JOURNAL OF MARITIME RESEARCH

Vol XVI. No. I (2019) pp 34–39

ISSN: 1697-4040, www.jmr.unican.es

The Cabotage Law and Indigenous Capacity Building in the Nigeria Maritime Industry: Onne Sea Port Scenario

Uwe Gruenefeld[1], Tim Claudius Stratmann[1], Yvonne Caroline Brueck[1], Axel Hahn[1], Susanne Boll[1], Wilko Heuten[1]

ARTICLE INFO

Article history:
Received 30 July 2018;
in revised form 18 August 2018;
accepted 18 November 2018.

Keywords:
Maritime piloting, accident analysis, ethnographic study, harbor, container ships.

ABSTRACT

In recent years, container ships have had to transport more and more goods due to constantly growing demand. Therefore, the container ships for carrying these goods are growing in size, while the harbors fall short in adapting to these changes. As a result, the berthing of these container ships in harbors has become more challenging for harbor pilots. In this work, we identify problems and risks with which pilots are confronted during the berthing process. First, we analyzed approximately 1500 accident reports from six different transportation safety authorities and identified their major causes. Second, we conducted an ethnographic study with harbor pilots in Hamburg to observe their actions. Third, we gained more specific insights on pilots environments and communications through an online survey of 30 harbor pilots from different European countries. We conclude our work with recommendations on how to reduce problems and risks during berthing of container vessels.

1. Introduction.

Over the past years, container ships have steadily been growing in size cf. Cullinane and Khanna (2000). This development is mainly caused by a higher demand, which requires these container vessels to transport more and more goods. But the constant lenghtening, widening, and deepening of these ships is becoming a huge problem when it comes to safely maneuvering in harbor areas. ”Most ship collisions, allisions, and groundings occur in harbors, because that is where navigation becomes restricted by land, shallow water, other vessels, and man-made structures like jetties, bridges, and piers” (cf. Frittelli (2008)). To ensure safety in harbor maneuvers, all relevant countries in the world are obligated to have pilots (e.g., in Germany cf. Hafenlotsenbruderschaft (2013)). Pilots are ex-¨ perts for specific areas and support the ship crew with important information about water depths, currents, and maneuvers. Even if the responsibility for the ship remains with the captain, pilots often take over control and give steering commands directly to the helmsman. Therefore, the pilot has to be aware of the current situation, including all environmental factors to avoid collisions or grounding. Understanding the situation is of high importance because each error has the potential to cause a collision or grounding Veit (2015). However, accident reports reveal that pilots have problems monitoring their environments successfully. As a result, accidents happen on a regular basis as shown in this work.

In this work, we want to investigate container ship berthing from the pilot’s perspective to identify situations that are critical and lack technical support. Therefore, we ask the following research questions: *(RQ1) What were the most common causes for container ship accidents in harbor areas in the past? (RQ2) What are the problems pilots have to face during the berthing process of container ships nowadays?*.

To answer our first research question *(RQ1)*, we identified problems and risks with which harbor pilots were confronted during the berthing of container ships in the past. We identified these problems and risks by analyzing approximately 1500 accident reports from six different transportation safety authorities. Here, we identified the accident reports involving container ships in harbor areas and categorized them with respect to the most common causes of these accidents. To answer our second research question *(RQ2)*, we conducted an ethnographic study in the harbor of Hamburg. Using the results from our ac-

[1]University of Oldenburg.

Figure 1: Classification of accident reports (percentage reports total percentage of all accidents for given authority).

Authority			Reports				
Name	Country	Period	Total	Container ships	in harbors	in rivers	in open sea
MAIB	Great Britain	1989-2015	519	94 *(18.1%)*	28 *(5.4%)*	22 *(4.2%)*	44 *(8.5%)*
TSBC	Canada	1990-2015	395	18 *(4.6%)*	4 *(1.0%)*	10 *(2.5%)*	4 *(1.0%)*
USCG	USA	1956-2015	193	13 *(6.7%)*	3 *(1.6%)*	8 *(4.1%)*	2 *(1.0%)*
BSU	Germany	2008-2015	177	59 *(33.3%)*	21 *(11.9%)*	24 *(13.6%)*	14 *(7.9%)*
NTSB	USA	1994-2015	140	18 *12.9%)*	7 *(5.0%)*	9 *(6.4%)*	2 *(1.4%)*
ATSB	Australia	1987-2015	68	21 *(30.9%)*	13 *(19.1%)*	1 *(1.5%)*	7 *(10.3%)*
			1492	223 *(14.9%)*	76 *(5.1%)*	74 *(5.0%)*	73 *(4.9%)*

Source: Authors.

cident analysis, we were able to identify critical aspects of the berthing process that are problematic to the same extent today as they were in the past. However, we also identified problems that became more relevant in recent years. To ensure that the results from our ethnographic study are generally valid, we conducted an online survey with 30 harbor pilots from different European countries. This gave further insights into these critical aspects.

2. Accident report analysis.

Knowing the past is the first step to understanding the present and taking actions for the future. Therefore, our first research question *(RQ1)* addresses the past by looking into the most common causes for container ship accidents in harbor areas. To understand these most common causes for container ship accidents in harbor maneuvers we looked into accident reports of different authorities. However, analyzing accident reports to gather insights is an usual method in the maritime research. Wagenaar and Groeneweg (1987) analyzed 100 accidents and found that the major types of human error that contribute to accidents are the result of wrong habits, wrong diagnoses, lack of attention, lack of training, and unsuitable personality. In general, about 75-96% of marine casualties are caused, at least in part, by some form of human error Rothblum (2000). This is understandable, since a maritime system is a system of people. To systematically investigate accident reports, several different methodical approaches were presented in related work (e.g., Koester (2001) or de la Campa Portela (2005)). More recent research shows that, over the last decade, the human error could still not be reduced and that a lack of situation awareness still dominates most accidents caused by human error Baker and McCafferty (2005). The importance of situation awareness was already identified in 2002 by Grech et al. (2002). Recently, Stratmann et al. investigated what negatively influences situation awareness, recognizing that most errors occur at situation awareness level 1, the assessment of the current situation Stratmann and Boll (2016). Compared to previous work, we concentrate on a subset of accident reports that involve container ships in harbor areas. Here, we assessed what kinds of accidents happened and what caused these accidents.

2.1. *Corpus.*

We analyzed 1.492 maritime accident reports written in English from six transportation safety authorities between the years 1956 and 2015. The reports were gathered from the British Marine Accident Investigation Branch (MAIB)[2], the Transportation Safety Board of Canada (TSBC)[3], the United States Coast Guard (USCG)[4], the Bundesstelle fur Seeun-¨ fallUntersuchung (BSU)[5], the American National Transportation Safety Board (NTSB)[6], and the Australian Transportation safety Board (ATSB)[7]. We crawled the accident reports with scripts from Stratmann and Boll (2016).

2.2. *Statistics.*

Depending on the national traffic of the transportation safety authorities, accidents with different types of vessels are reported (e.g., fishing vessels, passenger ships, bulk carriers, tankers, etc.). However, all authorities that we included in our accident analysis are investigating accidents with container ships. Therefore, we identified all accident reports that involved container ships, which were 223 out of 1.492 accident reports (14.9%) (see Table 1). We crawled all published accident reports from all transportation safety authorities, deciding not to use predefined time windows. Therefore, the periods of these reports vary among the different authorities (e.g., the accident reports from USCG start in 1956, although container ships were not existing at that time).

Since our focus is investigating harbor maneuvers, we divided the container ship accidents into different categories (in harbors, in rivers, in open sea). These categories reveal that container ship accidents happen more often in harbor areas than in river or sea areas, evidenced by were 76 out of 223 reports (34.1%). However, that is only two more accidents than in

[2]https://www.gov.uk/government/organisations/marine-accident-investigation-branch, last retrieved July 30, 2018
[3]http://www.tsb.gc.ca/eng/rapports-reports/marine/index.asp, last retrieved July 30, 2018
[4]https://www.uscg.mil, last retrieved July 30, 2018
[5]https://www.bsu-bund.de/EN last retrieved July 30, 2018
[6]http://www.ntsb.gov/investigations/accidentreports/pages/accidentreports.aspx last retrieved July 30, 2018
[7] https://www.atsb.gov.au/marine last retrieved July 30, 2018

rivers (74/223, 33.3%), and three more than in open sea (73/223, 32.7%). Still, it means that a third of all container ship accidents happen in harbor areas.

As a next step, we took all 76 accident reports of container ships in harbors as our subset to further analyze. We identified several different accidents: injuries (34/76, 44.7%), collisions (29/76, 38.2%), groundings (5/76, 6.6%), fires (3/76, 3.9%) and other (5/76, 6.6%). Here, injury is the most common type of accident. This includes, for example, pilots falling off of their ladders, or crew members losing balance and falling into the water or from a platform on the ship. Many of those accidents are fatal. We manually identified what caused these accidents: human errors (41/76, 53.9%), technical issues (26/76, 34.2%) and external factors (9/76, 11.8%). Human errors are mistakes made by pilot or crew member that lead to incidents such as falling off a ladder, whereas technical issues refer to equipment problems, such as a ladder falling apart even though all routines and checks were successfully implemented. An external factor in this scenario could be an unpredictably high wave hitting the pilot on the ladder. However, unpredictably high waves are not a phenomena of harbor areas. Here, we refer to bad weather conditions such as fog or heavy rain.

2.3. External factors.

In previous work, the causes stated by accident reports are mostly human error or technical issues. However, we believe that external factors, especially weather conditions, also play an important role. In the following section, we listed some of those accidents that were to some extent caused by unforeseen weather conditions or restricted visibility.

MAIB, Report No 22/2013 The vessel's bridge team lost situational awareness in dense fog as the vessel maneuvered from berth on the north shore, before grounding on the opposite side of the river.

BSU - Investigation Report 507/11 There was a strong rising tide and visibility was very impaired due to fog.

MAIB, Report No 7/2011 The vessel's design restricted the ability of personnel on the bridge to see objects near the vessel.

BSU - Investigation Report 264/10 The view astern on the tug was severely restricted by the funnel.

MAIB, Report No 17/2008 There were no defined operational limits or procedures for the tug operators when assisting / towing in restricted visibility.

MAIB, Report No 1/2008 The actions of the pilot to reduce the speed of approach of the vessel's bow were unsuccessful because Marineco Toomai was positioned just aft of amidships of Logos II and not on the port quarter as the pilot had assumed; The pilot did not accurately monitor the position of Marineco Toomai; There was a lack of co-ordination and communication between the pilot and the tug's skipper.

MAIB, Report No 8/1998 The pilot could not see the tug from the bridge and assumed that she had been running with the ship stern-to-stern, from which position it would have been relatively easy for the tug to position herself on the ship's port quarter.

2.4. Discussion.

To summarize our results from the accident report analysis, we can say that container ship accidents often happen in harbor areas (34.1%). To answer our research question *(RQ1)*, the most common causes are human errors (53.9%) and technical issues (34.2%). Stratmann and Boll (2016) give detailed insights on human errors in accident reports. However, we also identified external factors as a common cause for maritime accidents (11.8%). When an external factor is the cause listed in an accident report, it typically refers to restricted visibility. The recommendation given by many accident reports is knowing the operational limits (e.g., for operations in dense fog). However, even with a good weather forecast, it is not uncommon that a weather change surprises operators and maneuvers cannot be stopped. For the future, it would make sense to develop technical solutions to solve the problem of restricted visibility.

3. Ethnographic study.

After investigating the most common causes for accidents in the past, we want to understand which problems pilots are facing during the berthing process nowadays *(R2)*. Furthermore, while accident reports describe accidents fairly well, they do not give us a good understanding of the procedure and relevant information for pilots during the docking process. To address both points, we conducted an ethnographic study on a container vessel. The vessel is called 'Choapa Trader' (IMO number 9407885) and it is a container vessel. The dimensions of the ship are 294.1 meters long and 32.29 meters wide. The ship has a gross tonnage of 52.726 tons and was built in 2009. The vessel was going from Bremerhaven to Hamburg (both cities in Germany).

3.1. Observations.

During our observations, we took pictures and wrote a protocol of all the pilots' actions that we observed. These pictures are available for free on Github[8]. We observed that, along the way from Bremerhaven to Hamburg, at every point in time there was one pilot on board. The only exception was within the harbors, where two pilots were supporting the put out to sea and the ship berthing. The pilot change always started with the old pilot leaving the ship bridge. The new pilot then boarded on the lee side of the ship. Before the old pilot left the ship, both shortly exchanged important information about the ship maneuverability, unusual events etc. After that the new pilot goes to the ship bridge and the old pilot leaves the ship via a pilot ladder onto the pilot ship. To summarize our observations on the ship bridge, we classified our gathered data into three main categories.

Environment We observed that many different objects in the environment are relevant almost simultaneously (tugboats, buoys, moored ships, bypassing ships, quay walls) all while the tugboats were moving quickly around the ship and changing

[8] https://github.com/UweGruenefeld/EthnographicStudy

their positions. However, in many points of time the tugboats or other objects were not visible for the pilot because of occlusion (e.g., by container) or daytime / weather conditions (e.g., upcoming fog). Interestingly, pilots preferred to make eye contact with static objects to understand their ship's movement (e.g., in the last part of the docking process they looked at the quay wall and evaluated how fast their vessel approached it).

Behavior Interestingly, harbor pilots prefer to be on the outside of the ship bridge. This is mostly because they want to make eye contact with the tugboats or other important objects around (e.g., quay walls, buoys). The closer an object is, the more important is it for the pilots. But because their vision is occluded by containers or other parts of the ship, pilots have to move around on the ship bridge to find the best position for seeing the important objects around. However, in many situations they cannot observe all objects at the same time, and therefore have to make assumptions about their positions.

Communication Since two pilots assists in the docking process, one of them takes over the communication with persons that are not located on the ship bridge (e.g., tugboat drivers, onshore workers). This communication is done via UKW or VHF. Commands on the ship bridge are given verbally to the people. During our observation, it became clear that pilots often had to repeat parts of their commands because they were hard to understand, due to environmental conditions (e.g., background noise, wind).

3.2. Interviews.

During the trip from Bremerhaven to Hamburg we conducted semi-structured interviews with the captain of the ship and boarding pilots. In the first part of the interview, we talked about demographics and experience on container vessels. All participants of our interviews were male. The captain was 45 years old and had 28 years of experience as a mariner. The pilots were between 34 and 42 years old and had between 5 and 14 years of experience as mariners. Overall, we asked four participants (one captain and three pilots).

In the second part of the interview, we asked questions about the ship berthing process. All participants agreed that berthing the ship is by far the most difficult part of the job. We asked the participants if they can state why they think berthing a container vessel is so difficult. In their answers, our participants came up with three main contributing factors explaining why ship berthing is difficult: (1) large container vessels move into small ports involving many other entities such as tugboats or buoys, (2) many people assist in the docking process and the communication among them is difficult, and (3) a stream of information during each docking process has to be processed, and important information in this stream has to be identified quickly. Furthermore, participants stated that a lot of information is not available at any moment because it either takes too long to get the information, or the information is simply not available. The combination of all these factors makes the berthing process highly mentally demanding for the pilot.

In the third and last part of the interview, we asked the participants if they had any ideas for new technologies that might help making harbor maneuvers more safe. The following is a list of these ideas:

- Augmenting the ship bridge windows with information during river maneuvers. Thereby, mariners can observe the environment, and at the same time keep track of the instruments.
- The field of view on ship bridges is quite limited, which is not a problem in most cases. However, in docking scenarios, it is very difficult to keep track of objects that are close to the ship.
- Because the pilots like to have eye contact with their environments, it is important to be unrestricted in moving around on the ship bridge. For example, notebooks that some pilots use pose a problem, because they do not allow pilots to move on the ship bridge.
- One pilot said that in some scenarios it would be helpful to be able to interact with the portable pilot unit (PPU) in a hands-free operation mode.
- Some of the pilots mentioned the idea of virtual objects replacing real objects. Using this approach, they would be able to see virtual buoys, which would not only be much easier to keep up-to-date, but also would be visible even if occluded by something else.

Most interestingly, all pilots stated that they like new technologies in general. One pilot mentioned in particular the experience he had when PPU's were introduced. He said his first impression was that it would not be useful. However, it became a helpful tool, one without which he would not want to work.

During the ethnographic study, we observed that pilots wanted to have eye contact with objects around them in order to be aware of their positions. This was especially true for objects that were very close. With regard to our accident analysis, it became clear why many accidents happen in restricted visibility. Keeping eye contact with surrounding objects is not possible in that situation, and current technologies are not suited to assist because either it is technically challenging to monitor close objects or the virtually perceived information does not feel well-integrated into the real environment. A cognitive process is necessary to integrate the virtual information into the real world. Additionally, we observed that the communication with tugboat drivers and other workers is quite error-prone. The insights gained from our ethnographic study already show possible answers to our research question *(R2)*. However, to ensure that the results from our ethnographic study are generally valid, we conducted an online survey with harbor pilots.

4. Online survey with harbor pilots.

During our ethnographic study we identified problematic factors that might lead to new accidents in the future (e.g., communication between pilots and tugboat driver seems to be rather error prone). However, the study was limited to experiences made in one harbor. To identify the most important problems, we needed to further understand the environments in which harbor pilots work and to identify which problems persist across harbors. To investigate these aspects, we designed an online survey that we conducted with harbor pilots from different countries.

4.1. Design.

In our survey, we first wanted to understand more about the environment in which harbor pilots work. Therefore, we asked questions about the working environment. As a next step, we asked more specific questions regarding the communication between pilots and tugboat drivers during the docking process, because we had identified this as a critical aspect during our ethnographic study. We closed the survey with questions asking about the demographics of the harbor pilots.

4.2. Pretest.

Before asking pilots to participate in our survey, we did a pretest with an experienced pilot from Germany. Mainly, we focused the pretest on understand-ability and acceptability. First, we asked the pilot to fill out the questionnaire and make notes during that process. Apart from minor corrections, the survey was understood well. However, some questions were read with concern by our experienced tester. It was said that a survey that raises the impression that technology will improve jobs in the future also creates the fear of jobs becoming redundant and replaced by technology. Therefore, we had to make sure that this was not the impression one would get from reading the questions in our survey. To further ensure this, we added a detailed introduction explaining the reason for the survey.

4.3. Participants.

Overall, 30 harbor pilots (no female), aged between 35 and 63 (M=50.27, SD=7.22) participated in our online survey. Sixteen pilots were German-speaking, and mainly from the ports in Hamburg and Bremerhaven. 14 pilots were English-speaking, from ports distributed over Europe (e.g., Rotterdam, Antwerp). The experience of participants ranged from one to 26 years with an average of 15 years (M=14.97). Moreover, non of the harbor pilots in our survey worked as a pilot in a different area before (e.g., river pilot). We recruited the participants by manually crawling harbor pilots homepages in Europe and contacting them via e-mail.

4.4. Results.

In this section, we report the results of our online survey in the same order the questions appeared within the survey.
Q1: Who do you stay in contact with during harbor maneuvers? The answers were (in order): tugboat (26/30, 86.7%), mooring hawser (22/30, 73.3%), harbor control (14/30, 46.7%), captain (12/30, 40.0%), other pilots (10/30, 33.3%), bridge team (8/30, 26.7%), other ships (6/30, 20.0%) and rescue staff (2/30, 6.7%).
Q2: How many persons do you communicate simultaneously with during a harbor maneuver? The number varies between three and ten. On average the pilots have to talk to six different persons at the same time (M=5.90, SD=1.74).
Q3: What is the maximum number of tugboats involved in one of your harbor maneuvers? The number varies between two and six, but the average number of tugboats is four (M=4.40, SD=0.99).
Q4: What information do you communicate with the tugboats? Mainly, pilots communicate about applied forces and their directions (30/30, 100%), but also the positioning of tugboat (12 / 30, 40.0%), the maneuver plan (7/30, 23,3%), distances (6/30, 20.0%), and mooring line length (1/30, 3,3%).
Q5: What are some sample instructions you give to a tugboat? Analyzing the answers of this question, it become clear that all instructions were short and concise but do not share a uniform structure. One pilot said that each harbor uses different instructions.
Q6: Can you describe any safety-critical experiences due to miscommunication with a tugboat? The missing uniform structure for exchanging instructions can lead to miscommunication. One pilot mentioned that he was facing a critical encounter because a tug was on the wrong side of the ship, due to his not being experienced in the local instructions. Overall, 25 of 30 pilots reported having experienced a critical situation (e.g., due to language barriers, not paying attention, not experience with local instructions but also low UKW quality).
Q7: Has the communication between you and the tugboats changed over the last few years? If yes, how? Despite the experience with critical encounters due to miscommunication, 23 pilots stated that nothing has changed in the last decade with regard to communication between pilots and tugboat drivers. The other 7 pilots can only state minimal changes. One pilot mentioned that the instructions did not change much because they are treated as very traditional and local.

4.5. Discussion.

The results of our online survey show that most of the problems identified in the ethnographic study in Hamburg also apply to other European harbors. The communication with six different parties at the same time is especially mentally demanding. Given the error-prone technology, it became clear why accidents with wrongly positioned tugboats happen quiet frequently. Furthermore, it explains why almost all pilots (83.3%) recalled having experienced safety-critical situations due to miscommunication. With container ships increasing in size, this is a serious problem that needs to be dealt with in the future.

5. Recommendations.

Based on our findings from the accident analysis, the ethnographic study and the online survey, we have come up with the following recommendations to reduce problems and risks during the berthing process of container vessels:
Human error. Support the human in the decision-making process to avoid human error. As mentioned earlier, ship bridges are technical systems that mainly consist of humans. Developing systems that support humans may reduce the number of human errors in those systems.

Situation Awareness. In many accident reports, we found that a lack of situation awareness leads to wrong decisions, causing most collisions. Therefore, we want to highlight the importance of Bridge Resource Management for situations of navigation with a pilot on board, and to effectively communicate decisions, as suggested by Chauvin et al. (2013).

Near-distance Radar. During our studies, we observed that information about the position of near-by objects is required to successfully berth a large container vessel. Therefore, we suggest to assist pilots in harbor maneuvers with a novel radar system that allows pilots to effectively monitor near-by objects. Existing radar systems cannot solve this problem for two reasons: (1) objects that are coming too close will not be visible in the radar, and (2) the mapping of these objects onto a 2D screen makes it harder for pilots and seafarers to understand the positions of these objects in the real world. Therefore, we suggest the use of head-mounted Augmented Reality glasses to overlay the real world with information about the positions of occluded objects.

Communication. During the ethnographic study and online survey, we identified another important issue: the communication of the pilots with the tugboat driver. In our accident report analysis, we saw a couple of accidents that were caused by misunderstandings between the pilot and tugboat driver. Here, it is contradictory that each harbor implements its own speech commands. Furthermore, it is problematic that pilots do not have an effective way to monitor whether the tugboat driver implements the given instructions.

Conclusion.

In our work, we investigated the berth of container ships from the pilot's perspective. We revealed that more than one third of all container ship accidents happen in harbor environments. Furthermore, our ethnographic study showed that pilots face problems when monitoring their environments because many objects are hidden behind containers or not visible due to bad weather conditions. In a following online survey of pilots, we identified the communication via UKW/VHF as problematic due to missing standards and technical limitations. We think our work is a first step towards a better understanding of the ship berthing process and its associated problems. Future work can be built upon this work to develop solutions for solving the identified problems.

Acknowledgement.

We thank the Ministry of Science and Culture of Lower Saxony for supporting us with the graduate school "Safe Automation of Maritime Systems (SAMS)". And we would like to thank the BUSS DATA GmbH for supporting us with our ethnographic study.

References.

Baker, C., McCafferty, D., 2005. Accident database review of human element concerns: What do the results mean for classification? In: Proc. Int Conf. Human Factors in Ship Design and Operation, RINA Feb. Citeseer.

Chauvin, C., Lardjane, S., Morel, G., Clostermann, J.-P., Langard, B., 2013. Human and organisational factors in maritime accidents: Analysis of collisions at sea using the hfacs. Accident Analysis & Prevention 59, 26–37.

Cullinane, K., Khanna, M., 2000. Economies of scale in large containerships: optimal size and geographical implications. Journal of Transport Geography 8 (3), 181 – 195. URL: http://www.sciencedirect.com/science/article/pii/S0966692300-000107

DOI: doi: https://doi.org/10.1016/S0966-6923(00)00010-7

De la Campa Portela, R., 2005. Maritime casualties analysis as a tool to improve research about human factors on maritime environment. Journal of Maritime Research 2 (2), 3–18.

Frittelli, J., 2008. Ship navigation in harbors: Safety issues. In: CRS Report for Congress.

Grech, M. R., Horberry, T., Smith, A., 2002. Human error in maritime operations: Analyses of accident reports using the leximancer tool. In: Proceedings of the human factors and ergonomics society annual meeting. Vol. 46. SAGE Publications, pp. 1718–1721.

Hafenlotsenbruderschaft,¨ 2013. Hafenlotsenordnung. http-://www. hamburg-pilot.de/Hafenlotsordnung_2013_Stand_070-52013. pdf, letzter Zugriff am 02. November 2017. §5 Absatz 1 Nummer 1 HmbGVBl (Hamburgisches Gesetz- und Verordnungsblatt).

Koester, T., 2001. Human error in the maritime work domain. In: Proceedings of 20th European Annual Conference on Human Decision Making and Manual Control. pp. 149–158.

Rothblum, A. M., 2000. Human error and marine safety. In: National Safety Council Congress and Expo, Orlando, FL.

Stratmann, T. C., Boll, S., 2016. Demon hunt - the role of endsley's demons of situation awareness in maritime accidents. In: Bogdan, C., Gulliksen, J., Sauer, S., Forbrig, P., Winckler, M., Johnson, C., Palanque, P., Bernhaupt, R., Kis, F. (Eds.), Human-Centered and Error-Resilient Systems Development. Springer International Publishing, Cham, pp. 203–212.

Veit, S.-M., 2015. Die elbe ist ein enges revier. http://www.taz.-de/ !879062/, letzter Zugriff am 11. Juni 2017.

Wagenaar, W. A., Groeneweg, J., 1987. Accidents at sea: Multiple causes and impossible consequences. International Journal of Man-Machine Studies 27 (5), 587–598.