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Hazard and Near-Miss Reporting - Safety Through Numbers?

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ABSTRACT

Contemporary safety literature recognizes that reporting hazards and near-misses is important in the development of safety in risk prone industries. The shipping industry is one such, but the success of safety reporting programs has been limited. Near-miss reporting is essential to the concept of "continuous improvement" as envisaged by the International Safety Management Code. However, shipping - like other industries - suffers from considerable under-reporting. Near-miss reporting programs can be both mandatory or voluntary. To encourage reporting, many companies require a mandatory number of reports from seafarers. Managers find positive correlations between near-miss reporting and shipboard safety - more the near-miss reports, safer the vessel. However, there is also a debate whether mandatory systems provide better insights, as these may be made just to meet quotas.

This study aims to understand if greater numbers of mandatory reports do in fact indicate effective safety performance. Data from a shipping company was analysed to determine if there are any significant correlations between hazards, near-misses and incidents. The study finds that although 'quota' reporting does increase reporting, this does not translate into a subsequent reduction of near-misses and incidents.

1. Introduction.

Seafaring is considered to be a high-risk occupation (Oltedal and McArthur 2011) and until the introduction of the International Safety Management (ISM) Code by the International Maritime Organisation (IMO) in 1998, did not have any established regulations pertaining to safe shipboard operations. The ISM Code establishes safety-management objectives and requires a safety management system (SMS) to be implemented by shipping companies. It is based on the principles of continuous improvement and total quality management, and its application should "support and encourage the development of a safety culture" in shipping. The Code also states that investigations of near-misses is an integral component of continuous improvement in safety management systems (Batalden and Sydnes 2013).

Reason (1997) identifies reporting culture as one of the four critical elements of an effective safety culture. Hazard, near-miss and incident reports are considered invaluable to the success of any safety system; their analyses providing valuable means forming one of the central elements in the management of workplace health and safety (HSE 1997).

The success of this reporting regime – consequently the SMS - is dependent on workers voluntarily reporting any and all incidents, hazards and near-misses encountered by them. Unfortunately, voluntary near-miss and hazard reporting in the maritime industry has not been found to be very successful due to considerable underreporting for many reasons (Bhattacharya 2011, Georgoulis and Nikitakos 2013; van der Schaaf and Kanse 2004). As a result, many shipping companies have resorted to 'quotas' on reporting, be it near-misses or hazards. Some reports suggest that there has been an increase in reporting after establishing quotas or mandatory reporting requirements, and has been accepted as evidence of the safety performance of safety management systems (van der Schaaf 1992; Anderson 2018; Jones et al. 1999).

Reporting systems can be either mandatory or voluntary, but reports find that more useful information regarding errors and their causes is provided by voluntary reporting as opposed to mandatory systems (Tanaka et al 2010; Cohen 2000). However, such reporting should be reliable and reflective of the actual working environment; else, it can constitute a major threat to

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the utility and efficiency of any SMS (Oltedal 2011).

Although a considerable work has been done on the effectiveness of mandatory vis-à-vis voluntary reporting, fewer studies have addressed the question if the hazard/near-miss reports received under a quota system – where reliability of reports could be questioned – do provide any significant learning opportunities, and actually result in a decrease in future near-misses and incidents. It also raises the larger question whether, in the quest for numbers to indicate safety performance, the quality of near-miss reports is being compromised. The objective of this paper is to understand if a quota system of filing reports does in fact provide any tangible and useful benefits leading to improved safety, or it is just a Key Performance Indicator (KPI) for the benefit of customers.

1.1. The importance of near-miss and hazard reporting.

The shipping industry saw some major accidents between 1980s and early 1990s, such as those involving the Herald of Free Enterprise, Exxon Valdez, Estonia and Scandinavian Star. Investigations revealed organisational and human factors to be the dominant underlying causes (Batalden and Sydnes 2013), and an urgent need was felt for some sort of safety management systems to be established. This led to the development and introduction of the ISM Code by the IMO, implemented in 1998, and, according to the IMO, "presented shipowners with the positive and real business advantage, provided they truly want to change and move towards a safety culture in their business philosophy". Importance was thus placed on developing a safety culture in shipping that would consider safety as an integral part of all operations. The ISM code stresses continuous improvement and learning from near-misses, since near-misses can share the same underlying causes as losses (Batalden and Sydnes 2013).

Reason (1997) believes that a safe culture is the product of a number of interdependent sub-cultures - an *informed culture* built on the foundations of a *reporting culture*, that is dependent on a *just culture*. A *flexible culture* and a *learning culture* - the other elements of a safe culture – largely depend upon the establishment of the previous two. He also states, "any safety information system depends crucially on the willing participation of the workforce in direct contact with the hazards. To achieve this, it is necessary to engineer a reporting culture - an organizational climate in which people are prepared to report their errors and near-misses." Reporting and analysis form an integral component of successful safety management, and is one of the central elements in the management of workplace health and safety (HSE 1997). Repeat occurrences would indicate a failure of the safety culture.

In many organisations, the only safety information available to decision-makers is limited to that gained from accidents and near-miss reports (Cooper 2000). Since the frequency of near-misses is much more than incidents and accidents, it allows statistically reliable insights into the occurrence of factors that create the risk of incidents and also allow investigations of the root causes of a greater number of cases (van der Schaaf 1992; Jones et al. 1999). They also give qualitative insights into how small failures or errors develop into near-misses, providing "the link between highly visible and detectable (but rare) accidents and very frequent, but almost invisible, potentially dangerous behavioural acts" (Van der Schaaf 1992). They are also weak signals pointing to gaps in safety systems without causing high consequences, in addition to being less threatening to discuss because the consequences are limited.

Studies have reported a positive correlation between injury rates and the number of near-miss events, injuries and accidents (Krause et al. 2010, Lappalainen et al. 2011, Jones et al. 1999), although many caution against using reports as a measure of safety performance (van der Schaaf 1992; Phimister et al. 2003). Another upstream indicator of operational safety has been identified as hazard training - for hazard prevention and control - and is considered a major factor influencing safety levels (Vincent et al. 2004; Aksorn and Hadikusumo 2008). .

1.2. The problem of under reporting.

Despite universal acceptance of the importance of reporting hazards and near-misses, most industries - including shipping - suffer from significant under-reporting, constituting a major threat to the efficiency and utility of a SMS (Oltedal 2011). Healthcare services have under-reporting rates of 50-96%, shipping 59 – 70%, while some industries it is as high as 70 % (Bhattacharya 2011, Jones et al. 1999). An integral part of the ISM Code, and despite best efforts by companies to encourage reporting, near-miss reporting has been seen as the failing part of ISM code's implementation (Lappalainen et al. 2011; Bhattacharya 2011).

The causes of under-reporting are outside the scope of this study, but increased paperwork, unwillingness to create problems for co-workers, fear of blame and punishment, fear of being disciplined, embarrassment, fear of legal liability, etc are seen as barriers (Georgoulis and Nikitakos 2013; van der Schaaf and Kanse 2004).

1.3. Mandatory versus Voluntary reporting.

Reporting systems can be mandatory by law as well as non-mandatory. Many industries such as civil aviation, nuclear power plants, road and rail transportation have mandatory reporting regimes (van der Schaaf and Kanse 2004; Oltedal 2011). Many industries find nonpunitive and confidential voluntary reporting programmes providing more useful information about errors and their causes as opposed to mandatory reporting programmes (Tanaka et al. 2010; Cohen 2000).

Barach and Small (2000) contend that both voluntary and mandatory approaches are required as each has its own benefits and limitations, suggesting that since mature safety cultures are driven by forces external and internal to industries, over time these forces nourish voluntarism and reporting of near-misses. Mandatory systems tend to assign blame rather than identify and correct system-based causes of errors; voluntary systems are more conducive towards learning, focus on safety improvement and understand that errors occur because people cannot outperform unsafe systems that bind and constrain them (Mamoun 2006; Khon and Corrigan 2008). Voluntary reporting only works with high personnel motivation (Van der Schaaf

1992) while a strong and well-designed ana-lysis and response system will allow both these methods to be successful (Cohen 2000).

1.4. Are More Reports of Near-Misses and Hazards Indicative of an Effective Safety culture?.

The issue whether high near-miss and hazard reporting rates are a positive or negative indicator of safety performance remains contested (Phimister 2003). Many suggest that such reports are indicators of an effective safety culture; increased reporting being a positive indicator or metric of safety awareness and performance, viewed as a "safety index" (Jones et al. 1999; Edmondson, 2004, Shen and Marks 2016).

Van der Schaaf (1992) cautions against this stating that using report numbers as indicators of organisational performance is a faulty management decision. His experience at a chemical plant found an increase of 300% in near-miss reporting with no evidence if this increase had actually improved safety performance. At another site, senior management proclaimed that high near-miss reporting directly correlated with poor safety performance. Subsequently the number of near-miss reports declined but most likely the number of near-misses remained the same, actually increasing the risk exposure. In another study of 20 sites, eleven considered it desirable that the number of near-miss reports to increase or keep constant over time, while nine either did not maintain a view on this issue, or considered it a metric that is desirable to decrease over time (Phimister 2003; Gnoni and Saleh 2017)

Georgoulis and Nikitakos's (2013) study of 129 ships found average nine near-miss reports per ship annually; however, the shipowners believed that in reporting every small detail, the process would lose its importance and reality. They agreed that since all near-misses are not reported, it cannot be an indicator of safety standards, preferring to use numbers of accidents – which cannot be hidden - as an indicator. Storgard et al. (2012) found that contrary to views held by other experts, nearly all of their respondents did not consider the number of reports as an indicator of safety levels; more important was the quality of the report.

On hazards, Fang et al (2004) state that evaluation of on-site hazards can be used to measure safety performance; any decrease of potential hazards improves safety performance. Marcus' (1988) study of 24 US nuclear power plants found sharing of attitudes towards safety improved safety performance, increased productivity, provided a good safety record and three times fewer human error events than plants where such attitudes were not shared.

1.5. The Effectiveness of Incentives and Quotas.

To encourage turning in near-miss and hazards data, employers' resort to setting quotas, even offering incentives and rewards - both financial and nonfinancial - for reporting, as a proactive approach. The positive impacts of both financial and nonfinancial rewards on employees' safety performance have been highlighted by some studies (Sulzer-Azaroff et al 1994; Vredenburgh, 2002). However, reporting is expected to be reported voluntarily and without any coercion, as the value of the reports may be compromised. Every incentive system may not determinately lead to improvement of safety performance; objectives should be clear as ambiguity can lead to increased unsafe behaviours by employees. Such programs should be aligned to meet the goals of the organisation and can discourage incident reporting if not administered properly (Marshall 2001).

Weiss and Hughes (2015) suggest that employees can be encouraged to observe safe and unsafe behaviours by setting quotas till it becomes second nature, subsequently relaxing quotas without losing any high-quality observations that assist in continuous safety improvement. However, there is a risk of disengaging employees from the fundamental goal of reporting if there is any emphasis on quantity. Workplace Safety and Health Council (2016) state that setting quotas to cultivate the habit may help on starting a new reporting program, but there is a danger of dilution of the quality of data received. The Council further cautions that with mandatory programs, employees may submit reports for the sake of meeting the quota, and not out of genuine concern for safety. Furthermore, once the required quota is met, employees may stop reporting resulting in potentially more dangerous incidents going unreported.

On the efficacy of incentives, Ghasemi et al. (2015) found that incentives had a greater impact on safety performance for the first 6 months of implementation, but safety performance gradually declined over time. Glendinning (2001) found from a survey, that of organisations using incentives 50% stated that safety incentives cause non-reporting of injuries, 30% stated it causes peer pressure/hostility against injured employees, and, 20% stated that safety incentives make light of safety. Storgard et al's (2012) study also did not find support for the idea of having a reward system for making reports, as it just added to the number of useless reports. Employees considered safety as important in any case, and did not support the idea that safety is something that is rewarded separately.

Adamson (2015) argues that reporting fatigue sets in in organisations that demand a quota of such reports, with employees becoming jaded with the system making it open to abuse, cynicism and ridicule. It also runs the risk of becoming a "numbers game", where quantity becomes more important than quality, compromising the quality of reports and losing the original purpose is lost. Lamvik et al. (2008) find that insistence on mandatory reports has led to a fabrication of hazards to report just to be able to fill the quota, with systems drowning in information and an overwhelming amount of information being gathered and filed (Hale 2000).

Walker (2008) considers quotas of value for those employees who are not yet convinced of the utility of safety observations. He however cautions that a focus on quantity creates an emphasis on numbers rather than explicitly on behaviour. The number of reports should not be regarded as an indication of safety level, but rather as an indication of safety awareness, and quotas will cause more harms than benefits (Jones et al. 1999, Edmondson 2004).

1.6. Content Issues with Near-Miss Reports.

A serious concern arising out of mandatory reporting systems is that the quality of reports may be compromised with submission of less meaningful reports, as well as reporting of irrelevant issues (Darveau 2017). Krause et al (2010) opined that observations done poorly are worse than no observation at all, while Lamvik et al (2008) find that "real" episodes with potential for injury and damage are juxtaposed with the less important ones. In mandatory report databases, they have found reports concerning coffee spills, rotten fruit in the coffee shop, and a lack of beef for dinner on Wednesdays, together with injuries involving medical treatment, blocked emergency exits, and a lack of security around dangerous areas on board, such "nonsense" being included to meet the demand for a certain number of reports in the organisation. In case studies from cross industries, Douglas et. al (2015) found different reporting behaviours from different departments of the same organisation, where some departments produced better quality reports whereas other departments simply met the quota, submitting more reports with no real value to the organisation. There also seems that there are specific types of incidents and near-misses that get reported more often. Majority of reports were self-corrected near-misses, events with harm, personal injuries or such other untoward events arising out of technical problems or mechanical breakdowns, but not those which could be construed as their professional failures (Bhattacharya 2011, Georgoulis and Nikitakos 2013).

Summarizing, near-miss analyses are expected to identify gaps in safety systems, the correction of which will prevent reoccurrences. If learning from these reports is utilized in daily activities, it would imply that the number of near-misses and incidents should progressively decrease till we reach the ideal stage wherein safety attitudes are so deeply entrenched in employees that there is a continued decrease in hazards, near-misses and incidents. Thus, would a genuine decrease in near-miss reporting be indicative of an effective safety culture, or would it mean that low numbers point to its ineffectiveness? In such a situation, expecting a minimum number of reports per employee would be counter-productive as one is unaware if the reports are genuine or are being fabricated just to make up the numbers. To understand the relationships, the following research questions and hypotheses are set:

RQ: Can vessels consistently reporting high numbers of hazards be considered safer, and would the converse also be true?

H1: An increase in the number of hazards reported will result in a decrease in near-misses

H2: An increase in the number of hazards reported will result in a decrease in incidents

H3: An increase in the number of near-misses reported will result in a decrease in incidents

The analysis is limited to the extent of the numbers of reports and their significance; the quality, content etc of the reports are not being taken into consideration.

2. Methodology.

Data was collected from a major shipping company operating more than 50 vessels, for a period of three years between 2015 and 2017. The company finds a very strong correlation between good hazard, near-miss reporting and incidents onboard. Promotion of hazard and near-miss reporting results in fewer hazards and therefore fewer incidents; less reporting is equated with more injuries and accidents. Prior to 2017, the company had a mandatory monthly quota of reporting minimum 30 hazards and 2-3 near-misses per vessel. Starting from 2017, the quota for hazards was increased to 40 per month per vessel, near-miss reporting remained the same. A financial incentive was included for the vessel reporting most hazards. Hazards are noted on special booklets provided, and at the end of the month these are checked for closure at the safety meeting. Relevant pages from the hazard booklets are scanned and sent to the office. Near-misses and incidents are submitted electronically. Meaningful reports of near-misses (between 8 and 10) are circulated as safety alerts every quarter to all vessels. The company uses the following definitions:

Hazard: A possible source of danger, or a condition or practice with the potential of causing Injury, ill health, property, process or environmental loss

Near-Miss: An event or a sequence of events, which under different circumstances, could have resulted in an incident.

Accident: An undesirable or unfortunate happening that occurs unintentionally and usually results in harm, injury, damage or loss.

Incident: An uncontrolled or unplanned event, or sequence of events, that result in one or more of the following:

a. fatality or injury to any person on board or while signed on under the ship's articles
b. release of environmentally hazardous materials or substances from their designated containment
c. damage to property including the ship, its cargo, equipment or operational ability
d. loss of or adverse impact on process or earnings

3. Data Analisys and Results.

Reporting data for the years 2015, 2016 and 2017 are presented in Table 1, and figures 1, 2 and 3 below.

Salient information from the above table and figures 1 and 2 are as follows:

1. Maximum number of reported hazards increased from 12,671 in 2015, to 56,319 in 2017, an increase of 345% over three years. The average values of hazards per vessel per year went up from 222 in 2015, to 518 in 2016, to 971 in 2017.
2. The number of reported near-misses reported went up from 1594 in 2015, to 1817 in 2016 and to 1844 in 2017, an increase of 16% between 2015-17. The average reports per year however generally stayed in a similar range, moving from 28 in 2015, to 30 in 2016 and 31.8 in 2017.

Table 1: Summary of Incidents, Near-Misses and Hazards reported 2015 - 2017.

Year	Vessels	Incidents		Near Misses		Hazards	
		Total	Avg/vsl	Total	Avg/vsl	Total	Avg/vsl
2015	57	318	5.6	1594	28	12671	222
2016	60	310	5.2	1817	30.3	31089	518
2017	58	211	3.6	1844	31.8	56319	971

Source: Authors.

3. Incidents dropped from 318 in 2015 to 211 in 2017, a decrease of 33.6%. Average incidents per vessel per year went down from 5.6 in 2015, to 5.2 in 2016, and further down to 3.6 in 2017.

3.1. Correlation Analysis.

In order to determine the relationship, if any, between hazards, near-misses and incidents, correlation analysis was undertaken using SPSS. However, the frequency distributions were found to have large values of skewness and kurtosis, well in excess of the acceptable limits of ±1.96 for a two-tailed test. Since Pearson's correlation coefficient was to be used, the sampling distribution had to be normally distributed for the test statistic to be valid. Thus, outliers were selectively removed in order to arrive at normal distributions for all three variables in each of the three years. Deletion of outliers reduced the sample size from 57 to 50 in 2015, 60 to 50 in 2016 and 58 to 50 in 2017. The amended data showed skewness and kurtosis within desired levels of ±1.96. The reduced sample size was still considered large enough for correlation analysis.

a. Correlation between Hazards and Near-Misses: The correlation analysis for all the three years under study show positive *"r"* values, decreasing over time, with r=0.664, p<0.01in 2015, r=0.475, p<0.001in 2016 and r=0.323, p<0.05 in 2017. We thus fail to reject the null hypothesis that there is no significant relationship between hazards and near-misses. It can therefore be concluded that hypothesis H1 is not supported, and numbers of hazards reported are positively related to the number of near-misses. The coefficient of determination, R^2 is a measure of the amount of variability in one variable that is shared by the other. For 2015, R^2 is 0.441, for 2016 R^2 is 0.226, and for 2017 R^2= 0.104, indicating that hazards share 44.1% of the in near-misses in 2015, 22.6% in 2016 and 10.4% in 2017.
b. Correlation between Hazards and Incidents: The correlation analysis for all the three years under consideration show r=0.199 for 2015, 0.078 for 2016 and -0.021 for 2017, with p>0.05. Since the p value is not small (p>0.05), we fail to reject the null hypothesis H2 that there is no significant relationship between hazards and incidents. We can thus state that the numbers of hazards reported does not have any relationship with the incidents experienced.
c. Correlation between Near-Misses and Incidents: The correlation analysis for all the three years under review show r=0.155 for 2015, -0.122 for 2016 and -0.184 for 2017, with p>0.05. Since the p value is not small (p>0.05), we again fail to reject the null hypothesis H3 that there is no significant relationship between near-misses and incidents. We can thus state that the numbers of near-misses reported do not have any relationship with the incidents experienced.

As can be seen above, in all the three years, vessels reporting the least number of incidents (0 and 1) reported close to the average numbers of hazards for those years. Near-misses also followed a similar pattern, except for the year 2016, when they were higher than the average. From the time of the increase in mandatory reporting in 2017, the vessel with the highest incidents (10) reported more hazards than the average. Elsewhere, there does not appear to be any direct link between hazard numbers and incidents; even where vessels reported high number of hazards, numbers of incidents did not significantly reduce. At the same time, vessels with lesser numbers of hazards have suffered similar numbers of incidents.

The status of incidents on vessels reporting the highest and lowest hazards are shown in table 4 above. As can be seen, in 2015, the vessel with highest hazard reports (671) had 8 incidents, well over the average (222) for that year. Surprisingly, the vessel with lowest hazards (77) had only 2 incidents. In 2016 too, the vessel with highest hazards suffered 5 incidents, the lowest reporting vessel suffered 3 incidents. In 2017 it was 3 incidents for the highest reporting vessel, while the lowest had 6 incidents.

In order to understand if high hazard reporting would reduce future hazards as well as near-misses and incidents, the reporting data for the top and bottom five vessels was compared, shown in table 5 below. Vessel V3 had the highest hazards in 2017 (2279) with 3 incidents, while in 2015 she had 4 incidents with 216 hazards. For V39, the number of incidents went up from 2 in 2015 (77 hazards) to 5 in 2017 (1898 hazards). A

Table 2: Correlations between Hazards, Near- Misses and Incidents, 2015 - 2017.

		2015			2016			2017		
		Hazards	NearMisses	Incidents	Hazards	NearMisses	Incidents	Hazards	NearMisses	Incidents
Hazards	Pearson	1	**0.664****	0.199	1	**0.475****	0.078	1	**0.323***	-0.021
	Sig. (2-tailed)		0.000	0.167		0.000	0.588		0.022	0.885
	N	50	50	50	50	50	50	50	50	50
NearMiss	Pearson	**0.664****	1	0.155	**0.475****	1	-0.122	**0.323***	1	-0.184
	Sig. (2-tailed)	0.000		0.281	0.000		0.398	0.022		0.202
	N	50	50	50	50	50	50	50	50	50
Incidents	Pearson Correlation	0.199	0.155	1	0.078	-0.122	1	-0.021	-0.184	1
	Sig. (2-tailed)	0.167	0.281		0.588	0.398		0.885	0.202	
	N	50	50	50	50	50	50	50	50	50
		**. Correlation is significant at the 0.01 level (2-tailed).			**. Correlation is significant at the 0.01 level (2-tailed).			**. Correlation is significant at the 0.05 level (2-tailed).		

Source: Authors.

Table 3: Comparison of Near-Misses and Hazards reported vs. number of incidents.

2015				2016				2017			
Incident	Near Miss	Hazard	No. of Vsls	Incident	Near Miss	Hazard	No. of Vsls	Incident	Near Miss	Hazard	No. of Vsls
0	27	238	1	0	42-46	452-619	2	0	30-35	724-982	3
1	23-31	145-244	3	1	18-45	273-776	8	1	26-62	736-991	4
2	7-57	77-437	7	2	22-43	346-681	8	2	22-39	637-1584	14
3	24-45	224-277	4	3	4-53	161-885	8	3	23-48	649-2279	11
4	13-37	79-301	11	4	15-33	390-543	5	4	22-36	643-1567	11
5	11-32	127-295	5	5	20-41	324-1687	7	5	24-38	641-1898	3
6	19-56	177-539	9	6	17-40	408-546	5	6	20-33	492-1388	4
7	16-46	131-384	7	7	24-51	401-1023	4	7	32-38	691-897	3
8	25-36	210-671	2	8	18-38	477-595	3	8	21-36	711-1354	4
10	17-34	204-227	2	9	26	461	1	10	35	1077	1
11	27-34	150-262	2	10	24-38	393-700	3				
12	28-39	189-265	2	12	20	438	1				
16	24	233	1	13	23	576	1				
19	21	202	1	15	23-38	397-536	3				
				16	24	513	1				
Total Vessels			57				60				58

Authors.

Table 4: Table showing highest and lowest reports of safety data, 2015 - 2017.

Year		Hazards Data			Near Miss Data			Incident Data		
		Hazard	Near Miss	Incident	Near Miss	Hazard	Incident	Incident	Near Miss	Hazard
2015	Highest	671	36	8	57	194	2	19	21	202
	Lowest	77	7	2	7	77	2	0	27	238
2016	Highest	1687	29	5	53	503	3	16	24	513
	Lowest	161	4	3	4	161	3	0	42	452
2017	Highest	2279	44	3	62	991	1	10	35	1077
	Lowest	492	20	6	20	492	6	0	35	724

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similar pattern of increase in incidents with an increase in hazards can also be seen for vessels V52, V50 and V35.

As far as the low reporting vessels is concerned, the vessel with lowest hazard reports in 2015, V37, had 16 incidents. This reduced to 6 in 2016, as well as 2017 with an increase in hazards to 492 in 2017, about half the average of 971 for that year. V49 showed a decrease in incidents from 7 to 2 over three years, but the hazard count was still well below average. The other three vessels did not show any significant change in incidents, even though their hazard reporting increased considerably, but still remaining below the average for 2017.

4. Discussion and Conclusion.

On hazard reports, from the analysis of data we see that even though a large number of hazards are identified and reported – more than 6 per day over a full year in 2017 – this does not result in any significant reduction in the number of near-misses or incidents. The vessel reporting 2279 hazards, reported 44 misses and 3 incidents, while the vessel with the second highest hazards (1898) had 5 incidents with 38 near-misses. On the other hand, in 2017, there are ten more vessels with the same number of incidents (3) have near-misses ranging between 23 – 48, and have reported 649 to 1313 hazards. Three vessels with no incidents have average 32 near-misses, and reported average 812 hazards which is below the average of 971 for 2017.

Safety researches suggest that greater hazard identification should result in reduction in near-misses and consequent incidents. In view of this, the question arises whether a vessel reporting over 6 hazards a day consistently over a year, can be considered any safer even after the detection and correcting of so many deficiencies, as opposed to say a vessel reporting a third of the hazards.

Genuinely identifying and correcting hazards is possibly the best way to avoid near-misses and incidents. If hazards are dealt with systematically, there should probably not be repeat occurrences, reducing near-misses. However, in this case, hazards do not appear to be given much consideration, with apparently no significant follow up after the vessel sends in the reports and meets its mandatory quota. A sample snapshot of a random monthly hazard report from the deck department (figure 5) below shows that over a month, nearly 40 hazards have all been reported by a deck cadet, possibly with just a few months sea service. None of the other seniors have logged in any hazard, creating doubts over the existence of a vibrant safety culture on at least this vessel. If this attitude extends to the reporting of near-misses and incidents, and also to other vessels is not known.

The results also show that an increase in hazard reporting has not resulted in a consequent decrease in incidents or near-misses. Even an increase in reporting of near-misses does not show any negative correlation with incidents, something existing literature suggests should happen. Surprisingly though, an increase in hazard reports shows a positive correlation with near-misses; more hazards translating into more-near misses; something that should be considered an undesirable development and not an indicator of safe operations. Near-misses are as significant as incidents; they are incidents, without the element of good fortune and the ensuing consequences. The above goes against what was found in the literature review that reducing the number of near-misses that occur reduces the number that become accidents.

Noticeable is the fact that incidents in 2017 reduced by a third over the previous years. There is no specific reason that can be attributed to this. One possible reason could be fleet renewal by the company with eight older vessels replaced by five newer vessels in its fleet. Literature also suggests that major incident rates are independent of small incident rates, and their causation could be different.

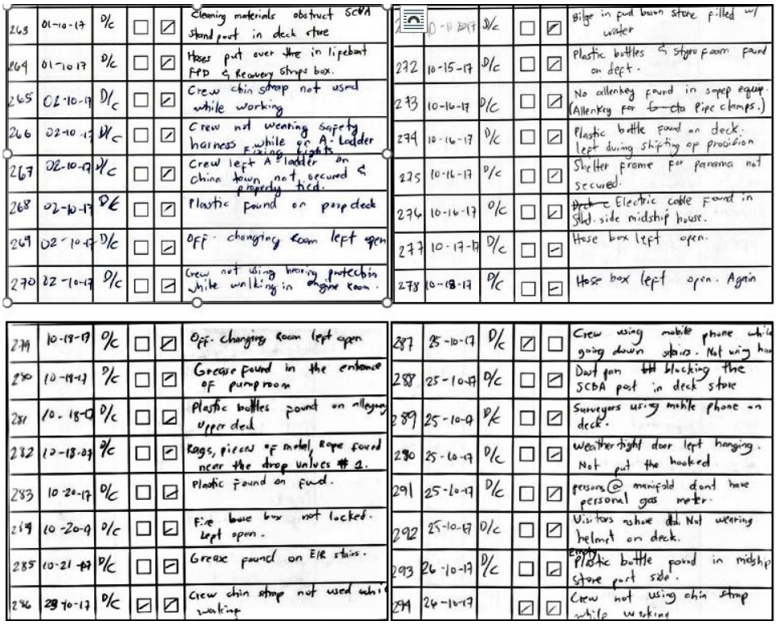
So, does the increase in reporting indicate heightened safety of operations on board? Andersen (2018) reports of a meeting with the management team of a shipping company, which stated their firm belief that the more near-miss reporting the safer the operation of vessels, claiming a clear correlation between near-miss reporting and safe operations - more near-miss reports, safer the vessel. Anderson's suggestion to increase the required

Table 5: Comparison over years 2015 - 2017 of vessels reporting highest numbers of hazards.

Year	Vessel	Highest Reporting Vessels			Vessel	Lowest Reporting Vessels		
		Incident	Near Miss	Hazard		Incident	Near Miss	Hazard
2017	**V3**	3	44	2279	**V37**	6	20	492
2016		7	24	1023		6	25	408
2015		4	23	216		16	24	233
2017	**V39**	5	38	1898	**V49**	2	29	637
2016		5	29	1687		1	26	449
2015		2	7	77		7	26	219
2017	**V52**	2	27	1584	**V66**	2	26	639
2016		1	32	538		2	22	390
2015		Not in fleet				2	16	84
2017	**V50**	4	28	1567	**V8**	5	31	641
2016		0	42	452		1	39	459
2015		2	57	194		4	29	206
2017	**V35**	6	30	1388	**V19**	4	24	643
2016		7	34	508		5	20	351
2015		3	24	268		6	27	221

Authors.

Figure 1: Sample of a random month's hazard reports.



Source: Authors.

number of near-miss reports per vessel by a factor two, making their vessels twice as safe, was met with silence and left unanswered.

By this logic it would appear that a vessels operational safety can be enhanced simply by making more reports mandatory. However, it is difficult to believe that safety managers in shipping companies, many being experienced seafarers, find logic in this method of enhancing shipboard safety. If so, why this insistence on numbers? One major reason can be customers' requirements. For example, many Oil Majors require 2 - 4 near-misses per month as part of a tankers KPI. This view is also shared by Anderson (2018) in his field study, where he finds that with regard to this KPI requirement, none of the respondent shipping companies were confident about the targets, nor were the oil majors rationale questioned. This need has been propagated over the years as it has been assumed to indicate a safety metric for improving safety awareness. He further finds that even though owners question the logic and the contribution to safety, they are frustrated with this as it has increased workload and bureaucracy. His study showed that near-miss KPI was an institutionalized activity embedded with the Managers that required identifying, measuring and recording of events, communicating information to oil majors in a systematic and repeated way, denoting a ritual fulfilled by managers which none could account the origin.

The fundamental question therefore is whether a high number of hazard and near-miss reports do indicate a strong and *effective* safety culture. It can be said that increased safety awareness has resulted in better reporting. However, classically, the number of reported near-misses at the beginning of system implementation will be low, while expectations will be high. As the system takes root, the actual numbers of near-misses should decline once the causes have been eliminated. With more awareness, identification and rectification, the number of near-misses is expected to go down gradually till the difference between expected and reported near-misses is very low, thereby indicating an effective safety culture.

On the other side, it can be argued that larger numbers of both hazards and near-misses indicate an *ineffective* safety culture. The high numbers of reports can be attributed to a working reporting culture, but an ineffective safety culture. If vessels consistently report high numbers of hazards and near-misses over years on a regular basis, one has to question if there is any improvement in working conditions or not, and if the reports are just to meet quotas. As Hudson (2007) states .....*if one wants to create an advanced culture, it takes a lot more than just getting near-miss reporting to work – or rather a fully working near-miss reporting system will be found at the end of the trajectory, not at the beginning. It may be that a reporting culture does not make a safety culture, but rather that a safety culture makes a reporting culture possible.*

For any safety culture to be effective, it has to be accepted by all as a means to a better working environment where learning from errors comes naturally. Employees should be provided with an environment which is blame free in its true sense so that the reporting of any errors - especially by senior staff – is seen as commendable instead of reprimandable. Once such an environment is created and sustained, reporting adverse events will become second nature as employees will know that it is for the common good, and there is no cheaper alternative to learning than from others mistakes. It should also be noted that professional knowledge and safety training also go hand in hand here, as one has to have the necessary competence to know when a near-miss occurred and what constitutes unsafe acts and conditions. Organisations should also avoid falling into the trap of fitting their data to established models, as each industry is different and unique. Till such time this happens, it would appear that reporting to quotas and looking for correlations will not yield the dividends required, but remain an exercise on paper to satisfy the numbers game, apart from creating a superficial and ineffective safety culture on board vessels.

Limitations.

The study is limited by the fact that data from only one shipping company has been used. However, in the absence of standard reporting procedures by different shipping

companies, data from multiple companies would have been difficult to analyse on a common platform. The analysis, discussions and conclusions take into account only numerical relationships to assess the research questions. Variables such as quality of reports, incentive methods, experience and tenure of seafarers etc have been kept out of the analysis.

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