Avoiding Collisions At Sea – Pareto Analysis

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ABSTRACT: It has been almost 40 years since the 1972 International Regulations for Preventing Collisions at Sea known as COLREGs were introduced, and regular amendments have been taking place accordingly ever since. Over the last half-century despite improvements in navigational aids such as ARPA and attempts to raise the standards of training through the various STCW conventions, collisions still occur. Many studies and accident reports indicate that the accidents were caused by either human error or are associated with human error as a result of inappropriate human responses. Collisions commonly represent many of these accidents. This paper discusses key issues regarding the application of Collisions Regulations (COLREGs) at sea, reports on the outcome of a recent EU funded eCOLREGs project known as ACTs and a report on a Pareto Analysis supporting the work being carried out in a new project called ACTS Plus which considers more complex cases where there are several rules applied or where there are more than two ships involved in a collision. This paper does not attempt to examine each and every rule included in regulations but the EU Project ACTs and ACTS Plus online platform include some 300 scenarios, many developed and videoed in ship simulators, for those interested to review and explore more. This paper discusses the importance of studying cases where the applications of certain rules or where more than one rule applies are open to misinterpretation.

KEYWORDS: *COLREGs, maritime education and training, collision avoidance, Pareto Analysis*

1. INTRODUCTION

The International Maritime Organisation (IMO) developed the first standard for Vocational Education and Training (VET) programmes for merchant navy officers (STCW) in 1978, and it has been amended in 1991, 1995, 2003 and 2010 respectively. However, there are currently no mechanisms to monitor how their standards are being applied as many VET providers have been found not to follow many requirements. Therefore, there has always been substantial diversity on the knowledge of seafarers affecting the safety of life at sea. The COLREGs provide various rules as to passing, crossing, overtaking manoeuvres to be made; detailing which ships have the right of the way depending on the circumstances and the types of ships involved, and what actions these ships should take. It also describes the rules on the signals (lights, shapes and sound signals). The recent IMO bulletin “maritime knowledge centre” reports that more than 90% of the collisions are attributed to the human factor (IMO, 2010), and this had earlier been reported by Parker (2010). Ziarati (2017) reports that majority of accidents and incidents are related to

collisions. There is a clear indication that Collision regulations are either not understood or ignored although it is a primary set of rules for taking actions to avoid collisions.

It is interesting to note that the earlier studies had been showing that 85% percent of all accidents are either directly initiated by human error or are associated with human error as a result of inappropriate human response (Ziarati, 2006). The human error reported to causing the accidents is now to have apparently increased by 5 percent in recent years. This may be linked to the revolution in automated equipments/systems on board the ships causing the number of accidents to decrease while increasing human element attributed to accidents. The Pareto Analysis methodology of Ziarati (2006) has been applied to identify where maximum benefits could be felt and which Rule if applied correctly could reduce the number of collisions most.

2. COLREGs IN MET

The purpose of Collision Regulations and resources needed have already been discussed (Stitt, 2002: IMO, 1999). However, across the world, countries have diverse methods of teaching the COLREGs as well as having diverse methods to identify the knowledge of their deck cadet/navigational officer's competency in COLREGs. Some by multiple choice questions, some with one to one exams to make sure that those deck cadets/navigational officers know/ understand the COLREGs. Research conducted by the Nautical Institute (Syms, 2002) highlights the suggestions of seafarers, that the improvement of maritime training and education (MET) systems is necessary which will help then to improve the application of COLREGs at sea. The same research (Syms, 2002) also reports that in northern European countries such as United Kingdom, Germany and France, the application and understanding of COLREGs is of a higher standard than when compared to other countries. Ziarati (2006) emphasises that mistakes are usually made not because of deficient or inadequate regulations, but because the regulations and standards, that do exist, are often ignored.

3. RESEARCH INTO TO COLREGS RULES

COLREGs currently have thirty eight rules and four annexes. It applies to all vessels upon the high seas and in all waters navigable by seagoing vessels. From the point of Belcher (2002), COLREGs are intended to operate in an environment where the Navigational Officer on each vessel has a complete understanding of the situation, knowing which rules are in effect, how

those rules are interpreted and what needs to be done in case the action does not occur. Thus, (Belcher, 2002), perceives that the COLREGs operate in an environment of mutual comprehension, understanding and coordination, with clear logical steps ensuring clarity and predictability. MAIB (2004) has conducted a safety study that reviewed 66 collisions and near collisions in their accident database. As a result of the study, the most common contributory factors in all these collisions were poor lookouts (Rule 5) and poor use of radar (rule 7(b), (c)). That means that the standards of lookouts are poor and ineffective and that the radar is not used properly to identify the risk of collision. In fact, COLREGs clearly state the necessity of maintaining a lookout in rule 5 and the use of radar in Rule 7(b), (c):

"Rule 5 - Every vessel shall all the times maintain a proper lookout by sight and by hearing as well as by all available means appropriate in the prevailing circumstances and conditions so as to make full appraisal of the situation and the risk of collision"

"Rule 7(b) – Proper use shall be made on radar equipment if fitted and operational, including long-range scanning to obtain early warning of risk of collision and radar plotting or equivalent systematic observations of detected objects.

Rule 7(c) – Assumptions shall not be made on the basis of scanty information, especially scanty radar information.

The examples of rule 5 and Rule 7(b), (c) are basic and easy to understand, interpret and comply with compared to other rules of COLREGs. However, it is interesting to see those are the first concerns in the full study report (MAIB, 2004). The same reports also point out that substantial numbers of accidents took place at night and in restricted visibility. The example below shows the collision attributed by poor lookout.

Case 1: Poor lookout - *A dredger collided with a fishing vessel in the Dover Traffic Separation Scheme, in daylight, calm conditions and clear visibility. The dredger had been on passage and following the flow of traffic, and the fishing vessel not engaged in fishing, had been crossing the scheme. The vessels approached each other on a collision course for 10 to 12 minutes with the fishing vessel on the dredger's port bow. The watch keeper on the dredger had seen the other vessel and, having identified it as a fishing vessel not engaged in fishing, was expecting her to alter course at the last minute.*

With regard to the provision of a lookout, STCW 95 states that the officer in charge of the navigational watch may be the sole lookout "in daylight" provided it can satisfy the provisions in STCW for lookout requirements (STCW, 95). Despite this international requirement to maintain lookout at night, the MAIB (2004) research shows that at least three of fourteen vessels had failed to keep a proper lookout at night. That same research also showed that only a bit over 25% used the radar properly along with the officer on the watch with regard to collisions.

In the same report, the reason for not maintaining lookout was attributed as "lack of competency". However, MAIB believes that poor visual lookout is linked to poor employment of ratings on the bridge (MAIB, 2004). MAIB reports that 20% of collisions are due to fatigue and some 80% due to competency factor. Bridge watch keeping practices have inevitably changed in recent years under the influence of automated systems which are being implemented in order to enhance efficiency and safety as well as to overcome the shortage of seafarers. As the advanced automation systems are developed and deployed on board, it influences the international rules and regulations which are under consideration for being updated in parallel to evolved systems on board the vessels. An earlier survey highlighted the concerns regarding the application of COLREGs rules at sea. The questions were directed to seafarers and in the results it was noted that close to 50% of the responses showed that seafarers either ignored or disregarded the COLREGs rules (Syms, 2002). In the same survey 90% of the responders identified the reason as "ignorance", "Poor knowledge of COLREGs" and "lack of training". Another finding of that survey was that the most common reason for making manoeuvres contrary to the COLREGs was reluctance to deviate/slow down.

4. SOME RESULTS FROM PROJECT ACTs

The Fig. 1 shows that there are serious concerns about the fact that the percentage of correct answers to a survey carried out by partners of the EU funded project ACTs (Ziarati et al, 2017) was around 70 but more alarming was that those with no experience of COLREGs did better than expected, in some cases almost performed as well as (in 2 cases better than) the more experienced seafarers and/or MET lecturers! This clearly should be a case for concern.

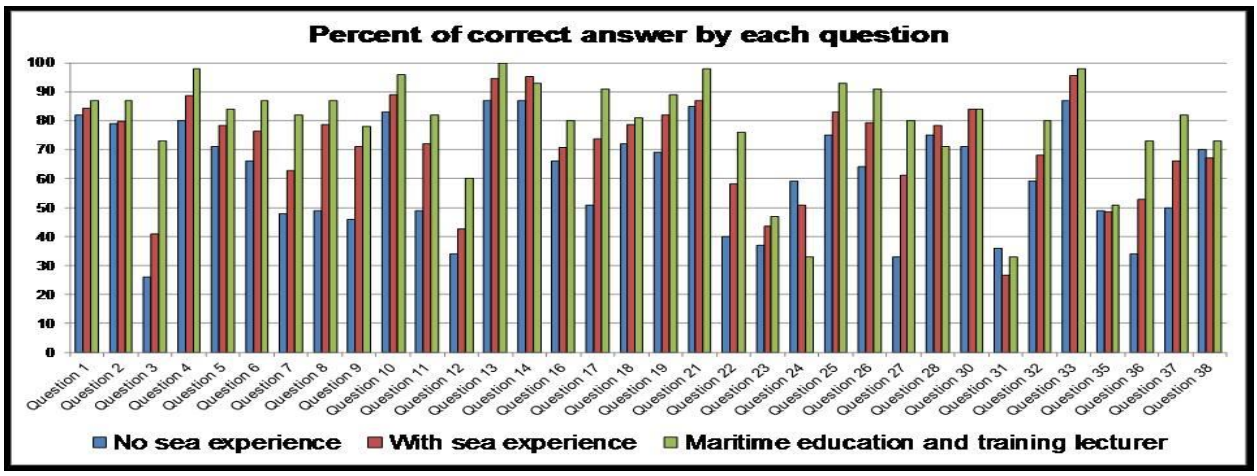

Fig. 1. % of Correct Answers by Respondents – All existing COLREG rules (Ziarati et al, 2017)

The hardest rules to understand in the survey concluded by Ziarati et al (2011, 2017) was found be rule numbers 19, 18 and 10 and to a lesser extent 8 and 9. Fig 2 shows the Pareto analysis for rules difficult to understand by students according to the lecturers.

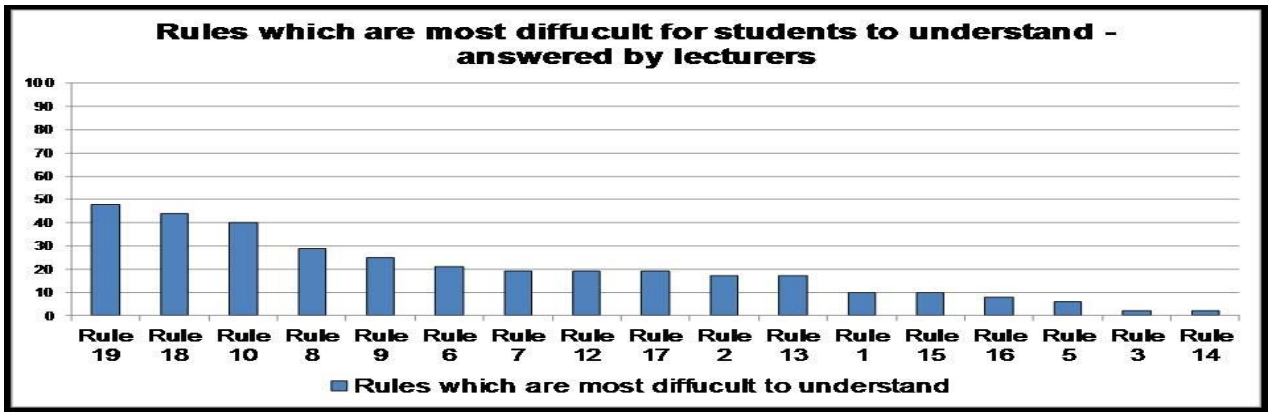

Fig. 2 Pareto Analysis – Identifying the most difficult rules to understand in ranking order

5. THE USE OF VHF AT SEA

Collisions should theoretically be avoided if all navigational officers comply with the International Rules for the prevention of collisions at Sea 1972. It is, however, shocking that these regulations were contravened to varying degrees in different locations across the world, which resulted in many accidents investigated and reported (MAIB, 2004; MARS, 2005). It is reported that the use of VHF is becoming a common practice in collision avoidance although it is not part of the COLREGs (MCA, 2002). The MCA (Maritime and Coastguard Agency) in the UK took this issue seriously and provided guidance for their seafarer network to highlight the

dangers associated with the use of VHF. According to MARS (2005) "*The use of VHF should be kept to minimum and only be used, for instance, an obstruction exists on starboard side for stand on vessel, and however, reduction of speed should be preferred on communicating the intention on VHF"*. It should not normally be the case for navigational officer to use VHF to take action to avoid collisions; however, it does usually happen. The MAIB study (2004) shows that after examination of the use of VHF in the collisions and near misses that it was only used in 14 of the 47 collisions, and was only effective in 3 of those.

Case 2 *- VHF assisted collision - A cargo vessel was outbound from River Humber in poor visibility. The master of the cargo vessel had the con, a helmsman was steering and the bosun was stationed on the forecastle as a lookout. The master saw the target of an inbound vessel on his radar, and he called the unknown fishing vessel using VHF with the intention of requesting to pass "green-to-green" in the channel. He received an instant response but, by then, it was too late. His ship was committed to the manoeuvre, and the fishing vessel was trying to pass red-to-red. They collided, causing extensive damage to the fishing vessel.*

Case 3 *– VHF assisted collision - Two container ships were navigating in China Sea. Risk of collision appeared however both did not realise it until 3 minutes before the accident. The stand on vessel tried to contact via VHF on three minutes prior to collision and got a response after several calls, a disagreement took place and the ships collided.*

Case 4 *- Rule 19: This case study is devoted to an article in Seaways (September 2008) which studied in some depth the problems of interpreting Collision Regulations (COLREGs) Rule 19. The article identifies the Rule 19 to be a continuing problem. The article is by Captain Roger Syms FNI, a Research Associate from the Australian Maritime College. He recollected a discussion with a seagoing officer concerning a discussion he had had with his colleagues, the subject of which was a collision problem in poor visibility. The scenario, somewhat similar to the Scenario 3 presented in the COLREGs survey a few years ago, is: Own ship and the other two vessels involved, one head on and the other to starboard steaming parallel at a range of 0.7 miles, are all proceeding at much the same speed, approximately 17kts. All were container vessels which suggest that all have better than average manoeuvring capabilities. Apparently the discussion as to the correct manoeuvre within the Rules came up with four possible responses: 1. Turn hard to port (according to rule 2b). 2. Reduce speed and turn hard to starboard. 3. Turn*

hard to starboard without reducing speed and 4. Do nothing. Let us now examine each of these proposed responses, in reverse order.

Option 4: Do nothing - This is simply not an option. A collision situation is developing with the vessel dead ahead, in such circumstances the own vessel has to take action. Once our vessel has determined that a "risk of collision exists" as per Rule 19(d), "she shall take avoiding action in ample time". Furthermore, Rule 19 (d) (i) states that we should 'avoid altering to port', which leaves us with only one remaining option, to alter to starboard.

Option 3: Turn hard to starboard without reducing speed - This is a correct response within the Rules 19 (d) and avoiding altering to port as per 19 (d) (i). It is clear that a drastic hard-over action is probably not necessary. Any reasonably apparent movement to starboard, anything say, beyond 50˚ will be sufficient to indicate to the vessel ahead that we are following the Rules and will result in allowing the vessel to starboard to draw ahead.

Option 2: Reduce speed and turn to starboard - In taking such action own ship is again clearly indicating that she is complying with the relevant sections of Rule 19.

Option 1: Turn hard to port (according to Rule 2b) - That this can be considered an option is cause for concern! Rule 2(b) suggests that actions beyond and contrary to the Rules may be necessary in order to 'avoid immediate danger'. At this point in time the vessel ahead is six miles and a little over 10 minutes away. This can hardly be construed as immediate danger. Second, even in the unlikely event that it could be construed as immediate, this situation cannot be viewed as in extremis, where no other options for safe compliant manoeuvres are available. In this case, as we can see, there are two perfectly good ones, both of which comply perfectly with the requirements of Rule 19.

Why not starboard? - So the question has to be asked, why would presumably competent seafarers contemplate such a dangerous manoeuvre to port? Or, put more correctly, why are they so reluctant to move to starboard? No apology should be made for moving into conjecture here and opt for Rule 19 (d) (ii), which states that what also should be avoided, when vessels are not in sight, is 'an alteration towards a vessel abeam or abaft the beam'. This may be convincing because a good 80% of the seafarers invariably get this wrong. It is one of the most commonly misconstrued rules in the book. The plain fact is that, in this case, Rule 19 (d) (ii) does not apply.

Why? Because the vessel to starboard does not comply with Rule 19 (d): 'A vessel (our own ship) ... shall determine if a close quarters situation is developing and/or risk of collision exists.' This vessel is proceeding parallel with us at 0.7 miles, and will remain so into infinity. She will remain at the same distance, therefore the risk of close quarters and/or collision does not even begin to exist. If this is yet another potential fatal misconstruction of 19 (d) (ii), what can be done in mitigation? Other than chucking out the whole sorry 1972 COLREGs mess and starting again, hence the argument that at least the current wording of 19 (d) should be reconstructed to remove this all too common confusion? What is needed is a set of words which make it absolutely clear that 'avoiding an alteration towards' refers to a vessel abeam or abaft beam, only when it is perceived as a close quarters or collision risk, and not, as seems to so many at sea, to apply to any vessel abeam or abaft the abeam in any circumstance. Yet again there is a Rule governing conduct in the most difficult circumstances a vessel can find herself in, zero visibility, still misunderstood by the majority of those at sea. It's high time something is done about it. Furthermore, with the advent of big data and artificial intelligent (AI) tools (Akdemir et al, 2014) it seems logical to use these tools and data to develop a decision making system for deciding which collision rule applies in certain circumstances and also involve other personnel in a ship operating company in the decision making process. In more complicated cases such as rule 19 and so forth or when several rules have to be considered an AI tool becomes more than just a feasible option.

6. CONCLUSIONS

It is clear that there are real concerns as respondents with no seafaring experience did better than expected. It is pertinent to note that results of survey were based on a sample of some 1500 people but even so the outcome is not encouraging. A new survey may have to be initiated to verify the outcome of the ACTs survey which could shed more light on the level of understanding and application of COLREGs. The introductory part of the paper has identified serious issues with COLREGs. Use of VHF has also been a case for concern. If COLREGs are understood better and interpreted correctly the probable effect will be the more confident navigational duties that officers can perform. It reduces the use and dependency on VHF.

The MET programmes are the parts of the broken segment if the COLREGs today are not as effective as it should be. There is no room for seafarers in charge of vessel to be 80% correct, what should be required are 100% confidence and no less. A set of standards for officers and

higher ranks across Europe may be helpful to justify the understanding of seafarers so that COLREGs can operate in an environment of mutual comprehension, understanding and coordination. The Project ACTs Plus online course with over 300 scenarios many of which were developed in ship simulators and videoed would help all seafarers to interpret COLREGs and apply them correctly when there is possibility of a collision. The COLREGs need to be updated to meet the improved technology demands. The more automated systems may well be included where needed. The national authorities may take the COLREGs more seriously and issue similar guidance (MCA, 2002) to their seafarer network to spread the word of COLREGs and discourage the use of VHF at sea. This paper was primarily written to warn against treating all rules equally. This is because as shown by the Pareto Analysis some of the Rules, particularly for instance Rule 19, are more challenging and hence further work as demonstrated by Case 4 above is recommended. Also it is of paramount importance to consider scenarios where more than one rule applies.

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