

## THE ENTRANTS' VIEW ON COLLISION AVOIDANCE

### ZAPOBIEGANIE ZDERZENIOM NA MORZU Z PERSPEKTYWY ADEPTÓW

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**Abstract:** Collisions are a serious threat to ship's safety and despite the existence of codified rules and obligatory COLREG course for the seafarers, the number of maritime accidents is still great. Noticing this we have decided to use group model building to extract the knowledge about the process of collision avoidance from our group of experts. As a result, we obtained 18 factors which we have divided into 4 categories in order of importance. After reviewing the results we have noticed that the experts focused on superficial and theoretical aspects of collision avoidance. Therefore we have concluded that their knowledge despite our initial assumptions was insufficient to thoroughly revise this topic. However, we have also recognized some patterns that would suggest that the current rules could be improved. Our goal is to cause a discussion that will, hopefully, result in changes in education, laws, or both.

**Keywords:** maritime navigation, collisions, collision avoidance, knowledge elicitation methods.

**Streszczenie:** Zderzenia są poważnym zagrożeniem dla bezpieczeństwa statku i pomimo istnienia skodyfikowanych przepisów oraz obowiązkowej dla marynarzy znajomości Międzynarodowych Przepisów Zapobiegania Zderzeniom na Morzu, liczba wypadków morskich wciąż jest ogromna. Zauważając to, podjęto decyzję o wykorzystaniu modelowania grupowego w celu wydobycia wiedzy o przebiegu procesu mijania się statków z wybranej grupy ekspertów. W rezultacie uzyskano 18 czynników, które zostały podzielone na cztery kategorie w zależności od ich znaczenia. Po przejrzeniu wyników zauważono, że eksperci skupili się na powierzchniowych i teoretycznych aspektach zagadnieniach unikania zderzeń statków. W związku z tym wysunięto wniosek, że ich wiedza, pomimo naszych pierwotnych założeń, nie była wystarczająca, żeby dogłębnie przyjrzeć się tematowi. Niemniej dostrzeżono także pewne wzorce, które mogą sugerować pole do poprawy aktualnie funkcjonujących przepisów. Celem pracy jest spowodowanie dyskusji, która, być może, zaskutkuje zmianami w systemie edukacji marynarzy, prawie lub też w obu tych dziedzinach.

**Słowa kluczowe:** nawigacja morska, zderzenia, zapobieganie zderzeniom, metody pozyskiwania wiedzy.

## **1. INTRODUCTION**

There are several issues at present within the maritime industry, with one of them being collision avoidance, especially in situations including more than two vessels. This is partly due to the fact that being a mariner is a hazardous occupation [Oldenburg, Baur and Schlaich 2010; Oldenburg and Jensen 2012] a covenant between the man and the sea, suited only for the most daring [Mellbye and Carter 2017], with experience being one of the most important virtues of a seafarer [Salter 2018]. Due to the fact that such a huge part of skills required for seafaring can only be obtained by seafaring itself, there is a lack of set boundaries that are so necessary in this modern era, especially in case of collision avoidance. The vast usage of the vague term 'good seamanship' shows this perfectly [Salter 2018].

The research currently being performed is more dedicated to collision avoidance algorithms [Lenart 2015; Perera et al. 2015; Lisowski 2016; Koszelew and Wołajsza 2017; Szłapczyński and Szłapczyńska 2017; Ożoga and Montewka 2018], which may be related to the autonomous merchant vessels' concept nearing its implementation [He et al. 2017] and progress in computational techniques. Instances of eliciting the experts involved in the collision avoidance daily routine in order to gain their insight into their experience and understanding of this safety-critical process are less frequent [Chauvin and Lardjane 2008; Nilsson, Gärling and Lützhöft 2009; Kircher and Lützhöft 2011; Wróbel, Gil and Montewka 2018], particularly when trainees are to be involved. For the latter case, simulator training is often considered as a case study [Sellberg, Lindmark and Rystedt 2018] but there are few research items on entrants' actual understanding of the collision situation and actions required to be taken [Mohović, Mohović and Barić 2015; Zekić, Mohović and Mohović 2015; Mohović, Barić and Mohović 2016].

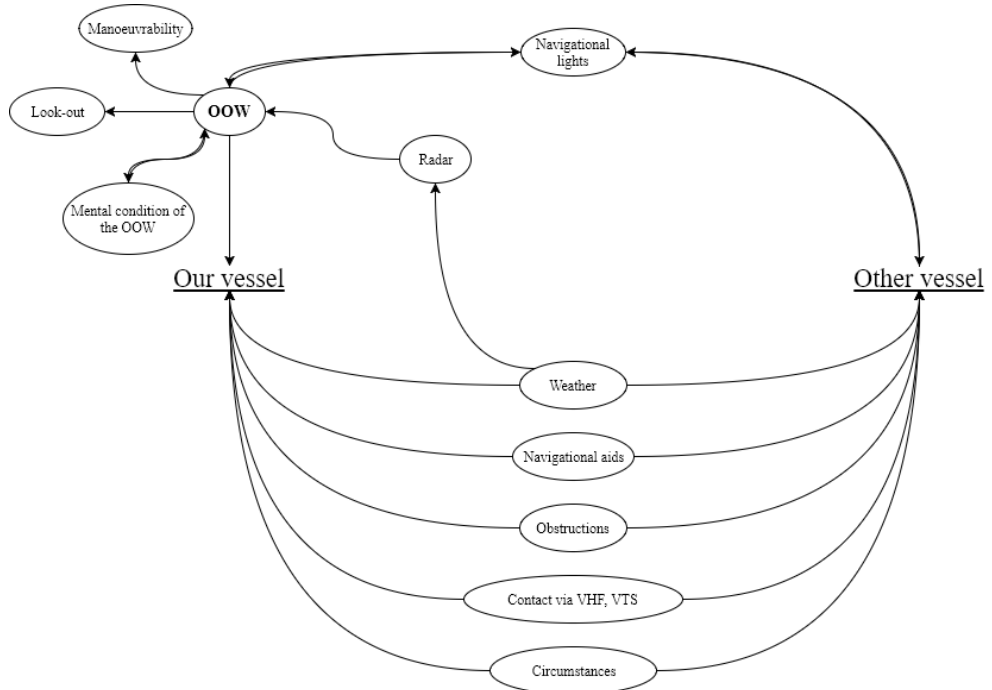
Noticing this research gap, we began to look for a method to elicit knowledge about collision avoidance from the entrants (or future experts, in other words), potentially in order to identify existing gaps in understanding of the subject, through group model building.

## **2. METHODS**

Group model building – a method for securing the experts' tacit knowledge – has been defined as “a process in which team members exchange their perceptions of a problem and explore questions such as: what exactly is the problem we face? How did the problematic situation originate? What might be its underlying causes? How can the problem be tackled?” [Vennix 1996]. It is as simple as it is successful, being based on mental, verbal, numerical and graphical knowledge, allowing the experts to express their knowledge, thoughts and ideas freely and clearly. The

method structures the development of knowledge descriptions into three sequential phases: the positioning, description and discussion phases [Ford and Sterman 1997].

For our study, we have chosen 9 entrants – top second-year students of Navigation major, each with at least a month of practice, mainly on board s/v „Dar Młodości”. In our opinion, the ideas the students have are usually new and fresh as they are usually newcomers to the industry, which in turn means that their minds are free of limiting influences, resulting in them having a bigger room for innovation. Their goal was to go through a process of vessels passing each other and to express their view on what factors should be considered in a case of collision avoidance. We have followed the aforementioned phases, with each being divided into several steps, starting with establishing context, focusing on one relationship at a time and illustrating the method. This was done by explaining the experts the concept of the knowledge elicitation method, describing the relationship by identifying and defining the input and output variables that the relationship describes, providing them with a description aid and giving them a relationship description worksheets of an analogous setting – a collision avoidance situation of a car on the road.



**Fig. 1. Exemplary chart showing individual factors**

Following this was the description phase, divided into the visual, verbal, textual and graphic description. This part is mainly done by the experts themselves and allowed them to project their knowledge onto paper. The products of this stage were complex charts describing elements to be considered in a considered situation. An example of the said chart can be seen below.

The next step was the discussion phase, consisting of the examination of individual descriptions, as well as comparing them. The previously mentioned papers were collected and used as the base of this phase. This helped the experts to come up with other ideas that were not mentioned by them before.

We have also followed rules set by Andersen and Richardson [Andersen and Richardson 1994], such as maintaining visual consistency, avoiding talking heads and reflecting after each major piece. Recognizing the issues arising from using overcomplicated mechanisms for estimate combination, we tried to focus on risk assessment as a means of describing, rather than quantifying risk [Rae and Alexander 2017].

We have decided to classify the mentioned factors into four categories: the most important, important, less important and of marginal importance, mentioned by 81–100%, 61–80%, 31–60% and 0–30%, respectively.

### **3. RESULTS**

#### **3.1. Most important factors**

There were four elements mentioned by all the experts – contact between the ships via VHF, VTS, etc.; the manoeuvrability of the vessel; navigational lights of the vessels and the weather. The highest category also includes proper look-out mentioned by 89% of the experts. While contact between the ships via any means does not need any additional explaining, the term manoeuvrability of the vessel may be understood in more than one way.

In our experts' view, it is to be understood as engine and rudder control with some of them mentioning several different manoeuvres one might undertake depending on a situation – using speed, course or both. Experts also found the knowledge of manoeuvring characteristic of own vessel crucial in determining the safest action in any given circumstances. The navigational lights were one of the factors corresponding to both ships, as they help us in identifying the other vessel and her manoeuvres as well as allow others to identify our own vessel. Another wide term used by all of our experts is weather in which they include amongst others state of visibility, wind, the seas and the currents. They have concluded that an impact of adverse weather conditions on a vessel cannot be ignored as well as a difference in scale of said impact depending on a size of the vessel. Fifth mentioned factor – proper look-out – being the basis of COLREG includes constant visual and audial observation, as well as using all other available means. Proper

look-out is fundamental when it comes to interpreting the situation around own vessel and determining any possible dangers, however, we always have to consider how mentioned earlier weather affects both our and others' ability to maintain a proper observation [Cockroft and Lameijer 2004; Rymarz 2004; van Dokkum 2012; Śniegocki 2016].

### **3.2. Important factors**

The second group of factors classified as important includes radar, additional navigational equipment and circumstances. Radar – mentioned by 78% of the students – is considered to be one of the most important and useful means of keeping an appropriate look-out thus no wonder it is a topic widely covered in maritime schools. Experts also stressed that it is crucial not to rely solely on radar reading and to always cross-check information. Having that in mind it is understandable that the next factor – additional navigational equipment – was mentioned by 67%. Most of them mentioned AIS which can be useful in identifying observed vessel and checking values of its course and speed with the ones indicated by radar. Others included also ECDIS and GPS which can be used to increase situational awareness. Last in this category is a wide term of circumstances listed by 67% of the experts. It included mainly other vessels in the vicinity, their intentions and manoeuvres. What is important to notice here is that COLREG only applies for close-quarters situations involving two vessels [Cockroft and Lameijer 2004; van Dokkum 2012], while reality can, in fact, be more complex and thus we have to consider how our manoeuvre towards another vessel will affect our situation with other ships in the vicinity.

### **3.3. Less important aspects**

The third group marked as less important factors includes environmental conditions, aids to navigation, sound signals, the experience of the OOW, ship's technical condition and obstructions. Numerous geographical factors were mentioned by 44% of our experts. Some of them, like available depth or rocks, come to mind easily, but others, like venture effect, can be less obvious, although definitely not less important. Aids to navigation were also mentioned by 44% of the experts. While trying to avoid collision with another vessel, we should make sure not to collide into a buoy or a lighthouse. Mentioned by 44% of the experts, sound signals take up whole Part D of COLREG, but apparently, they do not seem as obvious as lights mentioned by everyone. 44% of students considered the experience of the officer on watch to be a factor in collision avoidance. Worth mentioning is that a lot of our experts stated that in case of doubt an OOW should not hesitate to call the master to the bridge for an advice – putting the safety of the vessel and its crew over their own pride. Ship's technical condition was listed by

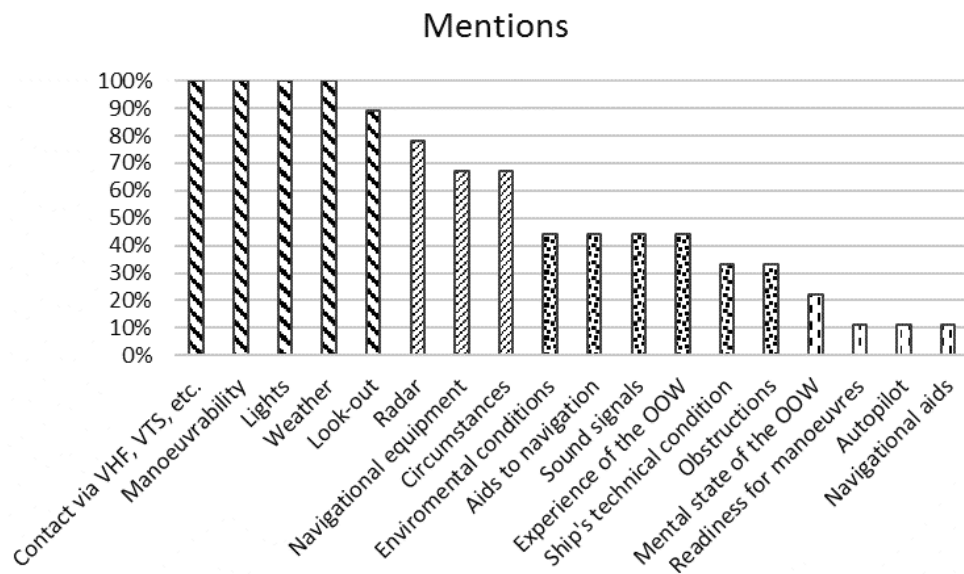
33% of the students. This is obviously important and includes mainly the way the ship will perform over time. The last factor in this group are obstructions mentioned by 33% and mostly explained as wrecks and other obstacles we can usually find charted on navigational charts.

### **3.4. Marginal factors**

The last category contains factors of marginal importance – mentioned by less than 30% of the experts. This includes the mental state of the OOW, preparedness for unexpected manoeuvres, use of autopilot and navigational aids. The psychological condition of the officer was considered only by 22% of our subjects. Factors such as fatigue and influence of repetitive work and routine should in our opinion play a greater role in evaluating officer's decision making in a collision situation, as human error takes its toll on maritime industry [Baker and Seah 2004]. Another barely mentioned factor was readiness for unexpected manoeuvres – listed only by 11% of the experts. The ones who did mention it considered it as a sort of an umbrella term describing both readiness of the crew and the vessel itself with components such as good communication between the bridge team and the rest of the seafarers on board, well-trained crew, clear procedures in case of emergency and proper maintenance of the machinery. Next factor – use of autopilot – was also listed by 11% of the students. It notes the difference in reaction time and the characteristics of a manoeuvre between a human and an autopilot. The last factor – navigational aids – was also mentioned by 11% of the experts and includes mainly use of nautical publications available on the bridge. All of the above-mentioned terms from this category could fit into a wide term of good seamanship. However, it is our belief that this term is too vague to really be useful, and may cause trouble to young, inexperienced mariners, as there is no reliable source from which one could learn what exactly it covers.

A summary of mentioned factors can be found in Figure 2, that depicts a chart presenting all the elements as listed by experts. Individual factors were divided into four groups, distinguished on the chart by different designs.

There were also clear patterns as to which parts of ships' safety were barely mentioned – the ones that the students did not use or were not taught about before, including the mental condition of the OOW, ship's technical condition, navigational aids and autopilot. Thus we can clearly see that this method is good for eliciting knowledge but one cannot elicit something that is not readily apparent to experts.



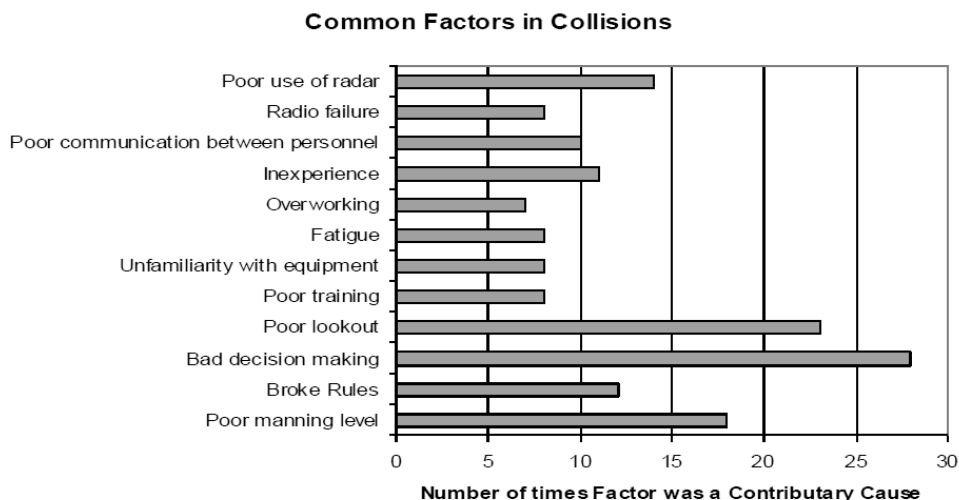
*Fig. 2. Factors mentioned by entrants in order of importance*

#### 4. CONCLUSIONS

It is easy to notice that the entrant's knowledge was closely related to their studies. The prevailing factors were the ones straightforwardly mentioned in the COLREG, with other aspects being referred to by less than a half of the experts. Mentioned elements lacked depth which could be a result of both the vagueness of the rules and the experts' lacks in experience. Simultaneously some rules of the road were completely omitted leading to a conclusion that the students were not taught the whole COLREG before their first practice.

Still the results we have elicited from the entrants were mostly consistent with common factors in collisions as described by Martin Ziarati and Reza Ziarati [Ziarati and Ziarati 2007] and seen in a Figure 3 below.

Lookout, use of radar and radio equipment scored highly both in ours and Ziarati's study. However, a lot of times the factors being contributory cause to a collision were the ones connected to soft skills like experience or communication between personnel. Similar factors were marginalized or even completely omitted by our entrants and that may be a reason for concern as well as an indication as to on which parts of education should maritime universities focus more nowadays.



**Fig. 3.** Common Factors in Collisions

Source: [Ziarati and Ziarati 2007].

We think that the maritime industry in general and ships safety on the sea, in particular, could benefit from clarification of the rules. It could start with either better explaining or excluding terms such as ‘good seamanship’, ‘proper’ or ‘substantial’. Another step might be setting the rules for cases of more than two vessels being present, which could be exceptionally helpful in today's’ busy seas.

We are aware that the results of our study were tainted by the fact that we have chosen students instead of skilled officers as our experts and by the small probe of the entrants. Because of their lack of proper practice at sea, they have less hands-on experience, however, it was our belief that their views might bring some new, fresh perspective on the topic of collision avoidance. We believe that a broader research is required to produce more conclusive and complete results. For instance, the applied method could be used to elicit multi-national experts.

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