YRKESHÖGSKOLAN NOVIA

ABOA MARE STUDENTS' UNDERSTANDING ON VHF RADIO AGREEMENTS AGAINST THE COLREGS

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Abstract

The aim of this thesis is to find out how maritime students at Aboa Mare react in a situation, where someone suggests a VHF radio agreement against the COLREGS rules. This is examined in a real-life exercise in ship bridge simulator, highlighting the risk of misunderstandings on radio in collision avoidance. Background information of the eleven participants were gathered via questionnaire. This data was analyzed along with the results of the simulator test by checking the existence of any statistically significant factors explaining the outcome.

Many accident investigation reports have concluded misuse of VHF-radio as a cause. Statistics show also that the human element is a major factor in maritime incidents. The findings of this work revealed one statistically significant factor, which explained the outcome. Students, who have used a handheld radio more often at school, were able to avoid poor communication and chance of misunderstanding in the test. The group of the students in this research was very small due to restrictions of covid-19 pandemic and time limitation. Further research with larger sampling is recommended.

Language: English
Key words: VHF radio, COLREGS, communication, misunderstanding

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EXAMENSARBETE

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Titel: Aboa Mare studerandes förståelse av VHF radioavtal mot COLREGS

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Abstrakt

Syftet med denna avhandling är att ta reda på hur studeranden inom sjöfart vid Aboa Mare reagerar i en situation där någon föreslår en överenskommelse via VHF radio som går emot COLREGS regler. Detta undersöks i en verklighetsbaserad övning via fartygs brygga simulator där man, för att undvika kollisioner, framhäver riskfaktorn av missförstånd via radio. Bakgrundsinformation om de elva deltagarna samlades ihop via frågeformulär. Uppgifterna analyserades, tillsammans med resultaten från simuleringsprovet, innan dessa kontrollerades för statistiskt sett viktiga faktorer som ledde till slutresultatet.

Enligt undersökningsrapporterna beträffande olyckstatistiken inom sjösäkerhetsöversikten har många av olyckorna som skett kunnat hänföras till följd av missbruk av VHF radion. Statistiken visar även att mänskliga faktorer har en stor betydelse för sjöfarts incidenter. Denna undersökning avslöjade en statistiskt sett betydelsefull faktor som även syntes i slutresultaten. De studeranden som oftare bar på en bärbar radio i skolan klarade bättre av att undvika dålig kommunikation och även minska risken för missförstånd i testet. Antalet studerande i denna undersökningsgrupp var i en mindre skala på grund av tidsbegränsning och Covid-19 pandemins restriktioner. Vidare forskning rekommenderas med en större undersökningsgrupp.

Språk: Engelska
Nyckelord: VHF radio, COLREGS, kommunikation, missförstånd

OPINNÄYTETYÖ

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Nimike: Aboa Maren opiskelijoiden ymmärrys COLREGS sääntöjen vastaisesta sopimisesta VHF radioteitse

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Tiivistelmä

Tämän opinnäytetyön tarkoitus on selvittää, miten Aboa Maren merenkulkualan opiskelijat reagoivat tilanteessa, jossa ehdotetaan VHF radioteitse COLREGS sääntöjen vastaista toimintaa. Tätä tutkitaan todenmukaisessa simulaattoriharjoituksessa keskittyen väärinymmärryksen mahdollisuuteen radiokeskustelussa, kun sovitaan laivojen välisestä kohtaamisesta välttäen törmäysriskiä. Tutkimukseen osallistui yksitoista oppilasta, joista kerättiin taustatietoja kyselylomakkeella. Aineisto analysoitiin yhdessä simulaattorista saatujen testitulosten kanssa, jonka jälkeen etsittiin tilastollisesti merkittäviä tekijöitä lopputuloksen kannalta. Merenkulun onnettomuusraporttien mukaan lukuiset törmäykset ovat johtuneet VHF-radion väärinkäytöstä. Tilastot osoittavat myös, että inhimillisillä tekijöillä on suuri merkitys laivaonnettomuuksissa. Tämä tutkimus paljasti tilastollisesti merkittävän tekijän, mikä näkyi myös lopputuloksissa. Ne oppilaat, jotka olivat koulussa puhuneet enemmän radiopuhelimeen, kommunikoivat selkeämmin välttäen väärinymmärryksen riskin kokeessa. Osallistujien määrä tässä tutkimuksessa jäi hyvin pieneksi Covid-19 pandemian rajoitusten ja aikakiireen vuoksi. Jatkotutkimusta suositellaan tehtäväksi suuremmalla osallistujamäärällä, jotta tutkimustulosta voisi pitää totuudenmukaisena.

Kieli: Englanti
Avainsanat: VHF radio, COLREGS, kommunikaatio, väärinymmärrys

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1 Introduction

During the past years as a student, I have worked onboard different type of ships as an ordinary seaman, and several general cargo ships as a deck officer. I remember the first week working onboard a ro-pax ferry between Finland and Sweden. We had just departed Stockholm about half an hour ago, and I was performing lookout duties next to a line pilot and second officer. As we were sailing outbound in beautiful Swedish archipelago, I heard for the first time a conversation on VHF radio, where the line pilot, the officer of the watch, made a radio agreement with another ro-pax ferry pilot, who was sailing inbound for Stockholm and approaching us. The two pilots agreed to meet starboard to starboard, which was against the COLREGS rules. A little later, when I asked the pilot about the matter, he explained to me, that it is quite common practice in certain situations. There are many narrow places and relatively hard turns in both Swedish and Finnish archipelago, and depending on the situation and the meeting place, if it is easier and that way also safer to meet starboard to starboard, the agreement on radio can be done, he continued. Those meetings happen relatively often as several ferries sail in the area on daily bases, so it’s common practice and perfectly makes sense.

Later as a second officer onboard a general cargo ship, I noticed that radio agreements are quite common also outside the narrow fairways of archipelagos. Especially when there were some restrictions on navigation. This surprised me, because at school I was taught to follow the rules of COLREGS. In many cases these agreements, even against the rules makes sense for the same reasons as mentioned, easier navigation and safety purposes. Economical point of view is also present if it is possible to save bunker and time. But this means there is a clear conflict between the rules and occasionally happening common practice, which can be very dangerous in case of any miscommunication or misunderstanding occurs with either party of such agreement.

When I started thinking and planning my thesis for school, I wanted to do research related to school simulators and collision avoidance at sea. As the above-mentioned behaviour on radio came up to my mind, I was able to narrow down the research problem into a specific scenario. I wanted to find out how maritime students would react as an officer of the watch in simulated situation, where someone suggests a VHF-radio agreement against the rules of navigation, and could the reactions be explained somehow.

1.1 Objective

The purpose of this thesis is to find out how maritime students will react as an officer of the watch in simulated situation, where someone suggests a VHF-radio agreement against the COLREGS. The key point of the study would not be in the obedience of the rules, but instead of the ability to handle the situation so, that there is absolutely no room for misunderstandings. The presumption is that more experienced students will be more likely to avoid bad communication in simulated test, which could lead into a dangerous situation and risk of collision.

With a simple questionnaire, it is possible to find out if there are any differences among the participants when it comes to experience or education. And most important, depending on the test results, are there any statistically significant factor which could explain the outcome of the test. Along with results from simulator tests, the idea is to determinate whether there is any need whatsoever to emphasize this matter in education programme of Maritime Management. Situational awareness is highly important matter to any officer of the watch. Therefore, for students who will most likely encounter this specific type of radio conversation on their early stages of career as an officer, it is not just beneficial for their future sailing career and peace of mind to be able to avoid unnecessary risks at sea, but also beneficial to general safety in the industry.

1.2 Research Method

The behaviour and reaction of maritime students in this specific scenario is tested in one of the simulators of Maritime Academy and Training Center Aboa Mare. The study includes a questionnaire done by the participants, which comprehends background information concerning onboard experience and education done so far in the school concerning courses related to navigation, simulators, and radio usage. Also, a few questions are asked to find out if students feel they have had sufficient education so far to be able to handle the specific situation.

2 History of Communication at Sea

For ages, humans have had the need and desire to explore oceans and use sea passages for various reasons. Using sea as a way of transport has been and still is exquisite but is has also been quite dangerous business as voyages became longer and nature of ocean is unpredictable. Not to mention about uncharted territories, injuries and deaths were inevitable. There is no doubt that seafaring has become safer over time, especially during the last century. As the shipping volumes keep rising, new means and protocols are developed. One important theme has always been communication. Not just only from safety aspect, but in general speaking. Over time, inventions, science, and technology has improved communication from ship to shore and from ship to ship.

2.1 Development of Communication

When people learned how to write, information could be passed on regardless of time and space. However, passing information over distance was relatively slow without any modern technology of telecommunication. Around the world messages were sent by different methods: fast runners, horseback riders, signal fires, loud drums, and sometimes even with trained pigeon carriers. It wasn't until the beginning of 17th century that long distance communication begin to evolve more rapidly as the laws of geometrical optics were understood better. (Michaelis, 1965)

2.1.1 Flag Signalling

The first documented communication using flags between ships was in the 16th century. Five flags were used to give fighting instructions. This highly restricted way of signalling expanded slowly but surely, and by the end of 18th century the Signal Book for the Ships of War was issued. In this book there were multiple signals for different manoeuvrings, battle tactics and other informative flags such as compass directions and numbered codes. Merchant ships also adopted hoisting of signal flags. (Kemp & Kemp, 2007, Signals at sea)

The development of signalling modernised in 1817, when British Captain F. Marryat established new code of signals. These codes became a basis for International Code of

Signals, which reached its final format in 1969. The system includes a flag for each letter, and each letter has a different meaning also. Additionally, information like dates, times and positions could be sent. Several different combos for different meanings required a code book, which in hands of professional seafarers made it possible to send complex notification and more detailed information along with normal complete message in unambiguous way. Despite all the modern technology up till today, International Code of Signals still exist, and flags are used around the world. (Kemp & Kemp, 2007, International Code of Signals)

2.1.2 Telescope

Hans Lippershey, a Dutch spectacle-maker got the glory of being the first one with patented telescope in 1608. With so called refracting telescope using converging lenses, it was possible to see an image of faraway object magnified through the eyepiece of a telescope. In other words, people were able to see further. Only one year later in 1609, Galileo Galilei used diverging lenses to create more powerful design, which was again improved by Johannes Kepler in 1611. Isaac Newton was the first to produce a reflecting telescope using mirrors in 1668. (Rennie and Law, 2019, Telescopes)

For seafaring, telescopes entered more broadly in the late 18th century when they became widely available. This meant being able to avoid navigational hazards and piracy due to the possibility to identify approaching ships at longer distances. Also, communication with signals was more practical. (Naval Telescopes, 2008, Age of Sail)

2.1.3 Semaphore Signalling

In the last decade of 18th century, a French engineer Claude Chappe invented the semaphore signalling with help of his brothers. In this system of communication, a set of horizontal beams made from wood, were put on roof of buildings or a tower made for this purpose. With pulling a rope, it was possible to swing the wooden arm into various angles. At the end of arms, there were also movable vertical extensions, which made multiple setups possible. Signalling codes could be read from another tower or station using a telescope. Although this system of messaging, also known as optical telegraph, was developed to be land based, it came in use onboard ships as well. Mechanical arms were then usually replaced by sailor's extended arms, held in certain position with small flags in both hands. (Michaelis, 1965, p. 11-16)

2.1.4 Telegraph and Morse Code

The revolution of electricity begun in the middle of 18th century when few scientists were experimenting static electricity and electrical conductors. It wasn't until the beginning of 19th century when bigger steps were made in the field. There were many researchers developing telegraph after two physicists made their discoveries. Alessandro Volta, the Italian physicist, created a way to store an electric current for controlled usage. This invention was called the battery. The second physicist from Denmark, Hans Christian Oersted uncovered the secret relation between electricity and magnetism. The knowledge of electromagnetism in hands of scientists called Sir William Cooke and Sir Charles Wheatstone in England, and Samuel Morse with the help of another fellow American Alfred Vail, made the telegraph a success story. Morse improved telegraph by assigning simple dots and dashes for letters of alphabet. The well-known code was named after him – the Morse code. (Michaelis, 1965)

2.1.5 Radio and Modern Telecommunications

It was 1865, when the first International Telegraph Convention took place in Paris. The international development of telecommunication started to take giant leaps towards the modern world. Telecommunications was defined as: "any transmission, emission or reception of signs, signals, writing, images, sounds, or intelligence of any nature, by wire, radio, optical or other electromagnetic systems." (Michaelis, 1965, p. 9) Only eleven years later, the telephone was invented, and in the last decade of the 19th century famous inventors such as Guglielmo Marconi, Nikola Tesla, Alexander Stepanovich Popov, and Jagadish Chandra Bose worked successfully with creation of wireless telegraphy, known as radio. The improvement of Radio Regulations begun in a meeting, when 29 nations gathered for the first International Radiotelegraph Conference. (ITU, history, 2022)

The modern telecommunications comprehend different means to rescue persons and ships at sea on any situation of distress, as well as other technical solutions to improve the safety onboard a vessel. The Global Maritime Distress and Safety System, known as GMDSS, concentrates on emergency situations. These methods and main devices are:

- VHF, MF and HF radios, including digital selective calling (DSC)
- Satellite communication systems and services
- Emergency position-indicating radio beacons (EPIRB)
- Maritime safety information and navigational warnings system (NAVTEX)
- Search and rescue transponders (SART)

(Bhattacharjee, GMDSS, 2022)

3 Regulations and Legislation

Ships are obligated to follow the local regulations and legislation of a flag state. A flag state is the country, where the ship is registered. For example, if a ship is sailing under Finnish flag, it means it is registered in Finland, and it must meet the requirements of Finnish maritime laws and comply with local authorities. A flag state has a responsibility to supervise safety, crew certification and pollution of the ship. However, ship owners have the possibility to choose the flag state for their ships. Reasons for selecting a different country are usually related to financial issues. For example, lower fees on taxes and fleet registration. (Maritime Industry Foundation, Flag States, 2022)

3.1 IMO

The International Maritime Organization, known as IMO, was established by United Nations in Geneva 1948. It has 175 member states including Finland. It is the head organization of maritime industry with number of committees and sub-committees. Every two years, a council of 40 member states elected by assembly, gather and prepares the budget and worklist for next two years. IMO's mission is to make maritime industry more safe, secure, and environmentally sound by preventing pollution from vessels. (IMO, History of IMO, 2019)

IMO changes the industry by adopting conventions and keeping them updated by adding amendments, as technology in the shipping industry evolves very rapidly. However, it takes relatively long time until a new set of regulations or rules entry into force, because they must be accepted officially by Governments of member states. (IMO, Conventions, 2019)

3.2 SOLAS

IMO's first adopted convention was a new version of the International Convention for the Safety of Life at Sea, known as SOLAS, in 1948. This has been the most important set of regulations concerning maritime safety in general. (IMO, History of IMO, 2019) For example, chapter four contains mandatory provisions related to radiocommunications onboard and requirements about installations, equipment, watches, energy sources, maintenance and personel. (SOLAS, Novia University Library's database, 2022)

3.3 STCW

The International Convention on Standards of Training, Certification and Watchkeeping, known as STCW, was adopted by IMO in 1978. The latest update is Manilla amendment from 2010. It states the minimum standards of education and experience for professional seafarers to be able to work onboard in certain position. The section A-IV/2 contains regulations about radiocommunications and radio operators. It states the minimum criteria for operating the Global Maritime Distress and Safety System, known as GMDSS. (STCW, Novia University Library's database, 2022)

3.4 COLREGS

The history of preventing collisions at sea goes back hundreds of years in time. However, there has not been any laws obligating ships to follow existing rules until the last century. Relatively long process of modern rules began to involve by London Trinity House in 1840. A set of rules were made, and eventually approved in Parliament six years later. The ongoing development of the rules for preventing collisions at sea reached its current form at the convention on the International Regulations for Preventing Collisions at Sea, known as COLREGS, in London 1972. (van Dokkum, COLREGS, 2014) Amendments have been made to the rules, the latest entered into force in 2016. (COLREGS, Novia University Library's database, 2022)

3.4.1 VHF-Radio in Collision Avoidance

There isn't direct reference about usage of VHF-radio in the COLREGS, and the rules do not require any radio communication whatsoever. However, it is possible to interpret the text of some rules in such way, that radio communication could be used. For example, in the rule 5 (Look-out) it is said: "Every vessel shall at all times maintain a proper look-out by sight and hearing as well as by all available means appropriate in the prevailing circumstances and conditions so as to make a full appraisal of the situation and of the risk of collision." Also, the rule 7a (risk of collision) states: "Every vessel shall use all available means appropriate to the prevailing circumstances and conditions to determine if risk of collision exists. If there is any doubt such risk shall be deemed to exist." One could easily argue, that making radio contact falls in the category of all available means in both rules. Although it is clearly stated in the rule 7, that the determination should mainly be done by radar, with compass bearing, and eyesight. (van Dokkum, 2014)

The rule 8, Action to avoid collision, deals with situations where a risk of collision has already been found to exist. To point out the essential matter of the rule, actions must be easily seen and made early enough while practicing good seamanship. There are no indications about the usage of VHF at all. (van Dokkum, 2014)

In the rule 19, Conduct of vessels in restricted visibility, it is stated how ships should navigate "in or near an area of restricted visibility", and what to consider. VHF is not part of the rule, but guidance text for the rule warns about making an agreement by radio, as in terms of possible misunderstanding. (van Dokkum, 2014)

3.4.2 Guidance about VHF

Even though VHF is not part of the rules, it surely is part of mandatory GMDSS equipment onboard ships today. (SOLAS chapter 4, regulation 7) The COLREGS Guide, also known as "rules of the road", includes guidance about how to interpret the rules. Some of these amplifications have noticed VHF as a tool, as mentioned earlier. (van Dokkum, 2014) The cornerstone of guidance concerning radio usage comes from Maritime and Coastguard Agency (MCA), which produces various guidance and regulations widely on maritime sector. (MCA official website) This Marine Guidance Note called MGN 324 (M+F) is included in the COLREGS guidebook. One main reason why this guidance was given lays behind the fact, that misuse of VHF is recognized to cause interference and even compromise the safety it was supposed to cherish at sea in the first place. This guidance has its own chapter especially for usage of VHF radio as an aid to avoid collisions. The following points are stated on the matter: (van Dokkum, 2014)

- In many collisions, at least one participant has been using VHF for collision avoidance. This behaviour could be dangerous and not helpful for the circumstance.
- Identification of a certain ship and making contact to the one intended can be challenging if there are several other vessels nearby and/or restricted visibility.
- There is a possibility to understand messages the wrong way, because of difficulties of spoken language.
- Precious time is lost at the same time, if mariners are trying to contact and communicate one another via radio instead of following the rules of COLREGS.

The note also mentions several accident cases, where VHF radio is used as an aid to avoid collision with bad outcomes. During one case already in 1995, a judge said:

"It is very probable that the use of VHF radio for conversation between these ships was a contributory cause of this collision, if only because it distracted the officers on watch from paying careful attention to their radar. I must repeat, in the hope that it will achieve some publicity, what I have said on previous occasions that any attempt to use VHF to agree the manner of passing is fraught with the danger of misunderstanding. Marine Superintendents would be well advised to prohibit such use of VHF radio and to instruct their officers to comply with the Collision Regulations." (MGN 324 (M+F), 2022)

4 Accidents

European Maritime Safety Agency (EMSA) publishes every year a report about statistics on casualties and incidents at sea. These statistics involve ships sailing under EU Member States flag, and accidents that has happened within territorial waters of an EU Member State. According to latest report of Annual Overview of Marine Casualties and Incidents, published by EMSA in 2021, collisions represent the major reason of serious accidents related to a ship, where fatalities have occurred. When looking at the latest data from 2016 to 2020, the report reveals that altogether 129 lives were lost in accidents during these years and 62 of those were related to collisions. (EMSA report 2021)

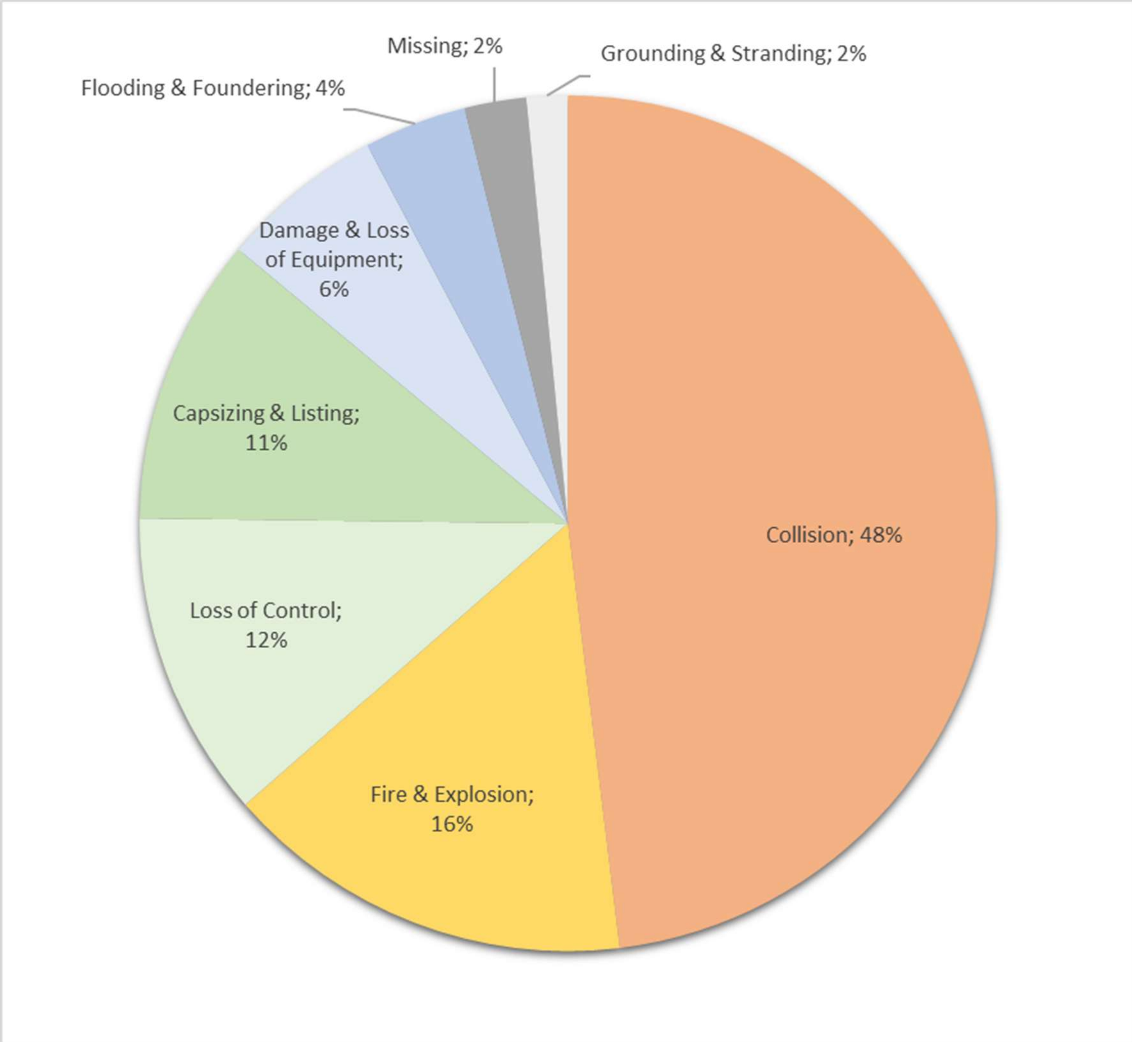

Figure 1: Distribution of Fatalities by Casualty Events 2016 – 2020. (EMSA report 2021)

All accidents reported are examined and analysed by investigators in order to prevent incidents in the future. The cause and contributing factors are found, and safety recommendations are given. When looking at the statistics from 2014 to 2020, it is evident that one factor is dominant. This is human action and behaviour by 89,5 % of all reported investigations. (EMSA report 2021) The Human element is there for an evident factor in maritime accidents. This fact is supported by the Mariners' Alerting and Reporting Scheme, known as MARS, is a free database of near misses and accident reports at sea. They provide service and information about risk assessment among other things without any judgment to operators in maritime industry. (MARS, the Nautical Institute, 2022)

Also, Confidential Human Factors Incident Reporting Programme, known as CHIRP, contributes to maritime safety by providing independent reporting system and feedback. (CHIRP, Aviation and Maritime Confidential Incident Reporting, 2022) According to recorded data, there are more than 100 cases where misuse of VHF radio has occurred. The root of the problem lies in education and obedience of the COLREGS rules as individual mariners are abusing VHF far too often in different ways:

- “VHF assisted collision.”
- “Jamming the airwaves with chatter and even music!”
- “Requirement to monitor more VHF channels than it is physically possible to do, creating distraction, overflow of information and noise pollution.”
- “Language barriers or problems with fluency.”
- “Inadequate communication protocols.”

(CHIRP article, 2017)

The human element being a significant factor in maritime industry, MCA has published a series of guidance notes concerning the matter, as well as sponsored a comprehensive work called “The Human Element – a guide to human behaviour in the shipping industry”. The Marine Guidance Note MGN 520 (M) specifies twelve major factors of people called “The Deadly Dozen”, which effects safety in maritime field. Three of the most common people related factors cover over half of the near miss reports from 2003 to 2015. These are: situational awareness, alerting and communication. (MGN 520 (M), MCA, 2017)

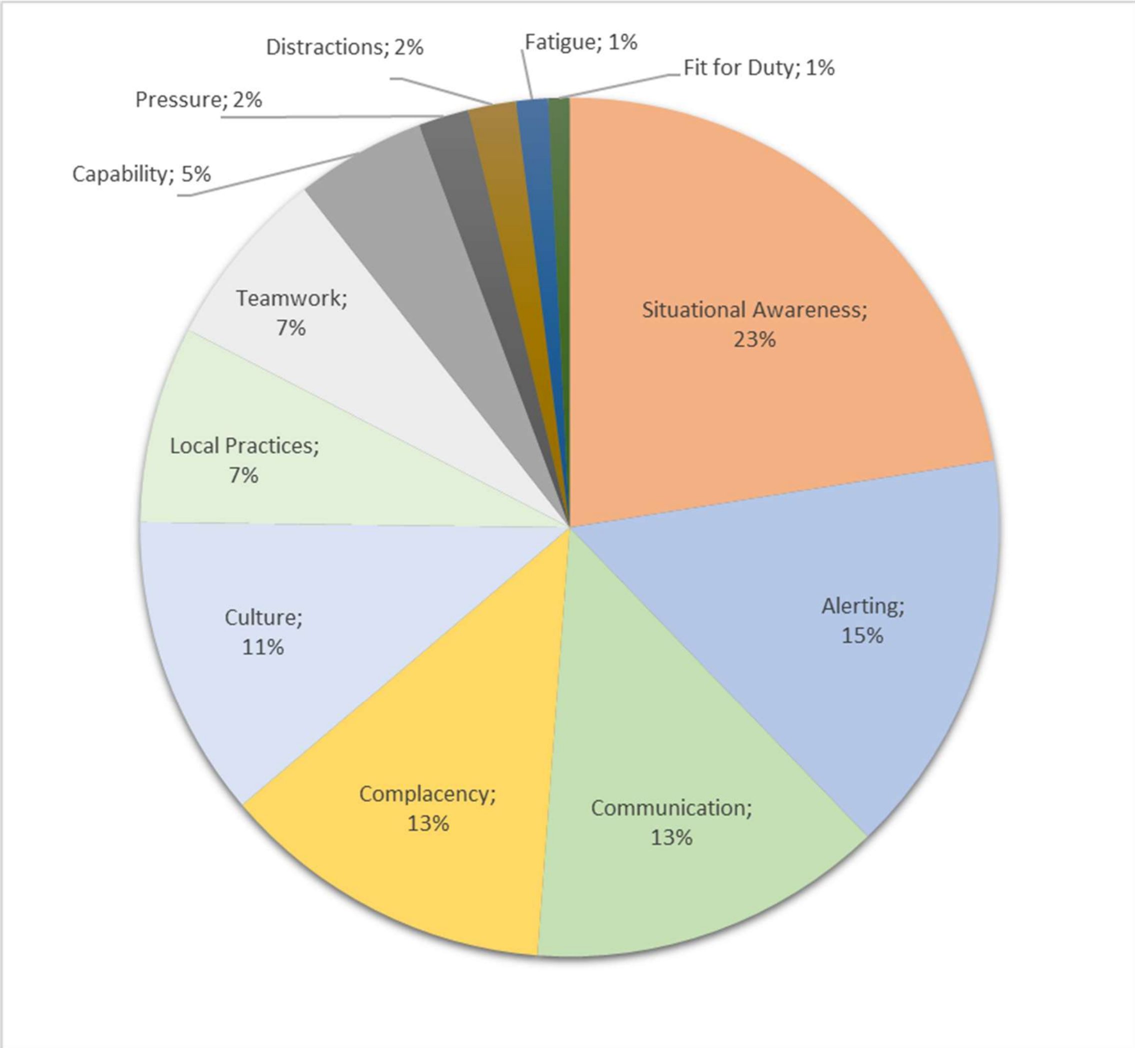

Figure 2: The Deadly Dozen CHIRP Near Miss Reports 2003 – 2015. (MGN 520 (M), MCA, 2017)

4.1 Case of Stena Jutlandica and Ternvind

On 19th of July in 2015, the ro-ro passenger vessel Stena Jutlandica and the chemical tanker Ternvind collided in the sea area of Kattegat, just outside the fairway into Gothenburg. That early morning, about ten minutes before the collision, Stena Jutlandica was approaching the fairway with fast speed of approximately 20 knots and east-north-easterly course, while Ternvind was sailing approximately 8 knots and heading south-west-southerly course. (SHK report 2016)

In this situation Ternvind was obliged to give away according to COLREGS rule 15, crossing situation: "When two power-driven vessels are crossing so as to involve risk of collision, the vessel which has the other on her own starboard side shall keep out of the way and shall, if the circumstances of the case admit, avoid crossing ahead of the other vessel.” (COLREGS, Rule 15, Novia University Library’s database, 2022)

About two minutes before the collision, Stena Jutlandica started to turn slowly to port so she could line up on the righthand side of the fairway, close to the green buoys. A few seconds later Ternvind called Stena Jutlandica via VHF radio, and the following conversation was recorded:

- Ternvind: “Stena Jutlandica. Ternvind”
- Stena Jutlandica: ”Ja, här är vi.” (Yes, we are here.)
- Ternvind: “Sir, can we pass starboard to starboard?”
- Stena Jutlandica: “Nä, jag har precis lagt min” (No have just put my) … “port side, so I’m turning to port now.”
- Ternvind: “Copy that, thank you.”

After this somewhat unclear and partly Swedish communication, Ternvind had the assumption that vessels would meet starboard to starboard, and so she turned more to port to give Stena Jutlandica more space. At the same time Stena Jutlandica called again:

- Stena Jutlandica: “Port to port if that is ok with you. I will keep as close to the green side as possible.”

But there is no answer whatsoever from Ternvind, and no further communication between the two vessels. Both ships soon realized that something was wrong, but they didn’t have enough time anymore to avoid the collision. (SHK report 2016)

According to Swedish Accident Investigation Authority, misunderstanding on VHF radio along with poor planning of the meeting were the major causes of the collision. The language should have been English, and importantly there were no confirmation on the calls. There was no clear answer “yes” or “no” with repetition of the question asked in accordance with IMO Standard Marine Communication Phrases (SMCP). (SHK report 2016) The SMCP is included in the convention on STCW to standardize communication among navigating officers at sea. For example, features of basic verbal communication are:

- “avoiding synonyms”

- “avoiding contracted forms”
- “providing fully worded answer to yes/no questions and basic alternative answer to sentence questions”
- “providing one phrase for one event, and”
- “structuring the corresponding phrases according to the principle: identical invariable plus variable”

(SMCP, IMO website, 2019)

4.2 Other Cases

Similar cases like the collision of Stena Jutlandica and Ternvind has happened more recently. A few minutes after midnight on 25th of March 2019 LNG tanker Aseem collided with VLCC Shinyo Ocean at the passage channel next to Hormuz Strait. The two vessels had already agreed over the VHF how to meet, when a third ship MV Silva nearby hoisted her anchor and was soon observed crossing ahead of Shinyo Ocean at close range. This interruption made the previous agreement hard to carry out. All three vessels communicated on VHF, and furthermore both vessels Aseem and Shinyo Ocean continued on the radio even a close-quarter situation had developed. According to the accident report this VHF communication was the immediate reason of the collision. (Marine Safety Investigation Report, 2020)

The oil tanker Seafrontier and the bulk carrier Huayang Endeavour collided in the Dover Strait on 1st of July in 2017. Misuse of the VHF in collision avoidance was obvious contributory cause of the accident. (MAIB Accident Report, 2018) Similar behaviour occurred before the collision between the Baltic Ace and Corvus J at North Sea in 2012 (BMA Investigation Report, 2016), as well as before the collision of container ship CMA CGM Florida and bulk carrier Chou Shan at East China Sea in 2013. (MAIB Accident Report, 2014)

5 Simulator Test

The simulator tests were held on 8th and 9th of March 2022 in Maritime Academy and Training Center Aboa Mare. These bridge simulators are used by maritime professionals in different maritime sectors, as well as by maritime students for educational purposes.

The bridges are built up to be as close to real ship bridges onboard as possible. The hardware and consoles are the same as in real life, and pictures of big screens can be changed to get the wanted view. It is possible to create realistic scenarios, even complex exercises with multiple different variables. (Aboa Mare, Ship Bridge Simulators, 2022)

5.1 Participants

The original purpose was to gather students from different stages of their studies, but due to the Covid-19 pandemic and its restrictions along with limited time for the project, the simulator tests were held in connection with a simulator course Manoeuvring 1 for maritime students. These eleven participants were mostly second year students, just a few courses away from completing the theoretical studies of navigational watchkeeping officer. All participants had previous experience using a bridge simulator in their studies, as well as handheld radio.

5.2 Setup

The test was an additional simulator exercise in the course for the students. The participants did not know about the purpose of this research nor what to expect from the exercise. The starting points for each participant were equal, as they entered the Transas bridge simulator Juliet in their own turn.

Figure 3: Ship bridge simulator Juliet in Aboa Mare. (Aboa Mare, Ship Bridge Simulators, 2022)

There was a short briefing (Appendix 1) written on paper about the exercise on the side table of the simulator, explaining the situation on hand; the student would approach Utö Pilot Station from southwest as officer of the watch, master's orders were to keep full speed ahead, and local VTS has informed about one outbound vessel called Tankos just north of pilot boarding area. A handheld radio was included in the exercise with one working channel for all communication, as instructed. All students were guided to read the briefing first, and notify the control room by radio, when they would be ready to start the exercise. The exercise was managed from the control room with a computer software. Also, a handheld radio was in use, as well as a camera view of the bridge simulator to observe student activity.

5.2.1 Vessels

Two vessels were included in the exercise. The feeder container ship, called Maria in the test, was controlled by the participant. This ship was chosen due to its characteristics of size, speed, and agile maneuverability.

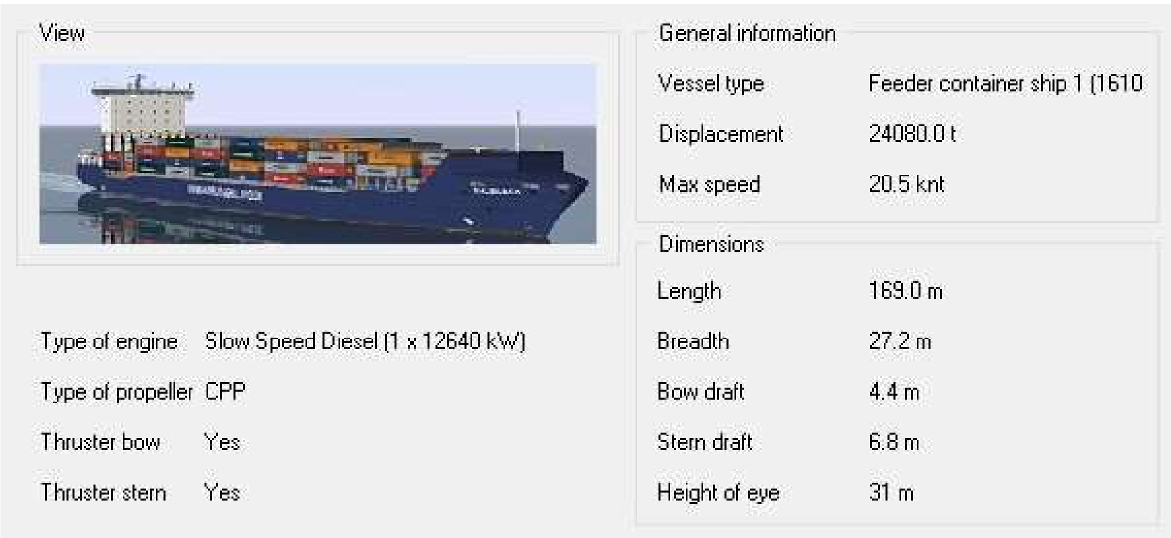

Figure 4: The Feeder Container Ship in the simulator tests. (Vessel info, general information, 2022)

The other vessel was the chemical tanker called Tankos, which was controlled via computer of the control room. These two ship models are often used in maritime school exercises at Aboa Mare.

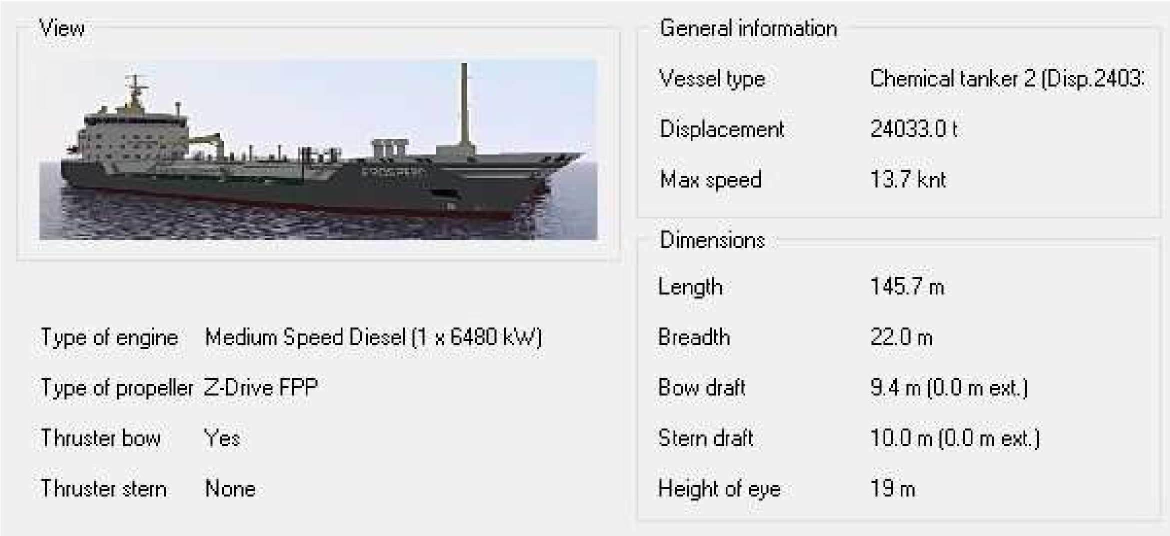

Figure 5: The Chemical Tanker in the simulator tests. (Vessel info, general information, 2022)

5.2.2 Starting Point

The exercise was placed southwest of Utö island, Finland. The pilot boarding area is just south of Tankos and the fairway lies between the red and green buoys.

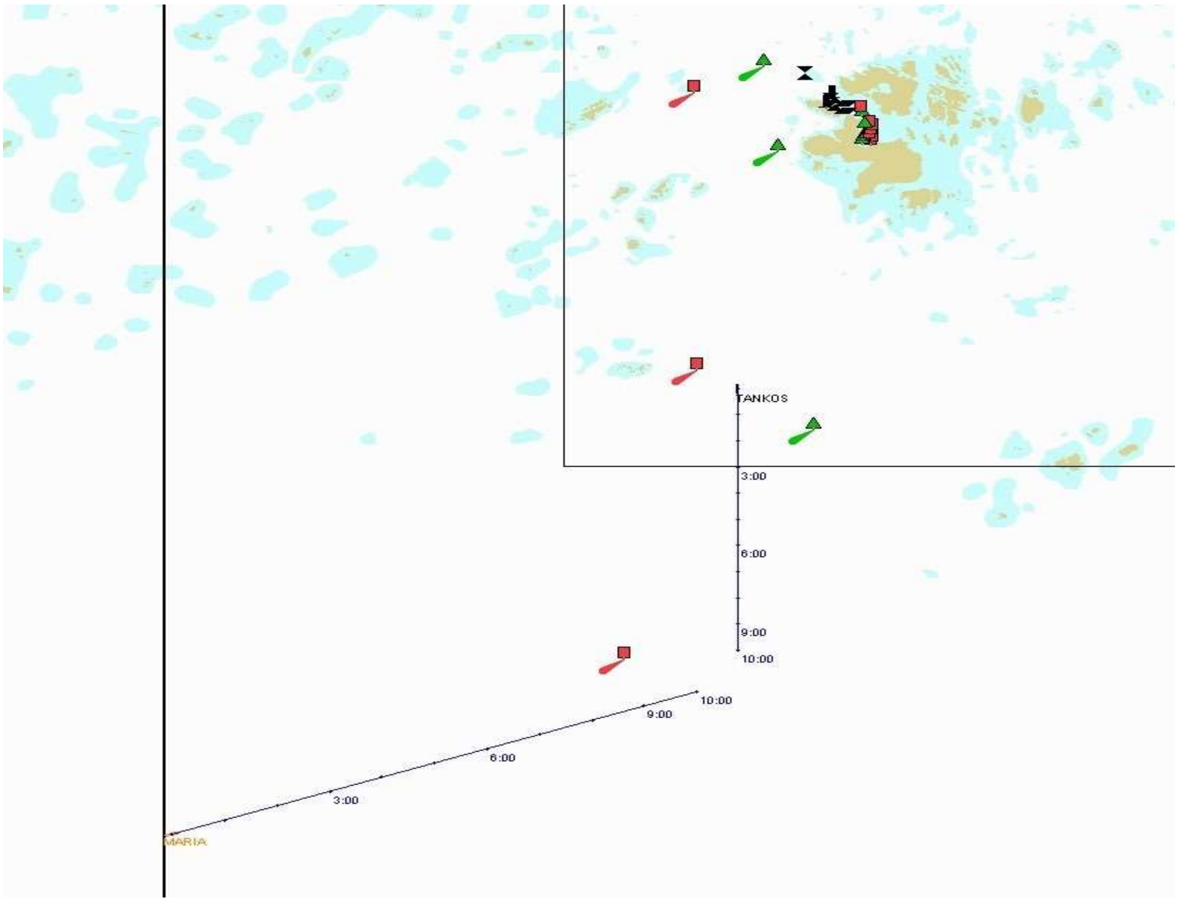

Figure 6: Screenshot from the beginning of the simulator tests. (Screenshot, control room, 2022)

The situation was chosen to be like in the case of Stena Jutlandica and Ternvind. The Maria would approach the last turning point towards the pilot station and fairway from west-south-west with full speed of approximately 20 knots, similar to Stena Jutlandica. The Tankos is just north of the Utö pilot station on southerly course and making full speed of 10 knots. The vectors in front of the vessels in the picture above indicates the position ahead, where they would be in certain time without any changes of course or speed. For example, if neither ship would proceed doing nothing, they would be very close to each other and collision after ten minutes.

5.3 The Script

In the briefing, it is already mentioned that one vessel called Tankos is approaching from the north. According to the script (Appendix 2), after two minutes from the start of the exercise, Tankos called Maria via radio. After connection was formed, Tankos asked if they could meet starboard to starboard. Despite the answer, Tankos would reply: "Okay, thank you". The purpose of this was to give poor reply and create possible misunderstanding in case the answer would be negative without a clear alternative answer. If so, a corrective action could be done with further conversation and clarification of the situation. This action would have to be initiated by Maria though. All conversations were saved as voice recordings, and the result was written down to script paper straight away with the number of the participant.

5.4 Aim

The purpose of the simulator test was not in the obedience of the COLREGS rules, but instead to find out if students could answer the suggested agreement against the COLREGS in such way, that there wouldn't be any chances for misunderstandings in communication on radio. The question is, how can one be sure that the other one has understood the question or message correctly?

This is determined in the test by the content of the answer. To pass the test and avoid any misunderstandings, the participant should have given a clear answer with repetition of the original phrase, just like guided by IMO Standard Marine Communication Phrases (SMCP). To make the test little bit more human as it were, synonyms were allowed if the answer was clear, and the original content of the question was repeated using just other words. For example, to the question: “is it okay that we meet starboard to starboard?”, a simple answer like “yes sounds fine to me”, “It’s okay” or “not a problem” were not excepted. Also, all plain negative answers without alternative answer were disqualified, if there were no further confirmation of planned meeting from Maria after Tankos replied: “Okay, thank you”. On the other hand, clear answers with fully worded alternative sentences like: “yes green to green is okay”, “negative we will follow the COLREGS“, and “okay you can cross my bow and I will turn to port and go astern of you” would have been or were accepted.

5.5 Background Information

All participants filled a background information form (Appendix 3) after they had done the simulator test. The idea was to gather data about certain variables defining the level of experience, and most of all if there would be any significant factor to be found, which could explain the outcome of the tests. These variables were: 20 courses related to navigation, simulator and/or handheld radio usage in those courses, onboard training days and onboard bridge hours. In addition, there were four poll questions regarding the agreement in the simulator test. The questionnaire was done anonymously, but a number was added so it could be attached to right simulator test afterwards without any doubt.

Although the students were mostly at the same stage of their studies, there were differences in all variables. This was due to special education characteristics in maritime school, where it is required to obtain certain amount of onboard training days. A student might miss some courses at school while at sea. It is generally known that the bridge simulators in Aboa Mare are heavily used by maritime professionals, so it is not always possible for students to just go in and practice. A teacher is also needed in the control room to set up exercises. Then during some courses, it might be possible to get some extra training, if there are some simulator(s) available. In most of the simulator courses one bridge is occupied by two to four students. Different tasks are given, and although the roles are changed at some point, it might be that not everybody gets to do everything. This most certainly applies to radio usage. There is usually one handheld radio for each bridge, and it might end up being used by the same active students more often than some others.

6 Results

In this chapter collected data, calculated measures and testing method are described. Empirical research objective is to analyse data which was collected via questionaries and test statistical significancy of different factors.

The hypothesis of the research was that more experienced students would pass the simulator test more often compared to less experienced students. Six participants from total of eleven passed the simulator test with clear and full sentence answers, whereas five students failed with poor and unconfirmed replies. The answers were then divided into two groups based on the outcome of the test.

6.1 Data

Data was collected via questionnaire which was filled by every participant after they finished the simulator test. Following data was collected via questionnaire (Appendix 4):

1. Test result (1 = test succeeded, 0 = test failed)
2. Completed navigational courses, coded from A1 to A20.
   (0 = Course not completed, 1 = Course completed)
3. Onboard training days (ONBOARD_DAYS)
4. Onboard bridge hours (BRIDGE_HOURS)
5. Onboard hours in total (ONBOARD_HOURS)
6. Navigational courses in total (TOTAL_COURSES)
7. Radio usage, radio used in a course (RADIO_USAGE)
8. Simulator usage, simulator used in a course (SIMULATOR)

These data attributes are ideal to point out maritime experience, comfortability to use radio and comfortability to use simulator. As the number of students were small, it was easily seen by looking the data of questionnaire (Appendix 4), that onboard training days or bridge hours didn't explain the results. In fact, two students with most sea days failed the exercise. Looking at the individual navigational courses taken, the same conclusion is clearly seen. Based on the collected data the following measures were calculated:

1. Radio Ratio = (courses with radio usage / total number of courses) * 100
2. Simulator Ratio = (courses with simulator usage / total number of courses) * 100

Table 1: Outcome of executed calculations

Participant	TEST	RADIO_RATIO	SIMULATOR_RATIO
3	1	28,6 %	42,9 %
4	1	15,8 %	84,2 %
5	1	25,0 %	37,5 %
6	1	35,0 %	50,0 %
9	1	66,7 %	83,3 %
10	1	62,5 %	62,5 %
1	0	41,7 %	50,0 %
2	0	0,0 %	78,9 %
7	0	15,8 %	94,7 %
8	0	11,8 %	52,9 %
11	0	14,3 %	64,3 %

6.2 Testing Method and Findings

To examine if calculated factors would explain the test results with statistically significancy, a T-test was chosen. This method is practical, when comparing two groups different from one another, and the tested data is independent, evenly distributed, and variance considered equal. A risk level of 5% was chosen, which is commonly used. This means 95% confidence interval, indicating same outcome if the test would be repeated. (Bevans, T-test, 2020)

Based on T-test the following hypothesis were defined:

H0 – RADIO_RATIO is explaining test results on statistically significant level

H1 – SIMULATOR_RATIO is explaining test results on statistically significant level

Table 2: H0 – RADIO_RATIO results

	SUCCESS	*FAIL*
Mean	0,389212615	0,167013121
Variance	0,043542818	0,023330985
Observations	6	5
Pooled Variance	0,034559781	
Hypothesized Mean Difference	0	
df	9	
t Stat	1,973885061	
P(T<=t) one-tail	0,039920762	
t Critical one-tail	1,833112933	
P(T<=t) two-tail	0,079841523	
t Critical two-tail	2,262157163	

*Significant on 0.05 risk level

Based on these results it can be concluded that radio usage is explaining test results on statistically significant level (0.05) and the hypothesis H0 is therefore valid.

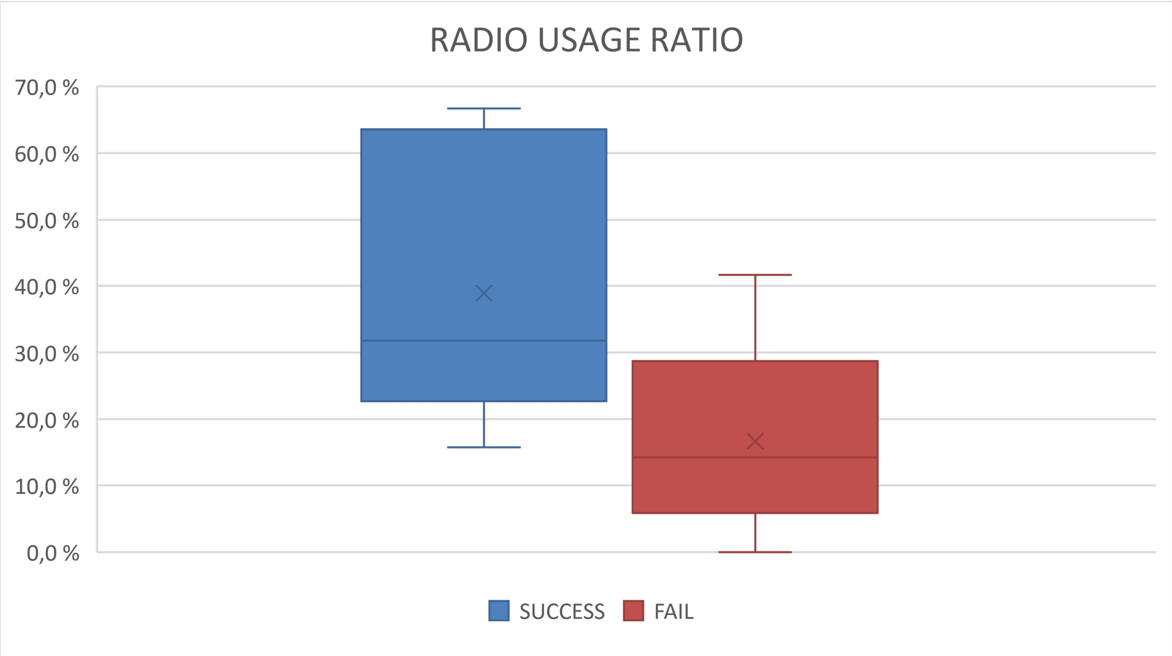

Figure 7: Radio usage ratio

Table 3: H1 – SIMULATOR_RATIO results

	SUCCESS	*FAIL*
Mean	0,600668338	0,681822203
Variance	0,040738896	0,034977542
Observations	6	5
Pooled Variance	0,038178294	
Hypothesized Mean Difference	0	
df	9	
t Stat	-0,685907	
P(T<=t) one-tail	0,255026498	
t Critical one-tail	1,833112933	
P(T<=t) two-tail	0,510052995	
t Critical two-tail	2,262157163	

Simulator usage did not explain test result on statistically significant level and therefore the hypothesis H1 can be rejected.

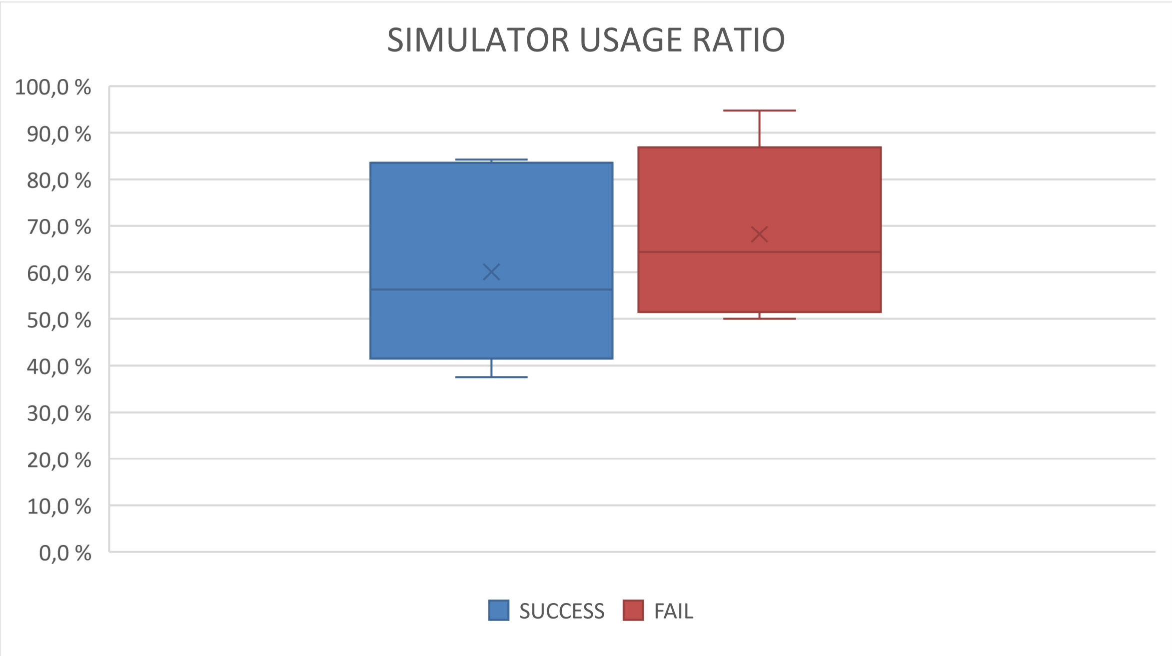

Figure 8: Simulator usage ratio

7 Conclusions

It is apparent that radio communication can be a risk in collision avoidance. Relaying too much on VHF in close-quarter situations can lead into misunderstanding and reduced situational awareness, as many accident cases have shown. The human element is strongly present in almost all accidents. Although the sample in this work was small, the findings of the research were interesting. Almost half of the students failed the simulator test. Experience at sea nor any specific course didn't contribute to passing the test. Instead, the usage of radio at school was found to be statistically significant factor in the results. It would be beneficial to global maritime safety if these radio agreements, especially against the COLREGS rules, were known to be hazardous in general. This can be done by emphasizing the matter in education programs in the industry.

8 Critical Analysis and Discussion

Based on this research, it is not possible to draw absolute conclusion because the random test sample was so small. However, there are undeniably truth behind presented facts. The statement that more experienced students or sailors would handle the special situation better than less experienced is rather simple and easily said. This might not be the case though, as many accident investigation reports reveals. Experiences captains and bridge teams have been involved in collisions due to miscommunication. More intriguing would be to find the reason and a solution for this, as the seafaring industry keeps expanding and close-quarter situations will develop increasingly.

Maritime legislation and rules are updated from time to time. Nevertheless, interesting fact is that the rules of COLREGS have been made before VHF-radio was widely in use onboard ships. Guidelines about VHF usage have been given and updated since, but not the actual rules of collision avoidance. The rules are taught at school globally, but how many sailors performing watchkeeping duties updates their knowledge by reading guidance notes from different organizations? As relevant question would be, how many of them knows where to find this information, if cultivation is not a habit? Maritime industry has so many different operators and agencies providing services and information that one could easily be puzzled.

Statistics, investigations, and reports don't lie, so there is no doubt that agreements against the COLREGS are made, occasionally with catastrophic results. There is seldom just one reason behind a collision of two vessels, but several factors and events leading to it. The human element has proven to be present in majority of maritime incidents. Communication is just one of many events involving people, but it shouldn't be underrated if seamen lives are at stake. We all are different individuals with different personalities and worldview. That is what makes us humans. Communication skills and habits can be learned at any time, if is purpose and will.

The simulator tests were essential part of this thesis. Relevant data was obtained from conversations without any manoeuvres by students. The pilot boarding area were just a few miles away. Radar and electronic chart were available. After the tests were done and more critical thought were put towards the planning of the exercise, it became clear how important it is to pay attention to details. In the briefing of the simulator test, Utö pilot station was mentioned as a destination for the participant. However, it turned out that many students didn't know where they were supposed to go or where the fairway was. All this became clear after the communications, when the exercises continued until the meeting of the two ships. Different manoeuvres were made, but some not towards Utö at all. How can one make decisions concerning navigation if destination is unknown? A wrong assumption was made that all participants would know Utö area, or at least find the target on chart. This matter was not significantly important, because the data was collected from conversations. Although, it might explain why some students didn't agree to the starboard-to-starboard suggestion. Most of those who declined, passed the test. The agreement would only make sense in the situation, if you knew you were supposed to turn north after the first red lateral mark. With this information, one could argue that if destination would have been known and more students would have been willing to accept the agreement that there would have been even more failures. Careful planning in simulator exercises is important.

With this limited sample of students, radio usage turned out to be significant factor for the outcome. This should be proven with much larger sample of students, including third- and fourth-year classes. Only then it would be evident, that radio usage should be emphasized during maritime education.

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APPENDIX 1

BRIEFING FOR THE SIMULATOR TEST

You are a second officer onboard a vessel called Maria. Your destination is Turku, and your watchkeeping duties are about to end as you are approaching Utö Pilot Station from southwest, where the Master will take over as he/she has the pilot exemption certificate. The Master has ordered you to keep full speed ahead.

A while ago, when you entered the Archipelago VTS area, the VTS informed you, that there is one outbound vessel called Tankos, which is also approaching Utö Pilot Station from north.

All communication on channel 5.

THE SCRIPT

After 2min from the start of the test, Vessel Tankos will call vessel Maria, until Maria answers and is on standby.

Tankos: “I can see you on our starboard quarter. We are going to continue southbound after the fairway ends, so a question, is it okay that we meet starboard to starboard”?

Maria: “_______________________________________

____

_______________________________________”

Tankos: “Okay, thank you “.

Maria: “_______________________________________

_______________________________________”

Tankos: “_______________________________________

_______________________________________”

Maria: “_______________________________________

_______________________________________”

APPENDIX 3

BACKGROUND INFORMATION

Mark the box ☐, if you have done the course. Circle "Yes" if you have used a simulator in that course. Circle the letter "R" if you have used a handheld radio in the course.

Courses	Simulator	Radio
☐ A1 Onboard Community and Watchkeeping Duties	Yes	R
☐ A2 Terrestrial Navigation and Collision Regulations	Yes	R
☐ A3 Terrestrial Navigation A	Yes	R
☐ A4 Terrestrial Navigation B	Yes	R
☐ A5 Terrestrial Navigation C	Yes	R
☐ A6 Terrestrial Navigation D	Yes	R
☐ A7 Navigational Aids: Radar	Yes	R
☐ A8 Navigational Aids: GNSS, Compasses and Steering	Yes	R
☐ A9 Navigational Aids: ECDIS	Yes	R
☐ A10 Watchkeeping Duties 1A: COLREGs	Yes	R
☐ A11 Watchkeeping Duties 1B: Bridge Routines	Yes	R
☐ A12 Radar Plotting 1: Manual Plotting	Yes	R
☐ A13 Radar Plotting 2: ARPA	Yes	R
☐ A14 Manoeuvring 1	Yes	R
☐ A15 Radio Communication GOC	Yes	R
☐ A16 Watchkeeping Duties 2: Bridge Routines, Simulator	Yes	R
☐ A17 Search and Rescue (SAR)	Yes	R
☐ A18 Navigational Aids: INS	Yes	R
☐ A19 Watchkeeping Duties 3	Yes	R
☐ A20 Manoeuvring 2	Yes	R

Other courses when you have been using a simulator:

☐ Course(s): _________________________________ Yes R

Onboard training days: _____ Onboard bridge hours: _____

The Simulator Test

On scale 1-5 in your opinion, how easy it was for you to answer to the question on radio? 1 being very easy, and 5 being very hard: _____

On scale 1-5 in your opinion, have the courses so far in school prepared you well for this kind of situation, where other vessel asks you to make agreement on radio to navigate against the COLREGS? 1 being very well, and 5 being not at all: _____

On scale 1-5 in your understanding, how common this kind of radio agreement is in the real world? 1 being very common, and 5 being very rare: _____

Would you do something differently if you could do the same simulator test again?

If yes, what and why: Yes / No

____
____
____
____
____
____
____
____

Free comments on the exercise:

____
____
____
____
____
____
____
____

APPENDIX 4

Participant	3	4	5	6	9	10	1	2	7	8	11
TEST	1	1	1	1	1	1	0	0	0	0	0
A1	1	1	1	1	1	0	1	0	1	1	1
A2	1	1	1	1	1	0	1	1	1	1	1
A3	1	1	1	1	1	0	1	1	1	1	1
A4	1	1	1	1	0	0	0	1	1	1	1
A5	1	1	1	1	0	1	1	1	1	1	1
A6	1	1	1	1	1	1	1	1	1	1	1
A7	0	1	1	1	0	1	0	1	1	1	1
A8	1	1	1	1	1	0	1	1	1	1	1
A9	1	1	1	1	1	1	1	1	1	1	1
A10	1	1	1	1	1	0	1	1	1	1	1
A11	1	0	1	1	1	0	0	1	1	1	0
A12	1	1	1	1	0	1	1	1	1	1	1
A13	1	1	1	1	1	1	1	1	1	1	1
A14	1	1	1	1	1	1	0	1	1	1	1
A15	1	1	1	1	0	1	0	1	1	1	1
A16	0	1	0	1	1	0	0	1	0	1	0
A17	0	1	0	1	0	0	1	1	1	1	0
A18	0	1	0	1	1	0	1	1	1	0	0
A19	0	1	1	1	0	0	0	1	1	0	0
A20	0	1	0	1	0	0	0	1	1	0	0
ONBOARD_DAYS	0	0	92	150	28	42	0	270	60	200	65
BRIDGE_HOURS	0	0	70	0	0	15	0	100	20	30	50
ONBOARD_HOURS	0	0	736	1200	224	336	0	2160	480	1600	520
TOTAL_COURSES	14	19	16	20	12	8	12	19	19	17	14
RADIO_USAGE	4	3	4	7	8	5	5	0	3	2	2
SIMULATOR	6	16	6	10	10	5	6	15	18	9	9