules and regulations governed by conventions and/or IMO, as well as the vast majority of vessels are subject to pilotage when navigating mandatory pilotage areas, are just some of the common features. In addition, it is fair to assume that every vessel is subject to similar risks at one point while under voyage. Henceforth, the selection of sub-indicators for the framework was derived from these assumptions. In addition to the literature as the fundamental basis of the framework, subjective expert opinions from subject matter experts (SME) were taken into account as part of the validation of the framework.

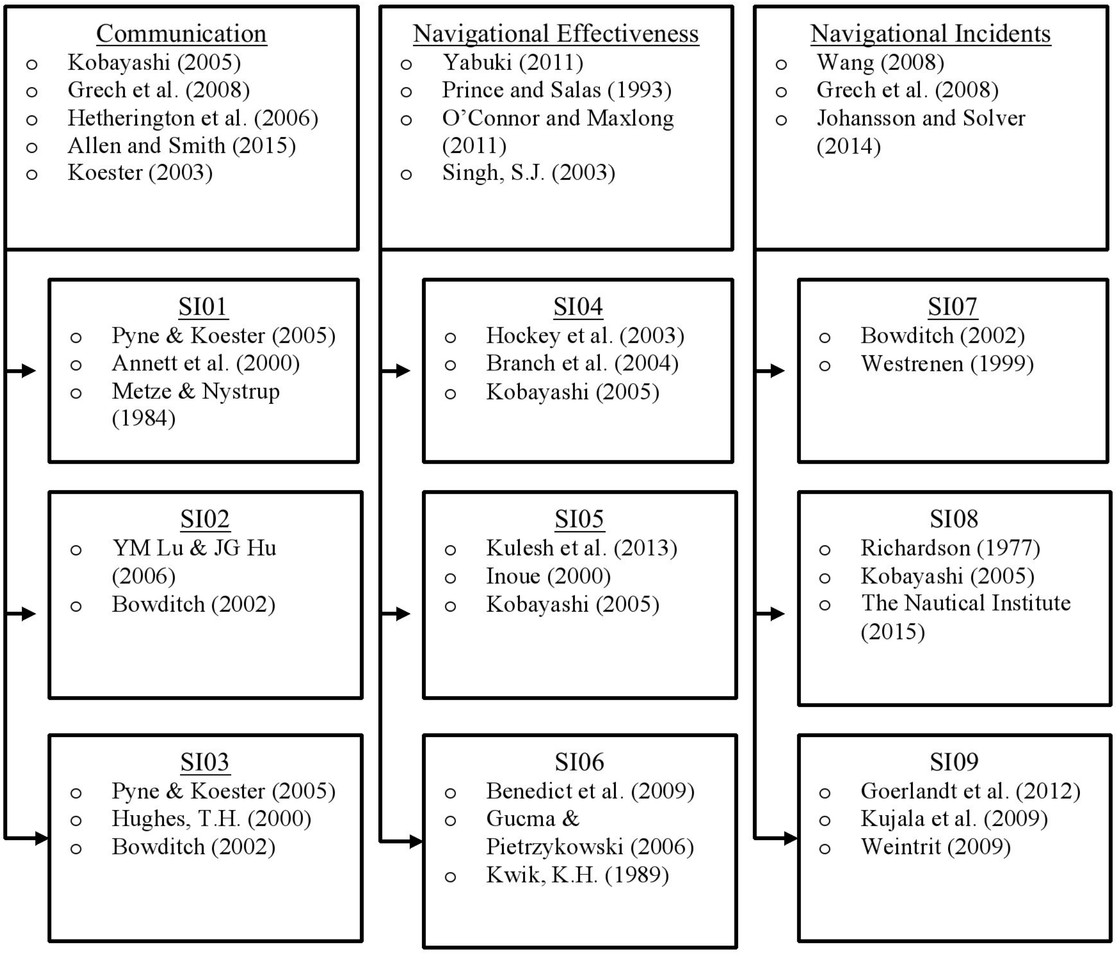

Figure 3. List of literature sources for the Safety.

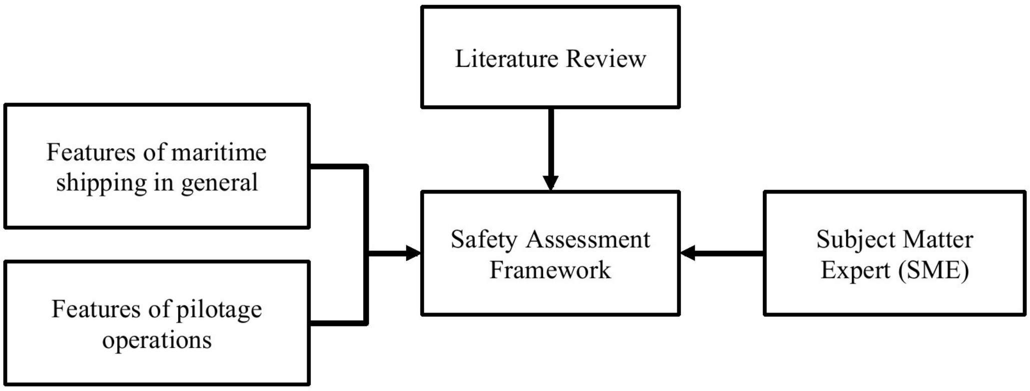

Figure 4. Figure shows the formulation of the Safety Assessment Framework based from the literature review and features of maritime shipping and pilotage operations, which were verefied by subject matter experts (SME).

Subject matter experts (SME). Apart from the already mentioned validation of the safety performance indicators and sub-indicators from the literature review, consultations from subject matter experts in the field of navigation and seafaring were necessary. Semi-formal interviews with an experienced navigation professor from the University College of Southeast Norway (HSN) and an Oslo-based Norwegian marine pilot were conducted to verify the authenticity of the selected SPIs used for the experiment. The author gathered additional expert opinions from at least 5 professional seafarers who work on board vessels through social media. The 5 seafarers worked as bridge deck officers during the time of the survey. Moreover, an online survey platform was utilized to gauge the weight of each SPI and sub-indicators that was used for pairwise comparison in the analysis (Table 1).

Table 1

The standardized weighting percentage of each safety performance indicator and sub-indicator using the pairwise comparison technique

Description	Weight
SPI	
Communication	0.20
Navigational effectiveness	0.71

Navigational incidents	0.09
SI01- SI03	
Closed-loop communication	0.12
Master/Crew-Pilot exchange	0.20
Common language communication	0.68
SI04- SI06	
Perform visual lookouts	0.27
Travel at safe speed	0.64
Safe rate of turn	0.09
SI07- SI09	
Instance vessel thread too close to object	0.12
Vessel go off track from course	0.27
Near collision and grounding	0.61

Organizing the Literature Review

Due to the broadness of the topic of maritime shipping and the factors that influence maritime safety, this thesis recognized the fact that literatures often overlaps with other topics, which may not be relevant for this research. Hence, literature review for this study was conducted in a systematic way wherein the author used coding and Microsoft Excel to organize the literatures according to their focus as shown in Table 2. This ensured a thorough review of the articles and the topic in focus.

Table 2

Table illustrates how the literature review was conducted and organized

Code	Title	Author(s)	Year	Maritime Safety	National Culture	Safety Culture	Human Factors	Communication	Teamwork	Team Performance	SA	Navigation	Pilotage	SPI/ SP
NC1	The impact of ship crew on maritime safety	Berg, N. Storgård, J & Lappalainen, J.	2013		X		X	X	X					
NC2	Can Cultural differences lead to accident? Team Cultural differences and sociotechnical operations	Strauch, B.	2010		X		X	X	X	X			X	X
NC3	Culture in maritime safety	Håvold, J. I.	2000	X	X	X	X							
NC4	INTERMAR: a course module for raising cultural awareness in maritime context	Lungu, D.; Cizer, L.	2013		X				X					
NC5	From safety culture to safety orientation: Validation and simplification of a safety orientation scale using a sample of seafarers working for Norwegian ship owners	Håvold, J.I. ; Nesset, E.	2009	X	X	X		X						
NC6	Human factors and national culture	Helmreich, R.L.; Merritt, A.C.; Sherman, P.J.	1996	X	X	X	X	X	X	X	X			
NC7	The role of national culture in determining safety performance: challenges for the global oil and gas industry	Mearns, K.; Yule, S.	2008	X	X	X				X				X
NC8	Safety culture in a Norwegian shipping company	Håvold, J. I.	2005	X	X	X								
NC9	Safety culture and safety management aboard tankers	Håvold, J. I.	2010	X	X	X								
NC10	The effect of safety climate on seafarers' safety behaviors in container shipping	Lu, C. -S. ; Tsai, C. -L.	2010	X	X	X								
NC11	National Cultures and safety orientation: A study of seafarers working for Norwegian shipping companies.	Håvold, J. I.	2007	X	X	X								
P1	Reporting and statistics of pilotage incidents within the Swedish maritime administration	Johansson, L. & Solver, A.	2014				X					X	X	
NAV1	Assessment of Maneuvering Performance of Large Tankers in Restricted Waterways: A real- time Simulation Approach	Sarioz, K & Narli, E.	2002	X								X		
NC12	Multicultural crews and the culture of globalization	Benton, G.	2005	X	X	X	X		X					X
C1	Assessing navigational teamwork through the situational correctness and relevance of communication	Øvergård, K.I.; Nielsen, A.; Nazir, S.; Sorensen, L.	2015	X				X	X		X	X		
MS5	Managing cultural diversity	Chirea-Ungureanu, C.; Georgescu, M.	2009	X	X		X	X	X					
MS1	Scenarios for the development of maritime safety and security in the Baltic sea region	EU Strategy for the Baltic Sea Region (EUSBSR)	NA	X			X					X	X	
MS2	Human Factors and Safety Culture in Maritime Safety	Berg, H.P.	2013	X			X							
MS3	Safety in shipping: The Human element	Hetherington et al	2006		X		X	X	X					
MS4	Accidents, safety and crew interaction in the maritime domain	Pyne, R.; Koester, T.	2005	X	X		X	X	X					
MS6	Human Factors and Maritime Safety	Chauvin, C.	2011	X			X							X

Aim of the Study

A comparative study was conducted using simulation experiment under which a marine pilot was introduced to the bridge crew. The bridge team - which comprise of the bridge crew and the pilot, performed a series of navigation maneuver along a pre-determined passage plan. During the course of the experiment, abnormal situations were introduced to the team. The goal was to identify if there was a significant difference in safety performance by comparing two team compositions, homogeneous team against heterogeneous team. The study seeks to investigate whether the nationality of the pilot impacts the overall safety performance of the team, and if so, which factors contributed to it.

The primary aim of the present study was to address the research question. However, the study also proposed a safety assessment framework that can be used to measure safety performance of teams operating under pilotage or similar scenarios.

Relevance of the Study

The literature review indicated that there has been little research done or a gap in knowledge is evident regarding the impact of national culture on team performance of bridge team in specific maritime operations such as pilotage. For example, the common and accepted methods of safety assessment regarding non-technical skills in the maritime industry have been mostly based on data derived from questionnaires, surveys and feedbacks as well as lagging safety performance indicators. The present study recognized the fact that there is nothing wrong with such methods, however, there is room for improvement. One area where improvement is needed is the use of proactive safety performance indicators and measuring them in an objective approach. This study may further contribute on the understanding and development of the importance of non-technical skills in relation to maritime safety within a dynamic and complex sociotechnical system in high-risk maritime operations. In addition, the proposed Safety Assessment Framework would provide additional insights on how to evaluate team safety performance. The author argued that this study will help shed more insight on the importance of considering national culture when designing and conducting simulation experiments for training and evaluation of future seafarers and as a consequence, may potentially increase overall safety performance of multicultural teams on board vessels.

Another relevance of this study is in the field of academia and knowledge sharing, particularly in the subject of training and assessment using simulators. The goal is to publish and share the outcome of the study to a selected peer-reviewed journal.

Therefore, the research question to be satisfied by this study is, "How does the nationality of a pilot affect safety performance of the bridge crew during pilotage operations?"

Hypothesis

The research aim to provide answers to the hypothesis:

H1: Homogeneous bridge team performs better than heterogeneous bridge team.

Methodology

Research Design

The study involved four phases. One graduate student from the Maritime Master program in Maritime Management from HSN took the primary responsibility of the study and the execution of all the activities as shown in *Figure 5*.

A literature review of existing studies about the chosen topic, the definition of the problem and the formulation of the research question was performed during the first phase. The second phase constituted the largest part of the study where the planning and formulation of the safety assessment framework, the preparation of the pre questionnaire (see Appendix C) and post questionnaire (see Appendix D), the recruitment process as well as the design, set-up and pilot testing of the simulator were all performed simultaneously. The third phase involved implementation of the simulation experiment and collection of data. Analysis and documentation were performed in phase four.

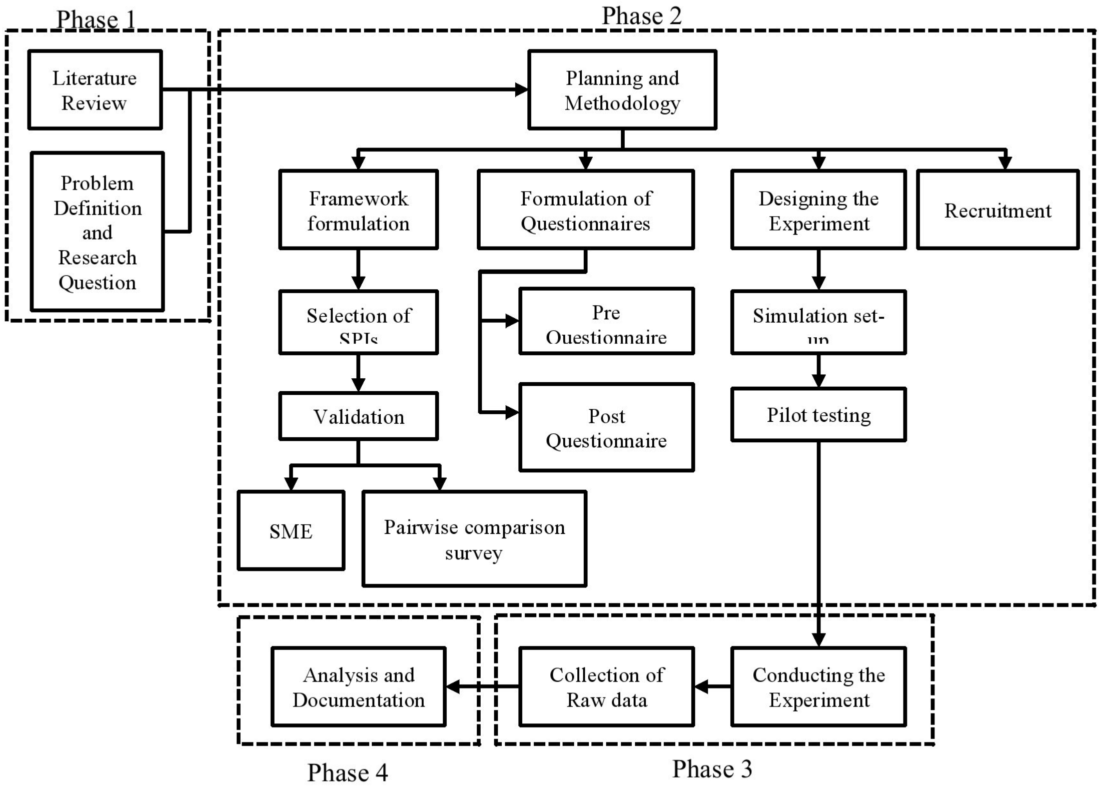

Figure 5. An illustration showing the four phases of the research design as well as the components within each phase.

The present study employed a simulation experiment aimed to compare safety performance scores of two teams with different nationality compositions- a homogeneous team against a heterogeneous team. The two teams were only allowed once to perform the same simulation experiment scenario with the same sets of laboratory conditions.

The study deployed different tools in order to collect, record, transcribe, code and compute the data. Microsoft Excel was utilized for the preparation of data. After the preparation of data, the analysis consisted of 3 steps as shown in Table 3 and utilized different statistical tools in SPSSv.23®. Following the violations of the parametric assumptions, the use of Mann- Whitney U test had to be considered instead of inferential statistics, as the criteria for Mann- Whitney U test was satisfied, in order to test the hypothesis.

Table 3

List of steps performed for data analysis

Steps	Description	Method/ tool
1	Check for non-correlation of variables	Pearson product- moment correlation
2	Test for assumptions of parametric inferential statistics	Normality test Levene's test for homoscedasticity Randomize sampling
3	Test the hypothesis	Mann-Whitney U test

Variables

Independent variable. For the purpose of the experiment, the term *nationality* pertained to where the participants came from and was limited to two separate categories, Norwegian and Foreign. The nationality availability and diversity factor of the sample was taken into consideration with regards to the decision of the number of nationality compositions. In order to identify which of the two categories each participant belonged to, demographic questions regarding nationality were incorporated into the pre questionnaire (see Appendix C). Participants were asked whether they hold a Norwegian passport or not. In addition, they were also asked whether they have spent a majority of their lives in Norway. Participants who answered *yes* to both of these questions were therefore classified as Norwegian while the rest were classified as Foreign. The homogeneous and heterogeneous teams were then formed after the participants were identified according to which nationality they belonged to.

Dependent variable. The 4 main dependent variables identified in this research are the, 1) safety performance, 2) communication, 3) navigation effectiveness and 4) navigational incidents.

Confounding variable. The confounding variables such as the type of the vessel used, the location of the passage route, the marine traffic in the area as well as the weather conditions (draft, current and visibility) were controlled during the design phase of the simulation experiment in order to have the least minimal influence to the dependent variables. Additional confounding variables are mentioned in the limitation section of the thesis.

Sample

Participants. In total, there were 36 students (80.6% male) who volunteered to participate in the simulation experiment with 69.4% at the age range of 18-24 years old (Table 4). All the participants for the experiment were students from the University College of Southeast Norway (HSN). First and second year nautical bachelor students were recruited to fill in the roles of the bridge crew. On the other hand, master students from the international program who specialized in maritime studies assumed the pilot roles. The difference of the class schedules between the bachelor and master students minimized the social interaction among the participants, which was crucial for the experiment.

Table 4

The age range of the participants

Age Range	Frequency	Percent	Valid Percent	Cumulative Percent
18-24	25	69.4	69.4	69.4
25-31	9	25.0	25.0	94.4
39 +	2	5.6	5.6	100.0
Total	36	100.0	100.0	

Firstly, the reason behind the difference of the sample pool source was to simulate a real pilotage operation scenario as much as possible. In most real case scenarios, team members of a real bridge crew are already familiar or have known each other and more likely have been working together for some time. On the contrary, pilots hop on board from one vessel to the other. This limits the time to develop mutual trust and respect between the pilot and the bridge crew. Secondly, all the participants were familiar with navigation operation either from maritime simulators from nautical subjects or experience on board vessels. This was done to minimize the discrepancies between the two sample sources.

Recruitment process. The main criterion that was used in the recruitment of the participants for the simulation experiment was that all the participants were HSN students who belonged in the maritime and nautical departments. The participants were contacted through the assistance of the HSN navigation department wherein the information regarding the experiment was sent through the school's student online information board (Fronter®). In addition, the students were also contacted between their class breaks. An overview of the study and experiment were presented along with important information such as the main purpose of the study, experimental set-up, time and date of experiment as well as the expected duration of the experiment. The willing students signed themselves voluntarily on a registration list with pre-determined experiment schedules. They were given the freedom to choose the appropriate time and which team to join.

Ethical consideration. Prior to the commencement of data gathering and simulation experiment, an application was submitted and accepted by the Norwegian Social Science Data Service (NSD) for data protection compliance (see Appendix A). During the experiment phase of the research, an information consent form detailing participants' rights as well as the purpose of the data to be collected were handed out to all the participants beforehand.

Moreover, a verbal consent was required from the participants regarding the use of video and audio recording during the experiment.

Simulator Set-up

A desktop Polaris Ship's Bridge Simulator (Version 7.2.0) from Kongsberg Maritime was used for the experiment (*Figure 6*). It provided a virtual view of the environment or scenario from the bridge deck of a vessel. The Polaris simulator was also equipped with features that displayed most of the important equipment that were present in an actual ship bridge. The simulator also featured programs necessary for data collection and analysis such as parameter log and SEA system, respectively. The parameter log recorded parametric data from the experiment (i.e. time-lapse, course, heading, depth, distance, rate of turn). On the other hand, the SEA system is an assessment tool for navigation instructors that give a score based on different navigation variables plugged into the simulation setup. Two separate screens were used for the experiment. One screen was equipped with a 120-degree forward view and RADAR while another one displayed the conning as well as vessel speed, rudder angle, bearing and course. A steering wheel and throttle control was also installed for the helmsman. A navigational paper chart with the passage plan was provided for the navigator.

The ship model used for the experiment was a product tanker with the length overall (LOA) of 141.5 meters x breadth of 23 meters and a draft of 9 meters. It had a fixed pitch propulsion system with a top speed of 13.4 knots (kn). The size and the response time of such vessel presented a challenge for the bridge team to perform a safe maneuver especially along narrow and shallow passageways with heavy marine traffic. The reason behind the vessel choice was based from the Norwegian maritime traffic regulations in compulsory pilotage waters stating that all vessels with 70m meters in length and above are subject to compulsory pilotage. In addition, stricter rules apply to vessels that carry dangerous and hazardous cargo such as crude oil, petroleum and other chemicals, according to the statutory regulation laid out by the Ministry of Transport and Communications on September 23, 2015 (Kystverket, 2015).

Experimental Set-up and Navigational Tasks

In accordance to the definition of a team by Salas et al. (1992), the simulation experiment was designed to engage interdependency of the whole team to complete the navigational task. *Figure 6* shows the laboratory set- up of the simulation experiment conducted in the Training and Assessment Research Group (TARG) laboratory in HSN. There were three cubicles, which represented the three working stations of the bridge crew of a vessel. There were two video and audio recorders strategically positioned to record the conversations and the interactions among the participants (cam 1) as well as the panoramic bridge view of the master's station (cam 2). The cubicles are divided with foam boards and a big box that acts as barriers to restrict the bridge crew from looking at each other's workstations. The pilot was positioned behind the bridge crew and in between the master and helmsman (*Figure 7*).

The main task of the bridge team was to safely perform a complete voyage according to the passage plans charted on the navigational maps of the navigator and the pilot. Two experienced navigation instructors from HSN were consulted beforehand regarding the formulation of the passage route. The passage route included the Drøbak-Spro area of the Oslo fjords of Norway. According to the Norwegian maritime traffic regulations (Kystverket, 2015), this is a compulsory pilotage area and contains narrow navigation sections (*Figure 8*). The passage route comprised of 6 legs with varying distances and difficulties. In total, the passage route was approximately 5.19 nautical miles (nm) from start to finish (Table 5).

The navigational scenario of the experiment included two abnormal situations intended to create challenges for the bridge team. These abnormal scenarios were; 1) RADAR signal jamming ten minutes after the start of the navigation, and 2) a wrecked sailboat not visible on the screen of the master as well as not indicated on the navigator's chart. The team was intentionally not briefed regarding the first abnormal scenario. On the contrary, only the pilot was briefed about the second abnormal scenario.

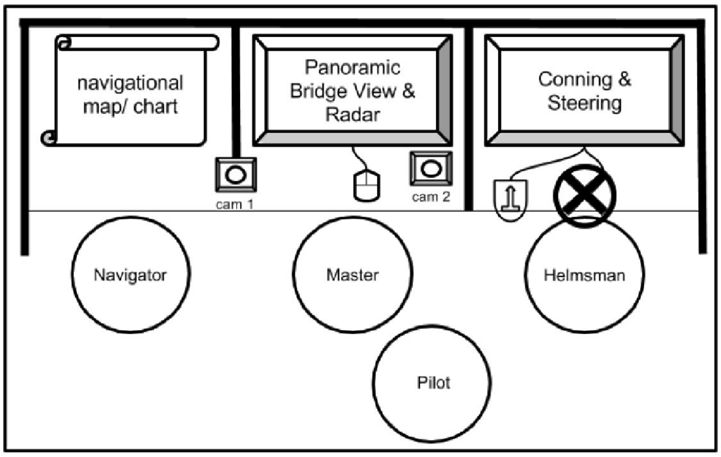

Figure 6. Details of the simulation experimental laboratory set-up conducted in the TARG laboratory in HSN.

Figure 7. Different teams performing the experiment. The master is seated between the navigator (on the left) and helmsman (on the right). The pilot is seated behind the master and helmsman.

Figure 8. Areal image of the passage route and location used in the simulation experiment. The start and finish of the route and the number of legs are indicated on the map. The map was adapted from Google earth®.

Table 5

The table shows the total number of legs, the start point and end point of and length of each leg. The total distance of the passage route is also shown

Leg	Start Point (Latitude & Longitude)	End Point (Latitude & Longitude)	Distance (Nautical miles)
1	N59°39.300 E10º37.187	N59º40.630 E10º36.888	1.34 nm
2	N59º40.630 E10º36.888	N59º41.435 E10º35.994	0.93 nm
3	N59º41.435 E10º35.994	N59º42.637 E10º35.711	1.18 nm
4	N59º42.637 E10º35.711	N59º43.066 E10º34.882	0.67 nm
5	N59º43.066 E10º34.882	N59º43.461 E10º34.787	0.69 nm
6	N59º43.461 E10º34.787	N59º43.791 E10º35.141	0.38 nm
Total			5.19 nm

Team and Team Compositions

In total, 9 teams were formed from the 36 students who volunteered for the experiment. The participant selection was done through random sampling. The teams were grouped into two- homogeneous and heterogeneous. There were 5 homogeneous teams (Table 6) and 4 heterogeneous teams (Table 7).

Table 6

Team composition of the homogeneous teams

Team	Participants		Gender	
	Bridge Crew	Pilot	Male	Female
1	Norwegian	Norwegian	3	1
2	Norwegian	Norwegian	1	3
5	Norwegian	Norwegian	4	
6	Norwegian	Norwegian	3	1
8	Norwegian	Norwegian	4	

Table 7

Team composition of the heterogeneous teams

Team	Participants		Gender	
	Bridge Crew	Pilot	Male	Female
3	Norwegian	Foreign	2	2
4	Norwegian	Foreign	4	
7	Norwegian	Foreign	4	
9	Norwegian	Foreign	4	

Participant Roles

Master. The master’s overall responsibility was to take command of the vessel at all times during the passage navigation. She/ he was responsible for the safety of both the vessel and the rest of the bridge team, guiding the vessel to its intended destination. The master had access to a monitor screen with a 120-degree panoramic forward view of the external environment of the vessel and a RADAR monitoring system (*Figure 9*). The master had the lead role in decision- making based on the information provided by the navigator, helmsman and the pilot.

Figure 9. Workstation of the Master equiped with a RADAR, visual lookout, a keyboard and a mouse.

Navigator. The navigator's main responsibility was to monitor and share information regarding the movement of the vessel along the intended route. She/ he was equipped with a paper navigational chart (*Figure 10*) and was only allowed to communicate verbally with the other team members.

Figure 10. Workstation of the Navigator equipped with a paper chart, passage plan, ruler, triangle and protractor.

Helmsman. The responsibility of the helmsman was to steer the vessel based on the instructions from the master or from the pilot, if deemed necessary. The helmsman had the responsibility to communicate and share information to the master regarding the maneuvering of the vessel. She/ he was equipped with a steering wheel, a speed throttle as well as a screen, which displayed information about conning, speed, rudder angle, course, bearing and heading (*Figure 11*).

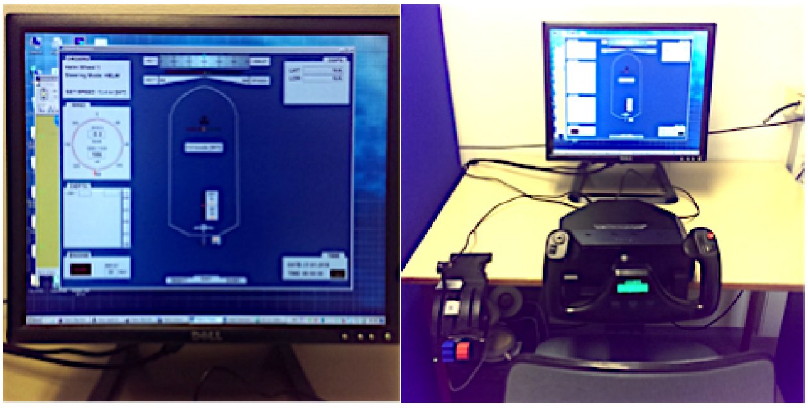

Figure 11. Workstation of the Helmsman equipped with conning display, a steering wheel and speed throttle.

Pilot. The pilot's primary task for the experiment was an advisory role for the master. She/he was stationed behind the master, navigator and helmsman. This allowed the pilot to have a visual access to the information from the bridge crew workstations. The pilot was equipped with his own passage chart/ map of the voyage (*Figure 12*). The pilot chart contained more details such as navigational objects, lighthouse and buoy positions as well as a wrecked ship that was not present on the navigational chart of the navigator and was not visible on RADAR. However, the pilot was not allowed to show the pilot passage chart to the rest of the bridge team.

Figure 12. Workplace of the Pilot equipped only with a passage plan.

HTA and Task Decomposition

The navigational scenario was described through a Hierarchical Task Analysis (HTA). The method involved defining the navigational scenario in detail by decomposing the task into hierarchical goals, sub-goals and operations (Anett, 2005). For this specific scenario, it involved decomposition of each individual team member's tasks. The HTA for the Master (*Figure 13*), Helmsman (*Figure 14*) and Navigator (*Figure 15*) were constructed based upon a study done by a master student (Nielsen, 2015). On the other hand, a semi-formal interview with an experienced Oslo-based Norwegian pilot was conducted for the construct of the HTA for the pilot (*Figure 16*).

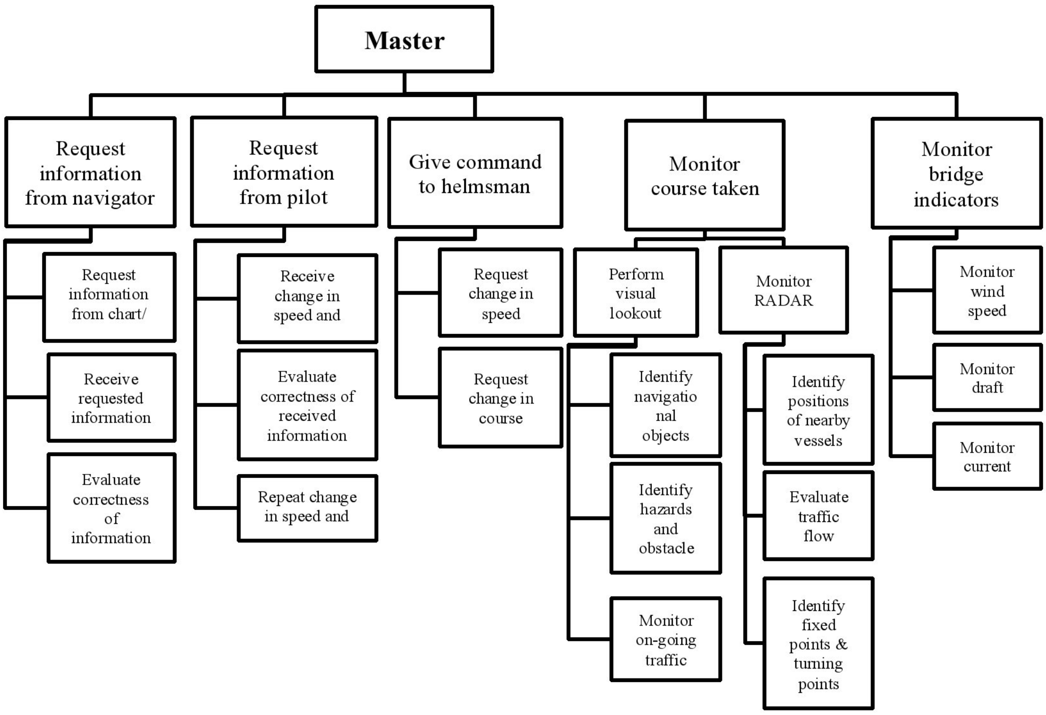

Figure 13. HTA for the Master.

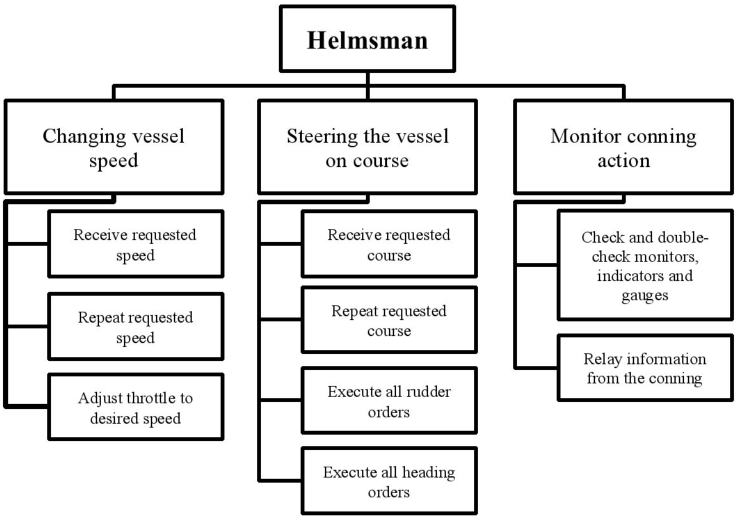

Figure 14. HTA for the Helmsman.

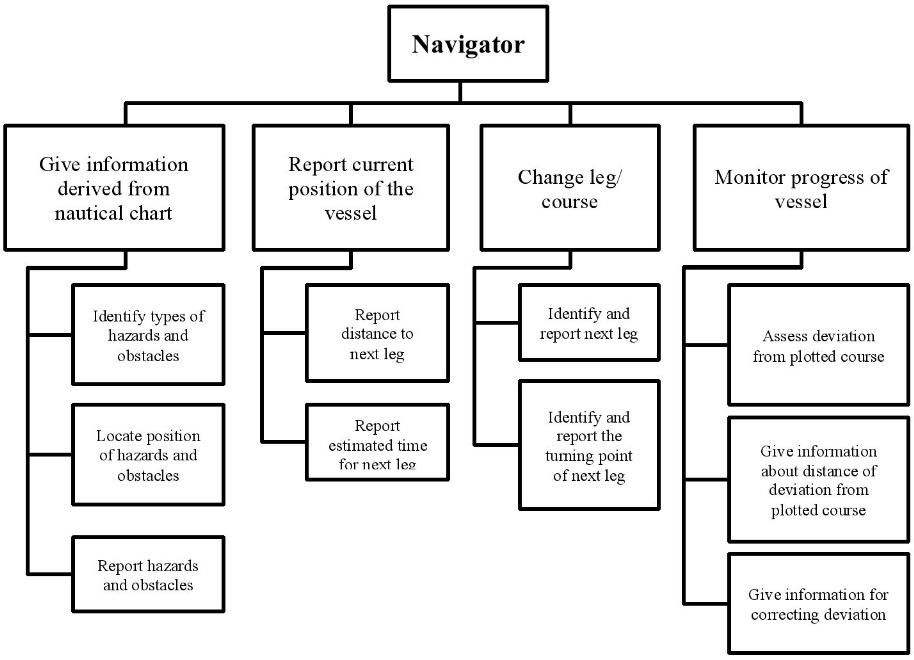

Figure 15. HTA for the Navigator.

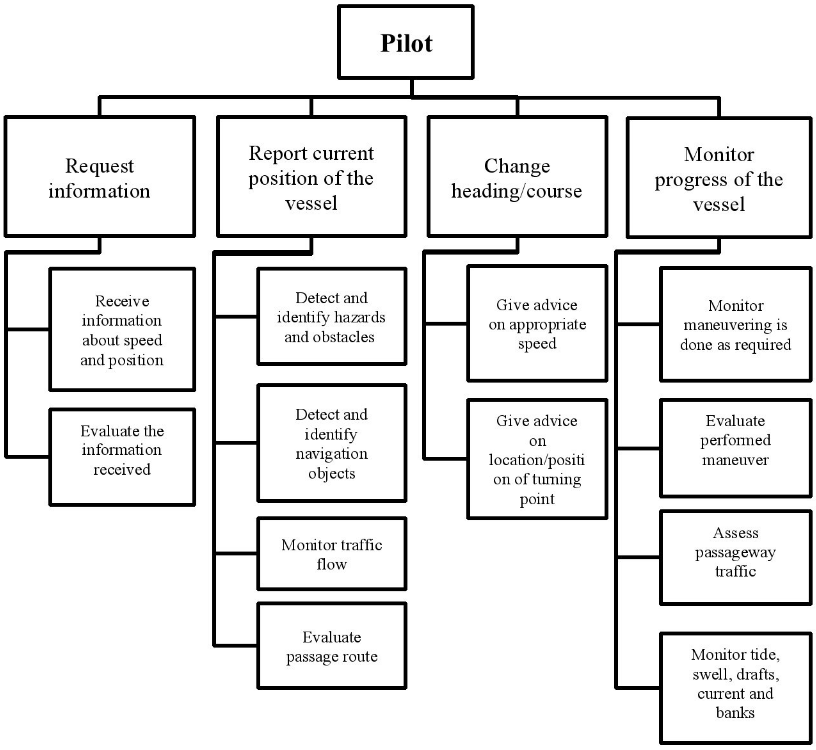

Figure 16. HTA for the Pilot.

Briefing and Debriefing

The participants were briefed for a few minutes outside of the simulation laboratory prior to the start of the simulation experiment. They were welcomed by the author and informed about the purpose of the experiment. Once seated inside the simulator room, the participants were asked to answer a set of pre questionnaires. Information regarding the rules of the experiment as well as the respective roles and expected tasks of each participants were then given. They were also briefed regarding the navigation conditions of the simulation, the pilotage location as well as the vessel's maximum speed (13.4 knots). The participants who acted as the bridge crew were given a few minutes to discuss how they would perform the task as a team. Meanwhile, the author briefed the participant assuming the pilot role regarding the abnormal situations of the experiment outside the simulator room. The experiment proper begun once the briefing was done.

Right after the end of the experiment, the participants were asked to answer a set of post questionnaire. They were informed about the true nature of the study as well as what were the hypotheses of the research. An explanation was given to the participants regarding the intentions behind the abnormal situations during the experiment and the reasons behind the design of experiment. Lastly, the participants were informed of the expected completion date of the research.

Data Collection

The collection of data for the entire study was done through different methods. The demographics of the participants were collected through the pre questionnaires. The Kongsberg Polaris simulator exercise assessment (SEA) system was used to collect measurements for the sub-indicators 5 to 9 (SI05- SI09) while Noldus© was utilized to record the experiment. The measurements for sub-indicators 1- 4 (SI01- SI04) were later derived from the audio and video recordings collected from Noldus©.

Pre and post questionnaires. The pre questionnaire was composed of 10 questions regarding the participants' general understanding and perception of safety, communication, national culture and teamwork. A 7 range Likert scale (0= not sure, 7 strongly agree) was used. The questionnaire also included 8 demographic questions about the participants' gender, age, occupation and nationality.

On the other hand, the post questionnaire was designed as user experience based aimed to measure their opinions regarding the experiment they just participated. It composed of 3 main categories present in the experiment- communication, adherence to command/advise and teamwork. A 7-range Likert scale was also used.

Polaris SEA system. The SEA (simulator exercise assessment) system is intended for maritime training in simulators as stated in the IMO STCW convention, revision in 1995. The system that presently is implemented in the Polaris simulators covers two levels- distinguished as basic and advance, which can be chosen by the instructor. For the purpose of this experiment, the author used the basic option.

The SEA system provided various navigation assessment parameters and criterions, which can be set-up and plugged-in prior to the experiment (Table 8). The assessment implies measuring the team's achieved values on chosen assessment parameters and comparing them with pre-set criterions. Additional features of SEA system include control modes, score normalization, criterion of the parameters relating to the penalty points as well as weight factors on penalty points.

Table 8

An example of the pre-set criterion feature of the SEA system assessment that measure the parameter (rate of turn)

Variable/ Parameter	Use if	Unit	Criterium	Minimum	Maximum	Weight factor
rate of turn	distance to P10 & speed segment 1	deg/min	inside limits	0.0	65.0	3.0

rate of turn	distance to P11 & speed segment 2	deg/min	inside limits	0.0	65.0	3.0
rate of turn	distance to P12 & speed segment 3	deg/min	inside limits	0.0	65.0	3.0
rate of turn	distance to P13 & speed segment 4	deg/min	inside limits	0.0	65.0	3.0
rate of turn	distance to P14 & speed segment 5	deg/min	inside limits	0.0	65.0	3.0
rate of turn	distance to P10 & speed segment 1	deg/min	inside limits	65.1	75.0	6.0
rate of turn	distance to P11 & speed segment 2	deg/min	inside limits	65.1	75.0	6.0
rate of turn	distance to P12 & speed segment 3	deg/min	inside limits	65.1	75.0	6.0
rate of turn	distance to P13 & speed segment 4	deg/min	inside limits	65.1	75.0	6.0
rate of turn	distance to P14 & speed segment 5	deg/min	inside limits	65.1	75.0	6.0
rate of turn	distance to P10 & speed segment 1	deg/min	inside limits	75.1	85.0	9.0
rate of turn	distance to P11 & speed segment 2	deg/min	inside limits	75.1	85.0	9.0
rate of turn	distance to P12 & speed segment 3	deg/min	inside limits	75.1	85.0	9.0
rate of turn	distance to P13 & speed segment 4	deg/min	inside limits	75.1	85.0	9.0
rate of turn	distance to P14 & speed segment 5	deg/min	inside limits	75.1	85.0	9.0

Noldus©. The purpose of the use of the Noldus© equipment for the study was to provide audio and video recording of the teams performing the simulation experiment. Two video cameras with built-in audio recorder were strategically placed at the simulation cubicles (*Figure 6*). Camera 1 was placed in an elevated position to capture the communication between the master, helmsman and the pilot. Camera 2 was placed facing the monitor screen of the master to record the number of visual lookouts the team performed during the navigation experiment. The number of lookouts was sub-indicator 4 (SI04) as shown in the Safety Assessment Framework.

Transcription

Transcription of communication among the team members was conducted in order to measure the scores for sub-safety performance indicators 1 to 3 (SI01-SI03). SI01 to SI03 were measurements for closed-loop communication, master/crew-pilot exchange and the use of common language by which the SEA system is not capable of measuring. All the transcription was derived from the video and audio recording from Noldus©. Due to time constraints, only a portion of the recording, where the first abnormal situation occurred, was transcribed. The duration of the clipped portion was 7 minutes and 5 seconds. The clipping process of the audio and video recordings was professionally done to ensure synchronization and accuracy. The purpose of the transcription was to measure the communication exchanges among the team members. However, the importance on the correctness and relevance of communication was not the priority. Despite that, the author took into account the relevance of communication to determine whether the conversation was related to the navigational task of the team. This is in accordance with a study conducted by Øvergård et al. (2015).

Results

Preparation of Data

After conducting the simulation experiment, collection of the raw data as well as the preparation of the data set for analysis was performed in Microsoft Excel™. Raw scores for each of the parameters were extracted and calculated according to each specific criterion. Table 9 shows the raw scores for each team. This section follows the Safety Assessment Framework construct in *Figure 2* and served as a proof of concept.

Table 9

The table shows the raw scores of the teams for each empirical parameter

Code	Team 1	Team 2	Team 3	Team 4	Team 5	Team 6	Team 7	Team 8	Team 9
P09	90	85	200	110	190	70	240	170	255
P08	14	23	19	6	16	18	19	20	15
P07	63	45	72	99	63	30	12	60	36
P06	20	35	32	16	25	38	53	30	41
P05	13	19	16	68	8	22	26	14	23
P04	0	10	110	160	100	80	10	50	0
P03	125	120	120	90	55	130	130	50	-5
P02	145	60	15	65	130	50	115	150	55
P01	95	130	105	75	55	100	120	25	100

Note. P01- P09 represents the parameters mentioned in *Figure 2*.

As already discussed, the parameter scores were derived from using different methods. The standardized scores (z) were calculated using $z = x - \mu / \delta$, to accurately compare each scores (Table 10).

Table 10

The table shows the standard scores of the teams on each of the parameters. The mean and standard deviation of the parameters are derived from the data sets in Table 9

Code	μ	δ	Team1	Team 2	Team 3	Team 4	Team 5	Team 6	Team 7	Team 8	Team 9
P09	156.67	69.87	-0.95	-1.03	0.62	-0.67	0.48	-1.24	1.19	0.19	1.41
P08	16.67	4.85	-0.55	1.31	0.48	-2.20	-0.14	0.28	0.48	0.69	-0.34
P07	53.33	25.71	0.38	-0.32	0.73	1.78	0.38	-0.91	-1.61	0.26	-0.67
P06	32.22	11.29	-1.08	0.25	-0.02	-1.44	-0.64	0.51	1.84	-0.20	0.78
P05	23.22	17.70	-0.58	-0.24	-0.41	2.53	-0.86	-0.07	0.16	-0.52	-0.01
P04	57.78	57.83	-1.00	-0.83	0.90	1.77	0.73	0.39	-0.83	-0.13	-1.00
P03	90.56	47.53	0.73	0.62	0.62	-0.01	-0.75	0.83	0.83	-0.85	-2.01
P02	87.22	48.42	1.19	-0.56	-1.49	-0.46	0.88	-0.77	0.57	1.30	-0.67
P01	89.44	32.83	0.17	1.24	0.47	-0.44	-1.05	0.32	0.93	-1.96	0.32

Note. μ = Mean, δ = standard deviation

In accordance with the safety performance framework used for this study in Level 1, the standardized scores of the sub- safety performance indicators for each team were multiplied by the pre- determined weight (Table 11).

Table 11

The table shows the product z- scores of the teams calculated by multiplying the normalized scores in Table 10 the weight of each sub-indicator (see Table 1)

Code	Weight	Team 1	Team 2	Team 3	Team 4	Team 5	Team 6	Team 7	Team 8	Team 9
SI09	0.61	-0.58	-0.62	0.38	-0.41	0.29	-0.75	0.35	0.12	0.86
SI08	0.27	-0.15	0.36	0.13	-0.60	-0.04	0.08	0.13	0.19	-0.09
SI07	0.12	0.05	-0.04	0.09	0.21	0.05	-0.11	-0.20	0.03	-0.08
SI06	0.09	-0.10	0.02	-0.00	-0.13	-0.06	0.05	0.16	-0.02	0.07
SI05	0.64	-0.37	-0.15	-0.26	1.62	-0.55	-0.04	0.10	-0.33	-0.01

SI04	0.27	-0.27	-0.23	0.25	0.48	0.20	0.11	-0.23	-0.04	-0.27
SI03	0.68	0.49	0.42	0.42	-0.01	-0.51	0.57	0.57	-0.58	-1.37
SI02	0.20	0.24	-0.11	-0.30	-0.09	0.18	-0.16	0.12	0.26	-0.13
SI01	0.12	0.02	0.15	0.06	-0.05	-0.12	0.04	0.11	-0.23	0.04

Note. SI01- SI09 = P01- P09

The scores of the SPIs were achieved by performing 2 steps (Table 12). To illustrate, the scores of SI01- SI03 from Table 11 was summed up as the first step to calculate the score for communication. For the second step, the summed score was multiplied by the weight that was pre-determined (*0.20)*. The product is the assigned score for communication. Lastly, the sum of the 3 SPIs constituted the overall safety performance score of the team.

Table 12

The table shows the product of the sum of the sub-indicators grouped according to its SPI multiplied by the determined weight of each SPI (see Table 1)

Weight	SPI	Team 1	Team 2	Team 3	Team 4	Team 5	Team 6	Team 7	Team 8	Team 9
0.09	Navigational incidents	-0.06	-0.03	0.06	-0.07	0.03	-0.07	0.06	0.03	0.06
0.71	Navigational effectiveness	-0.14	0.24	0.15	-0.36	-0.04	0.01	0.07	0.14	-0.07
0.20	Communication	-0.08	-0.03	-0.04	0.34	-0.11	-0.02	0.01	-0.06	-0.00
Overall safety performance score		-0.29	0.18	0.17	-0.09	-0.12	-0.09	0.15	0.11	-0.02

Inter-Rater Reliability

Inter-rater reliability tests were performed to determine the reliability of the coding from the transcription that contained the communications among team members during the experiment. This was necessary to ensure the consistency and trueness of the scoring for sub-indicators for communication (SI01- SI04). Two coders, including the author, performed an independent evaluation on a dataset. The communications were evaluated and rated according to the number of visual lookouts performed, closed-loop communication performed, master/ crew-pilot exchange and common language in the bridge. As for the number of lookouts performed, the agreement between the coders was 76.9% (Table 13), which was interpreted as substantial reliability.

Table 13

The inter-rater reliability test for the number of visual lookout performed by Team 3

Agreement percentage	Kappa	Significance of Kappa	Rho	Significance of Rho	Confidence interval low	Confidence interval high
76.92	4.81E-16	0.50	0.96	0.09	-0.99	0.99

Analysis

The analysis involved 3 steps as shown in Table 3 in the methodology section. The analysis was done in SPSS. In this section, the results of the analyses using various statistical tests were presented.

Step 1. Pearson's product moment correlation coefficient, also known as Pearson's r, was performed to check for correlation of the variables (Table 14). Testing the relationship between the variables will indicate whether they are unrelated, hence there is independence. This was necessary to prove the segregation of the variables in question from each other and satisfy that they were actually measuring different parameters. The test showed that communication and navigational effectiveness are correlating ($r = -0.67, P = 0.05$).

Table 14

Matrix of Pearson's product moment correlation

		Navigational incidents	Navigational effectiveness	Communication
Navigational incidents	Pearson's r	1.00	0.46	-0.37
	Sig. (2-tailed) (p)		0.21	0.33
Navigational effectiveness	Pearson's r	0.46	1.00	-0.67
	Sig. (2-tailed) (p)	0.21		0.05*
Communication	Pearson's r	-0.37	-0.67	1.00
	Sig. (2-tailed) (p)	0.33	0.05*	

* = Significant.

Step 2. In order to use parametric testing, the following assumptions needs to be satisfied:

1) *The population are normally distributed,*
2) *The standard deviation of the normal distributions are the same,*
3) *The data is taken from an interval or ration scale.*

Step 2a. The normal distribution of the variables was tested. As shown in Table 15, the skewness of the variables (-*0.47*) as well as the mean (-*0.0001*), median (-*0.02*) and mode (-*0.29*) showed that the variables are negatively skewed. This may either indicate a highly skewed distribution or a type II error (Doane & Seward, 2011). The histogram in *Figure 17* showed an uneven distribution along the bell curve. The analysis showed that the assumptions for normal distribution were not satisfied.

Table 15

The table shows the mean, median, mode, standard deviation, range and the skewness of the variables

Mean	-0.001*
Median	-0.02*
Mode	-0.29*
Standard Deviation	0.20
Skewness	-0.50*
Range	0.47

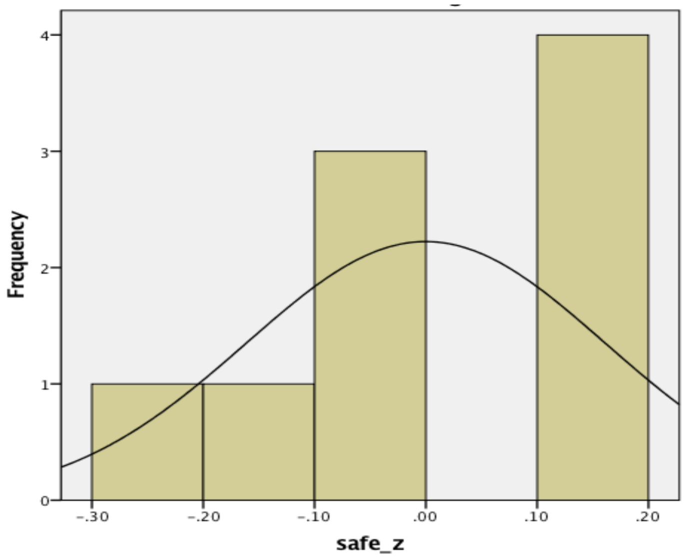

Figure 17. The distribution of the variables.

Step 2b. Levene's test was performed to test for the homoscedasticity of the variance (Table 16). According to Levene (1960), a $p < 0.05$ is an indication of a violation of the assumption. The test showed that the significance value ($p = 0.04$) for the homoscedasticity for the variable communication (Bryman & Cramer, 2011). A violation occurred, thus a non-parametric equivalent of the analysis is more suitable.

Table 16

Matrix of Levene's test of homoscedasticity of variances

Variance	Levene Statistic	df1	df2	Significance (*p*)
Navigational incidents	0.30	1	7	0.60
Navigational effectiveness	0.53	1	7	0.49
Communication	6.43	1	7	0.04*

* = Significant.

Step 2c. In light of the sampling process adopted by this present study, the sample was collected in a randomized way. In this case, there was no violation of the assumptions for parametric testing.

Based on the analysis performed, it showed that Step 2a and Step 2b proved that assumptions for parametric testing were violated and thus cannot be performed. Therefore it is statistically reasonable to conduct non- parametric testing on the hypothesis.

Step 3. The hypothesis presented for analysis was, "*homogeneous bridge teams perform better than heterogeneous bridge teams."* The non- parametric Mann- Whitney U test was performed to prove the hypothesis. It was assumed that:

1) *The observations of all the groups are independent from one another,*
2) *The responses are ordinal,*
3) *H1 is "the probability of an observation from the population X exceeding an observation from Y exceeding an observation from X: P (X>Y) ≠ P (Y>X)."* (Bryman & Cramer, 2011).

After thorough consideration of the aforementioned assumptions, it was proven that there were no violations. Thus, Mann- Whitney U test was performed (Table 17). Table 18 showed the significance of communication.

Table 17

Mann- Whitney U test was performed to test the hypothesis

Variable	Team	Mean	Standard deviation	Standard error of Mean
Navigational incidents				
	Homogeneous	-0.02	0.05	0.02
	Heterogeneous	0.03	0.07	0.03
Navigational effectiveness				
	Homogeneous	0.04	0.15	0.07
	Heterogeneous	-0.05	0.23	0.11
Communication				
	Homogeneous	-0.06*	0.04	0.07
	Heterogeneous	0.08*	0.18	0.09

* = Shows that heterogeneous teams perform better than homogeneous teams.

Table 18

Test statistics for the significance of the variable communication

	Rated quality
Mann-Whitney U	2.00
Wilcoxon W	17.00
Z	-1.96
Asymp. Sig. (2-tailed)	0.05*

* = Significant.

To summarize, the analysis indicated that there was independence among variables although communication and navigational effectiveness showed (*r = -0.67, P = 0.05*). Following the test for violations of the assumptions for parametric testing, it was proven that 2 out of 3 assumptions were violated. The normality test denoted a possible high skew distribution or type II error (*-0.50*). Levene's test ($p = 0.04$), where $p < 0.05$, indicated a violation for homoscedasticity. Thus, parametric testing was not suitable.

Mann- Whitney U test was performed to prove the hypothesis since the assumptions for non- parametric test were not violated. The Mann- Whitney U test demonstrated that heterogeneous ($\mu = 0.08$) scored higher than homogeneous ($\mu = -0.06$) for communication (*asymp significance = 0.05*). Thus, the hypothesis was rejected.

Discussion

Investigating the factors influencing team safety performance in pilotage operations is vital to maritime safety (Grech et al., 2008). One of the influencing factors is nationality composition of the bridge team. The present study examined whether the nationality of the pilot influence the team performance in the bridge. In order to achieve this, the research design employed three critical steps. The first step was to formulate and validate a safety assessment framework suited for pilotage operations. Secondly, a simulation experiment was constructed based from the proposed safety assessment framework wherein a comparative study was performed between two team compositions, heterogeneous team and homogeneous team. Thirdly, non- parametric analyses were done with the use of SPSSv.23. Finally, the study tried to recognize the relationship between nationality, communication, navigational effectiveness and navigational incidents as influencing factors to safety performance of a bridge team.

Firstly, heterogeneous teams are more likely to commit errors under abnormal situations than homogeneous teams, according to Strauch (2010). In addition, Salas et al. (1992) argued that by improving the interactions among team members, team performance could be enhanced. The hypothesis present in the present study was in line with the statement of Strauch (2010). Interesting though, the findings of the analysis contradicted the aforementioned claim. On the context that communication is an influencing factor for team performance, the results showed that heterogeneous team ($\mu = 0.08$) actually performed better than homogeneous team ($\mu = -0.06$). However, the result cannot conclusively argue that the heterogeneous team performed the navigational task safer than the homogeneous team. In addition, this study cannot for certain conclude the validity of the findings due to the limitations of the design of the study. Therefore, further research is needed in order to achieve more insight of the topic in focus.

Secondly, the finding of the present study seemed to suggest that communication and navigational effectiveness tend to correlate. The results indicated that the relationship between the two was at the borderline of the limit ($r = -0.67, P = 0.05$). This result may open different interpretations and discussions. The possible reasons for the ambiguity may be due to safety performance indicators and empirical parameters not thoroughly defined. Hetherington et al. (2006) argued that cultural issues and language definitely influence safety and that there is a need to articulate a methodology that distinctly differentiates language and nationality.

Thirdly, the proof of concept was among the main reasons why the present study was conducted. The study argued that the proposed Safety Assessment Framework provided a better approach in assessing safety performance of a team. The distinctive feature of the framework was the application of the pairwise comparison and weighting of safety performance indicators. In addition, the study provided an argument that normalization of scores from subjective and objective sources can further be developed. With respect to this, Øvergård et al. (2015) indicated that methods can be improved by refining the weighting of indicators.

Lastly, the author reasoned that the implication of the findings of the present study goes beyond this thesis. It entices motivation for the academia to perform additional research. On the other hand, this study may help promote the improvement of existing assessment methods from which the shipping industry may benefit.

Limitations

The limitations associated with the research design and methodology should be considered with regards to the findings presented in the current study.

Sample size. Based on Cohen's (1998, 1992) calculations, the sample should preferably have involved a minimum of 24 teams in order to achieve the desired result for the current study. The author managed to recruit a total of only 36 participants for the experiment. Only 9 teams with four participants in each team constituted the complete data set collected. One of the factors that contributed to the limited sample is was the design of the experiment wherein the study required a specific sample pool. In line to this, Ek et al (2003) argued that inaccessibility to sample has been an issue with such research, which explained the aforementioned limitation. However, the intention of the current study was to be a pilot study to provide a platform for further research of the topic. Another contributing factor was the time availability of the participants, planning and scheduling of the simulation, logistics and coordination of the teams. The present study argued that the most significant limitation for this study was the sample size. Thus, this particular limitation should be addressed well in advance.

Participants. The participants in the present study were first and second year bachelor students in navigation as well as master students, wherein both groups had limited seafaring experience. The participants were not as experience as the professional seafarers although the participants have undergone navigation courses through the simulation. However, it was expected that the participants possessed the necessary navigational skills to completely perform the experiment task. In addition, the freedom of the participants to choose which team they wanted to belong to may reflect characteristics of bias with regards to teamwork and team performance (Heckman, 1990). Moreover, other variables such as limited nationality diversity available, uneven gender distribution, limited age range of the participants as well as the selection of participants may have influenced the findings of the present study.

Validity. The experiment was conducted inside a laboratory emulating a vessel bridge and where a desktop simulator was used to represent the navigational equipment found in a real bridge deck of a vessel. The location and environmental condition inside the laboratory was not conducive and may have influenced the performance of the participants. In addition, the desktop simulator may not stipulate the accurate representations of a real navigation scenario. With the participants being aware that they were performing the navigation in a desktop simulator, their attitude towards danger and safety during abnormal situations may not denote in realistic scenarios (Øvergård et al., 2015). Moreover, the limited capacity of the desktop simulator resulted in low-fidelity (Lee, 2004) of the screens, restricted panoramic and RADAR view for the master as well as the slow reaction time of the vessel throttle for the helmsman. Therefore, future research should be conducted in a more advanced bridge simulator to address the aforementioned issues.

Parameters. The findings of the present study suggest that the method of identification and selection of empirical parameters for the experiment can be improved. The choice of parameters in the present study was based on the features of the desktop simulator. The use of a more advanced bridge simulator that features more parameters to choose from will address such issues for future research.

Coding. Refining the weighting scheme for the safety performance indicators as well as the coding of the communication performed among the team members can improve the reliability of the findings of the present study.

Conclusion

The findings of the present study showed that the heterogeneous team performed better than the homogeneous team. Nevertheless, this does not necessarily indicate that the heterogeneous team performed the task in a safer manner than the homogeneous team. In addition, the findings were not sufficient to conclusively determine the impact of nationality to team safety performance. However, the findings showed that communication and navigational effectiveness barely correlated each other ($p = .051$). This suggests that future research is needed to develop a method to clearly distinguish the two variables when measured.

Furthermore, the present study suggests that there is a need for further research regarding team performance in pilotage operations as well as the identification and development of well-defined safety performance indicators that can be used in real time assessment. In line with this, the present study proposes the importance to refine the Safety Assessment Framework.

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Appendix A

Norsk samfunnsvitenskapelig datatjeneste AS
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Vår dato: 01.02.2016 Vår ref: 46397 / 3 / HJP Deres dato: Deres ref:

TILBAKEMELDING PÅ MELDING OM BEHANDLING AV PERSONOPPLYSNINGER

Vi viser til melding om behandling av personopplysninger, mottatt 04.01.2016. Meldingen gjelder prosjektet:

46397	*An Assessment on the Impact of Nationality to Crew Safety Performance*
Behandlingsansvarlig	*Høgskolen i Sørøst-Norge, ved institusjonens øverste leder*
Daglig ansvarlig	*Salman Nazir*
Student	*Bret Alistair Nuico*

Personvernombudet har vurdert prosjektet og finner at behandlingen av personopplysninger er meldepliktig i henhold til personopplysningsloven § 31. Behandlingen tilfredsstiller kravene i personopplysningsloven.

Personvernombudets vurdering forutsetter at prosjektet gjennomføres i tråd med opplysningene gitt i meldeskjemaet, korrespondanse med ombudet, ombudets kommentarer samt personopplysningsloven og helseregisterloven med forskrifter. Behandlingen av personopplysninger kan settes i gang.

Det gjøres oppmerksom på at det skal gis ny melding dersom behandlingen endres i forhold til de opplysninger som ligger til grunn for personvernombudets vurdering. Endringsmeldinger gis via et eget skjema, http://www.nsd.uib.no/personvern/meldeplikt/skjema.html. Det skal også gis melding etter tre år dersom prosjektet fortsatt pågår. Meldinger skal skje skriftlig til ombudet.

Personvernombudet har lagt ut opplysninger om prosjektet i en offentlig database, http://pvo.nsd.no/prosjekt.

Personvernombudet vil ved prosjektets avslutning, 13.06.2016, rette en henvendelse angående status for behandlingen av personopplysninger.

Vennlig hilsen

Vigdis Namtvedt Kvalheim

Hanne Johansen-Pekovic

Kontaktperson: Hanne Johansen-Pekovic tlf: 55 58 31 18
Vedlegg: Prosjektvurdering

Dokumentet er elektronisk produsert og godkjent ved NSDs rutiner for elektronisk godkjenning.

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OSLO: NSD. Universitetet i Oslo, Postboks 1055 Blindern, 0316 Oslo. Tel: +47-22 85 52 11. nsd@uio.no
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Personvernombudet for forskning

Prosjektvurdering - Kommentar

Prosjektnr: 46397

INFORMASJON OG SAMTYKKE
Utvalget informeres skriftlig og muntlig om prosjektet og samtykker til deltakelse. Informasjonsskrivet er godt utformet.

Ved et muntlig samtykke må utvalget informeres om følgende for å tilfredsstille kravet om et informert samtykke etter loven:
- hvilken institusjon som er ansvarlig
- prosjektets formål / problemstilling
- hvilke metoder som skal benyttes for datainnsamling
- hvilke typer opplysninger som samles inn
- at opplysningene behandles konfidensielt og hvem som vil ha tilgang
- at det er frivillig å delta og at man kan trekke seg når som helst uten begrunnelse
- dato for forventet prosjektslutt
- at data anonymiseres ved prosjektslutt
- hvorvidt enkeltpersoner vil kunne gjenkjennes i den ferdige oppgaven
- kontaktopplysninger til forsker eller student/veileder.

INFORMASJONSSIKKERHET
Personvernombudet legger til grunn at forsker etterfølger Høgskolen i Sørøst-Norge sine rutiner for datasikkerhet. Dersom personopplysninger skal sendes elektronisk eller lagres på mobile enheter, bør opplysningene krypteres tilstrekkelig.

PROSJEKTSLUTT OG ANONYMISERING
Forventet prosjektslutt er 13.06.2016. Ifølge prosjektmeldingen skal innsamlede opplysninger da anonymiseres. Anonymisering innebærer å bearbeide datamaterialet slik at ingen enkeltpersoner kan gjenkjennes. Det gjøres ved å:
- slette direkte personopplysninger (som navn/koblingsnøkkel)
- slette/omskrive indirekte personopplysninger (identifiserende sammenstilling av bakgrunnsopplysninger som f.eks. bosted/arbeidssted, alder og kjønn)

Appendix B

Introduction
This study attempts to collect information about the relative importance of different safety performance indicators used to assess safety performance of a bridge team. The purpose of this survey is for an academic research with the goal to formulate an assessment framework with the aim of developing safety performance indicators in the shipping industry. This survey is designed to ask for expert judgements from seafarer professionals as well as bridge officers. The assessment approach uses the Analytic Hierarchy Process (AHP). We ask you, as a subject expert in navigation and ship operation, to make a pair-wise comparison of the criteria. Through further calculations, we will then obtain weightings for each criterion.

Confidentiality
All data obtained from participants will be kept confidential and will only be reported in an aggregate format (by reporting only combined results and never reporting individual ones). All questionnaires will be concealed, and no one other than then primary investigator and assistant researches listed below will have access to them. The data collected will be stored in the HIPPA-compliant, Qualtrics-secure database until it has been deleted by the primary investigator.

Participation
This will only take a few minutes of your time with only 12 questions. Participation in this research study is completely voluntary and is truly appreciated.
Important:
The Indicators are grouped together into 3 and should only be compared with the other indicators in the same group and not indicators from the other group.

Group 1 (Q1-Q3)
- communication (between members of the bridge team)
- navigational effectiveness (includes skills of the team to perform safe maneuver)
- navigational incidents (includes near misses)

Group 2: (Q4-Q6)
- closed loop communication
- master-pilot exchange
- common language communication

Group 3: (Q7-Q9)
- perform visual lookout
- travel at safe speed
- perform safe rate of turn

Group 4 (Q10-Q12)
- instances vessel thread too close to fixed objects
- vessel go off track from planned course
- near collisions

Q1.
Communication and **Navigational Effectiveness** are paired to find the relative importance of each when studying safety performance of seafarers in the bridge. **Important**: Just choose one of the two is more important for you over the other and then drag the slider of your chosen criterion to gauge the level of importance over the other. Leave the not chosen as is.

	Equal importance 1	3	Essential Importance 5	7	Absolute Importance 9	
Communication						1
Navigational Effectiveness						3

Q2. **Communication** and **Navigational Incidents** are paired to find the relative importance of each when studying safety performance of seafarers in the bridge. **Important**: Just choose one of the two is more important for you over the other and then drag the slider of your chosen criterion to gauge the level of importance over the other. Leave the not chosen as is.

	Equal importance 1	3	Essential Importance 5	7	Absolute Importance 9	
Communication						1
Navigational Incidents						3

Q3. **Navigational Effectiveness** and **Navigational Incidents** are paired to find the relative importance of each when studying safety performance of seafarers in the bridge. **Important**: Just choose one of the two is more important for you over the other and then drag the slider of your chosen criterion to gauge the level of importance over the other. Leave the not chosen as is.

	Equal importance 1	3	Essential Importance 5	7	Absolute Importance 9	
Navigational Effectiveness						1
Navigational Incidents						1

Q4. **Closed-Loop Communication** and **Master-Pilot Exchange** are paired to find the relative importance of each when studying safety performance of seafarers in the bridge. **Important**: Just choose one of the two is more important for you over the other and then drag the slider of your chosen criterion to gauge the level of importance over the other. Leave the not chosen as is.

	Equal importance 1	3	Essential Importance 5	7	Absolute Importance 9	
Closed-Loop Communication						1
Master-Pilot Exchange						2

Q5. **Closed-Loop Communication** and **Common Language Communication** are paired to find the relative importance of each when studying safety performance of seafarers in the bridge. **Important**: Just choose one of the two is more important for you over the other and then drag the slider of your chosen criterion to gauge the level of importance over the other. Leave the not chosen as is.

	importance 1	3	Importance 5	7	Importance 9	
Closed-Loop Communication						1
Common Language Communication						2

Q6. **Master-Pilot Exchange** and **Common Language Communication** are paired to find the relative importance of each when studying safety performance of seafarers in the bridge. **Important**: Just choose one of the two is more important for you over the other and then drag the slider of your chosen criterion to gauge the level of importance over the other. Leave the not chosen as is.

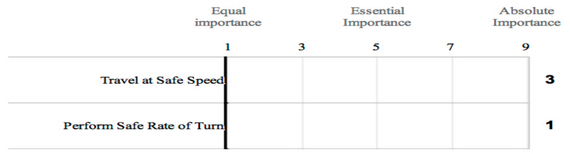
	Equal importance 1	3	Essential Importance 5	7	Absolute Importance 9	
Master-Pilot Exchange						1
Common Language Communication						3

Q7. **Perform Visual Lookout** and **Travel at Safe Speed** are paired to find the relative importance of each when studying safety performance of seafarers in the bridge. **Important**: Just choose one of the two is more important for you over the other and then drag the slider of your chosen criterion to gauge the level of importance over the other. Leave the not chosen as is.

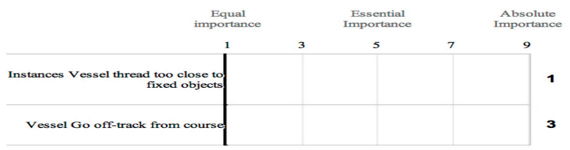
	Equal importance 1	3	Essential Importance 5	7	Absolute Importance 9	
Perform Visual Lookout						1
Travel at Safe Speed						1

Q8. **Perform Visual Lookout** and **Perform Safe Rate of Turn** are paired to find the relative importance of each when studying safety performance of seafarers in the bridge. **Important**: Just choose one of the two is more important for you over the other and then drag the slider of your chosen criterion to gauge the level of importance over the other. Leave the not chosen as is.

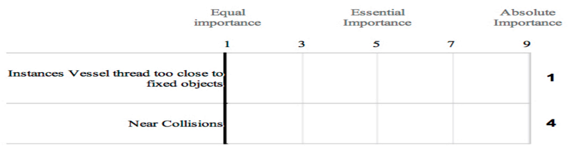
Q9. **Travel at Safe Speed** and **Perform Safe Rate of Turn** are paired to find the relative importance of each when studying safety performance of seafarers in the bridge. **Important**: Just choose one of the two is more important for you over the other and then drag the slider of your chosen criterion to gauge the level of importance over the other. Leave the not chosen as is.



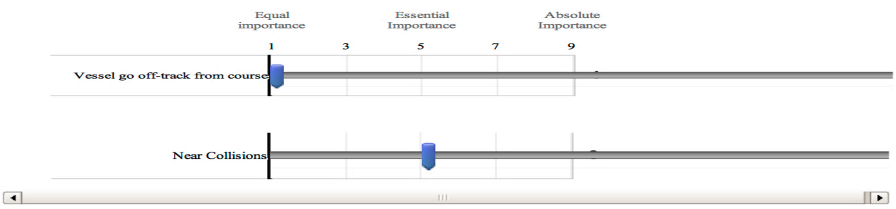
Q10. **Instances Vessel thread too close to fixed objects** and **Vessel go off-track from planned course** are paired to find the relative importance of each when studying safety performance of seafarers in the bridge. **Important**: Just choose one of the two is more important for you over the other and then drag the slider of your chosen criterion to gauge the level of importance over the other. Leave the not chosen as is.



Q11. **Instances Vessel thread too close to fixed objects** and **Near collisions** are paired to find the relative importance of each when studying safety performance of seafarers in the bridge. **Important**: Just choose one of the two is more important for you over the other and then drag the slider of your chosen criterion to gauge the level of importance over the other. Leave the not chosen as is.



Q12. **Vessel go off-track from planned course** and **Near collisions** are paired to find the relative importance of each when studying safety performance of seafarers in the bridge. **Important**: Just choose one of the two is more important for you over the other and then drag the slider of your chosen criterion to gauge the level of importance over the other. Leave the not chosen as is.



End. **Thank you for your participation**

Appendix C

Information for Participants

Title: **An Assessment on the Impact of Pilot Nationality to Crew Safety Performance**
Department of Maritime Technology, Management and Innovation, Masters Program
Type of Experiment: Desktop Bridge Simulation
Research Duration: Spring 2016

Team No: ______ Participant No: ____

Thank you very much for participating in this research study.

- The purpose of the experiment is to gather data regarding the effect of nationality to the overall safety performance of a team during pilotage of a vessel.
- Research Question: How does the nationality of a pilot affect safety performance of the bridge crew during pilotage operations?
- We would like to ask you a few questions to be analyzed using quantitative approach. The pre-questionnaire contain general questions that are **maritime** related as well as **demographics**. The post-questionnaire contain user experience questions based on the experiment conducted.
- During the course of the experiment, you have the right to withdraw at any time.
- Rest assured that your privacy is protected because your name will not appear on the questionnaires.
- Only the responsible master student and the immediate supervisors can access the information collected.
- The information collected will be disposed off in a safe and proper way after the completion of the research.
- If you have any questions, feel free to approach the researcher or e-mail at alistair.bret@yahoo.com.

Please tick the box below

☐ The objectives of this research have been clearly explained to me. I understand that my privacy is guaranteed. I have fully understood the above statements and I hereby give my consent regarding the use of the data collected.

Pre- Questionnaire

Instruction: Please **encircle** the appropriate number on the scale. Fill in the answers by putting either "**X**" or "✔" in the appropriate box or number and give information when asked to do so.

Maritime Questions:

1. Where do you scale your knowledge about the maritime industry in general?

Not Sure	Nothing At all			Neutral			Expert
0	1	2	3	4	5	6	7

2. When given a task, how many times do you think about safety while performing?

Not Sure	Not At all			Neutral			All the Time
0	1	2	3	4	5	6	7

3. Safety performance is a team effort.

Not Sure	Strongly Disagree			Neutral			Strongly Agree
0	1	2	3	4	5	6	7

4. Understanding nationality/national culture is an important factor of maritime safety.

Not Sure	Strongly Disagree			Neutral			Strongly Agree
0	1	2	3	4	5	6	7

5. Nationality of the crewmembers affects team performance in a positive way.

Not Sure	Strongly Disagree			Neutral			Strongly Agree
0	1	2	3	4	5	6	7

6. How confident do you feel of your English language skill?

Not Sure	Elementary Proficiency			Neutral			Native Proficiency
0	1	2	3	4	5	6	7

7. How well can you communicate verbally with the English language with others?

Not	Elementary			Neutral			Native

Sure	Proficiency						Proficiency
0	1	2	3	4	5	6	7

8. Numbers of years of experience working on board a ship/vessel.

   No experience ☐ 1- 3 years ☐ 4- 6 years ☐ 7- 9 years ☐ 10 years or more ☐

9. Number of times you have participated in simulator training for the year 2014-2015.

   Not participated ☐ 1- 3 times ☐ 4- 6 times ☐ 7- 9 times ☐ 10 times or more ☐

10. In average, how many times in one minute do you verbally communicate to the other members of your team?

    No communication ☐ 1- 3 times ☐ 4- 6 times ☐ 7- 9 times ☐ 10 times and above ☐

Demographic Questions:

1. What is your gender? Male ☐ Female ☐
2. Which age bracket do you fall into?

   17 y.o. and below ☐ 18-24 ☐ 25-31 ☐ 32-38 ☐ 39 y.o. and above ☐
3. What is your current occupation? ________________
4. If you are a student, please indicate the level of education you currently belong.

   ☐ Vocational/ Short course ☐ Graduate/ Master

   ☐ Undergraduate/ Bachelor ☐ PhD
5. Do you have a Norwegian passport? Yes ☐ No ☐
6. Have you spent majority of your life in Norway? Yes ☐ No ☐
7. Are you an International student of HSN? Yes ☐ No ☐
8. What is your nationality? ___________

Thank You

Appendix D

Post Questionnaire

To be filled out by the researcher
Participant No. __________
Team No. __________
Position: ☐ Navigator ☐ Master ☐ Helmsman ☐ Marine pilot

Instruction: Mark the box with an "**X**" that best characterizes how you feel about the statement.

1. How much do you agree regarding communication within the team during the experiment?

	Not Sure	Strongly Disagree			Neutral			Strongly Agree
Closed loop communication was always present in the bridge	☐	☐	☐	☐	☐	☐	☐	☐
I communicated openly to my team	☐	☐	☐	☐	☐	☐	☐	☐
Team talks at a speed which enables everyone to understand what they are saying	☐	☐	☐	☐	☐	☐	☐	☐
Team members always use the common language so that they are understood the first time	☐	☐	☐	☐	☐	☐	☐	☐
There was language barrier in the team throughout the experiment	☐	☐	☐	☐	☐	☐	☐	☐

2. How much do you agree regarding adherence to command and/or advise?

	Not Sure	Strongly Disagree			Neutral			Strongly Agree
Chain of command was always present in the bridge	☐	☐	☐	☐	☐	☐	☐	☐
Command of master was being followed immediately	☐	☐	☐	☐	☐	☐	☐	☐
Advise of pilot was being followed immediately	☐	☐	☐	☐	☐	☐	☐	☐
Number of corrective actions done during the whole voyage	1-3 times ☐		4-6 times ☐		7-9 times ☐		10 & up ☐	None ☐

3. How much do you agree regarding teamwork?

	Not Sure	Strongly Disagree			Neutral			Strongly Agree
There was teamwork in the bridge	☐	☐	☐	☐	☐	☐	☐	☐
Every team member was aware of his/her role in the team	☐	☐	☐	☐	☐	☐	☐	☐
I trusted the decisions my team made	☐	☐	☐	☐	☐	☐	☐	☐
I feel my team performed the navigation safely	☐	☐	☐	☐	☐	☐	☐	☐

Thank you for your participation