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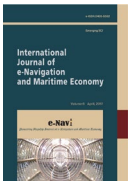

Original article

Hazard and Near-Miss Reporting – An Analysis of The Effectiveness of Increased Error Reporting

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Abstract

Contemporary safety literature recognizes that error reporting - reporting of hazards, near-misses and incidents is important in the development of safety in high risk industries such as shipping - where the success of such reporting programs has been limited. Reporting is integral to the concept of "continuous improvement" as envisaged by the International Safety Management Code. However, shipping - like other industries - suffers from considerable under-reporting. At the same time, many Safety managers find positive correlation between numbers of such reports and shipboard safety, and to encourage reporting, many follow a mandatory reporting system. This study attempted to understand whether increasing numbers of submitted error reports does result in a consequent decrease in incidents/accidents, thereby validating this premise. The study was limited to the fleet of only one shipping company, and to the quantitative analysis of the error reports; not the content or quality of such reports. To achieve this, annual compiled error reports from across all fleet vessels of one shipping company were collected. This company had made a significant increase in the numbers of reports to be submitted by vessels in its fleet thereby presenting this opportunity. These reports were analyzed using Pearson correlation to determine any statistically significant correlations between numbers of hazards and near-misses reported, and recorded incidents/accidents. Analysis of the data showed that, from a quantitative point of view, the mandated increase in the number of reports did not result in a decrease in the numbers of near misses or incidents/accidents. It was concluded that merely increasing the number of reports may not improve safety performance, but may lead to the submission of reports just to meet requirements thereby devaluing the entire process. Companies should look at more effective ways through which the safety culture can be enhanced and improve on-board safety performance.

Keywords: Safety, Near-Miss, Quota System, Hazard, Mandatory Reporting, Shipping Industry

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1. Introduction:

Seafaring is considered to be a high-risk occupation (Hasanspah et al, 2020, p.1) and until the introduction of the International Safety Management (ISM) Code by the International Maritime Organisation (IMO) in 1998 – a new chapter IX of the International Convention for the Safety of Life at Sea (SOLAS), 1974 - did not have any established regulations pertaining to safe shipboard operations. The ISM Code is based on ISO 9001 which is to enhance a product quality by the model of a process-based Quality Management System (QMS). ISO 9001 is the world's most recognized standard, aimed at helping organisations meet the needs of their customers and other stakeholders more effectively through the use of QMS.

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).

CCPS (2019, p. 3) defines hazards as chemical or physical conditions that have the potential to cause damage to people, property, or the environment. A Near-miss is an incident in which an adverse consequence could potentially have resulted if circumstances (weather conditions, adherence to procedure, etc.) had been slightly different. An incident is an unusual, unplanned, or unexpected occurrence that either resulted in, or had the potential to result in harm to people, damage to the environment, or asset/business losses, or loss of public trust or stakeholder confidence in a company's reputation. An accident is an incident that results in a significant consequence involving human impact, a detrimental impact on the community or environment, property damage, material loss, or disruption of a company's ability to continue doing business.

The enhancement of safety performance thus depends on a robust SMS and effective safety culture. Reason (1998, p. 1) identifies reporting culture as one of four critical elements of an effective safety culture. Hazard, near-miss and incident reports are considered invaluable to the success of any safety system; such management systems are a critical aspect of safety performance in shipping, and reporting, analyzing, and learning from these can prevent recurrence and thereby improve shipboard safety (Hasanspah et al, 2020).

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, 2012, p. 4). As a result, many shipping companies have resorted to 'quotas' (requiring a certain number of reports per worker) 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 (Anderson, 2018, p. 10).

Error reporting systems can be either mandatory or voluntary, but studies find that more useful information regarding errors and their causes is provided by voluntary reporting as opposed to mandatory systems (UMBC, 2017, p.37). However, such reporting should be reliable and reflective of the actual working environment; else, it can constitute a major threat to the utility and efficiency of any SMS (Oltedal, 2011, p.1).

Although a considerable work has been done on the effectiveness of mandatory vis-à-vis voluntary reporting, few studies have addressed the question if the hazard/near-miss reports received under a system based on quotas 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.

2. Importance of near-miss and hazard reports

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 organizational and human factors to be the dominant underlying causes

(Batalden and Sydnes, 2013, p18), 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 investigations of near-misses, and forms an integral component of continuous improvement in safety management systems (ISM Code, 2010, p. 69).

Reason (1998, p. 1) 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."

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 near misses can be considered a loss that did not happen due to a fortuitous break, such reports provide learning opportunities that can potentially lead to avoidance of future accidents (CCPS, 2019, p 49).

Hazards cause people to make errors, resulting in damage to people, property and environment, or accidents (Fukuoka, 2019, p.13), and recognition and managing hazards can improve the safety climate and its effect on enhancing worker's safety attitudes, perceptions, and behaviors (Huang and Yang, 2019, p. 4). Hence identifying hazards and reporting near misses are essential to safety performance. Fang et al. (2004, p. 44) state that evaluation of on-site hazards can be used to measure safety performance; any decrease of potential hazards improves safety performance.

Near misses can be quantitatively analyzed as there is abundant data available, and the resistance to data collection for near misses are lesser than for adverse events, especially since the predictors of adverse events and near misses are considered similar (Tanaka et al., 2010, p. 776). 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 behavioral acts" (Van der Schaaf, 1992, p. 22). 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 (Lappalainen et al., 2011), although Van der Schaaf (1992) cautions using reports as a measure of safety performance. Stral (2010, p. 6) state that "the essence of safety culture is the ability and willingness of the organization to understand safety, hazards and means of preventing them, as well as ability and willingness to act safely, prevent hazards from actualizing and promote safety."

2.1 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. Studies in different industries such as steel, airline and railways have revealed a high case of underreporting at 70%, the agriculture sector at 85% and energy sector at 30 (Bhattacharya, 2011, p. 5, 6). 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, p.168). The causes of under-reporting are outside the scope of this study, but include the fear of blame, disciplined, embarrassed, or legal liability, etc. are seen as barriers (ISM Code, 2010, p. 70).

2.2 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. However, many industries find non-punitive and confidential voluntary reporting programs providing more useful information about errors and their causes as opposed to mandatory reporting programs (Tanaka et al., 2010, p. 776).

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 (Maamoun, 2006).

2.3 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. Some suggest that such reports are indicators of an effective safety culture; increased reporting being a positive indicator or metric of safety awareness and performance (Georgoulis and Nikitakos, 2013).

Van der Schaaf (1992, p. 3) 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.

Georgoulis and Nikitakos's (2013, p. 660) study of a hundred and twenty nine 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, p. 1018) found that contrary to views held by other experts, nearly all respondents in their study did not consider number of reports as an indicator of safety levels; more important was the quality of the report.

2.4 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 non-financial - for reporting, as a proactive approach. The positive impacts of both financial and non-financial rewards on employees' safety performance have been highlighted by some studies (Goodrum and Gangwar, 2004; Karakhan et al, 2018, p. 6). However, reporting is expected to be 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, p. 7) 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 six months of implementation, but safety performance gradually declined over time; Karakhan et al (2018, p. 3) found that the ability of incentives to impact worker behaviours is not always guaranteed, while Storgard et al's (2012, p. 1018) study 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, p. 27) 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. Lamvik et al. (2008, p. 2) found that insistence on mandatory reports 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.

Adamson (2015, p. 27) considers quotas of value for those employees who are not yet convinced of the utility of safety observations, cautioning that a focus on quantity creates an emphasis on numbers rather than on behaviour. Report numbers should not be regarded as an indication of safety level, but rather as indicators of safety awareness and quotas will cause more harm than benefits.

2.5 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 resulting in essential facts drowning in a sea of information (Lamvik et al, 2008, p. 6). They also 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 some days, 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 organisations. 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).

From the above review we find that the identification and elimination of hazards has the potential of reducing both near misses and accidents. To test this, the following null and alternate hypotheses are set:

$H1_0$: There is no statistically significant relationship between the number of hazards and near misses.
$H1_1$: There is a statistically significant relationship between the number of hazards and near misses.
$H2_0$: There is no statistically significant relationship between the number of hazards and near misses.
$H2_1$: There is a statistically significant relationship between the number of hazards and near misses.
Similarly, near-miss analyses are expected to identify gaps in safety systems, the correction of which will improve safety performance and prevent repeat occurrences of incidents and incidents.

To verify this, the following null and alternate hypotheses are set:

$H3_0$: There is no statistically significant relationship between the number of hazards and near misses.
$H3_1$: There is a statistically significant relationship between the number of hazards and near misses.
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 as the issue under consideration is the quantitative nature of such reports rather than qualitative aspects. Qualitative aspects would require a different approach as well as data.

3. Methodology

Data was provided by a Singapore based shipping company operating more than 50 vessels, for a three year between 2015 and 2017. The company has provided data based on anonymity and will be referred as ABC Marine. The company receives regular hazard, near-miss, incident and accident reports which are compiled annually, analysed and disseminated internally and to all ships. The company finds a very strong correlation between good hazard, near-miss reporting and incidents onboard, and feel the promotion of hazard and near-miss reporting results in fewer hazards and therefore fewer incidents; less reporting is equated with more injuries and accidents. Over the three years, the company has annually increased the mandatory monthly quota of hazard reports drastically, from 10 to 40 hazards per vessel per month, while the requirement for near-miss reports remained at 2 – 3 per vessel per month. 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 shipboard safety meeting. Relevant pages from the hazard booklets are scanned and sent to the office. Near-

misses and incidents are submitted electronically. Meaningful reports (8 to 10) are circulated as safety alerts every quarter to all vessels.

Annual data was segregated vessel-wise to determine total report numbers and averages per vessel. The data was also segregated on the basis of the number of reports per vessel against the numbers of near-misses and incidents, as well as on the basis of the highest and lowest reporting vessels. From the summary of yearly reports, to determine the relationship, if any, between hazards, near-misses and incidents, correlation analysis was undertaken using Statistical Package for the Social Sciences (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 validity. Thus, outliers were selectively removed to normalize distributions for all three variables in each of the three years. Deletion of outliers reduced the sample size from fifty-seven to fifty in 2015, sixty to fifty in 2016 and fifty-eight to fifty 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.

4. Data analysis and results

Reporting data for the three years are presented in Table 1below.

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: ABC Marine

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 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.

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.

4.1 Hypothesis Testing (Table 2):

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.

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

		Hazards		
		Pearson Correlation	Sig. (2-tailed)	N
2015	Hazards	1		50
	Near Misses	**0.664****	0.000	50
	Incidents	0.199	0.167	50
2016	Hazards	1		50
	Near Misses	**0.475****	0.000	50
	Incidents	0.078	0.588	50
2017	Hazards	1		50
	Near Misses	**0.323***	0.022	50
	Incidents	-0.021	0.885	50

**. Correlation is significant at the 0.01 level (2-tailed).

		Near Miss		
		Pearson Correlation	Sig. (2-tailed)	N
2015	Hazards	**0.664****	0	50
	Near Misses	1		50
	Incidents	0.155	0.281	50
2016	Hazards	**0.475****	0	50
	Near Misses	1		50
	Incidents	-0.122	0.398	50
2017	Hazards	**0.323***	0.022	50
	Near Misses	1		50
	Incidents	-0.184	0.202	50

**. Correlation is significant at the 0.01 level (2-tailed).

		Incidents		
		Pearson Correlation	Sig. (2-tailed)	N
2015	Hazards	0.199	0.167	50
	Near Misses	0.155	0.281	50
	Incidents	1		50
2016	Hazards	0.078	0.588	50
	Near Misses	-0.122	0.398	50
	Incidents	1		50
2017	Hazards	-0.021	0.885	50
	Near Misses	-0.184	0.202	50
	Incidents	1		50

**. Correlation is significant at the 0.05 level (2-tailed).

Since p<0.05, we reject the null hypothesis $H1_0$ that there is no significant relationship between hazards and near-misses, and accept the alternate hypothesis $H1_1$. The positive "r" value indicates a

positive correlation between hazards and near misses and the data under analysis thus shows an increase in the number of near-misses with an increase in hazards, although it decreases from a strong effect of 0.664 in 2015 to a medium effect 0.323 in 2017. This goes against established knowledge that an increase in hazard identification should result in a decrease in near-misses and incidents. The average numbers of near-misses over the years under analysis ranged between 28 and 31.8, the decrease in the value of "r", can be attributed to the numerical increase in average hazards from 222 in 2015, to 971 in 2017, and not to any improvement in safety performance.

b) Correlation between Hazards and Incidents: The 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 $H2_0$ that there is no significant relationship between hazards and incidents, and reject the alternate hypothesis $H2_1$. The data thus shows no statistically significant relationship between the number of hazards and near misses, although based on safety literature, a negative correlation between hazards and incidents would be expected.

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 H30 that there is no significant relationship between near-misses and incidents. We thus find from the data that the numbers of near-misses reported do not have any relationship with the incidents experienced, something which goes against safety literature that reduction of near-misses should reduce numbers of incidents.

Table 3 shows a comparison of near-misses and hazards reported against the number of incidents. 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. After the increase in mandatory reporting, 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.

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

2015			
Incident	Near Miss	Hazard	No. of Vsls
0	27	238	1
1	23-31	145-244	3
2	7-57	77-437	7
3	24-45	224-277	4
4	13-37	79-301	11
5	11-32	127-295	5
6	19-56	177-539	9
7	16-46	131-384	7
8	25-36	210-671	2
10	17-34	204-227	2
11	27-34	150-262	2
12	28-39	189-265	2
16	24	233	1
19	21	202	1
Total Vessels			57

2016			
Incident	Near Miss	Hazard	No. of Vsls
0	42-46	452-619	2
1	18-45	273-776	8
2	22-43	346-681	8
3	4-53	161-885	8
4	15-33	390-543	5
5	20-41	324-1687	7
6	17-40	408-546	5
7	24-51	401-1023	4
8	18-38	477-595	3
9	26	461	1
10	24-38	393-700	3
12	20	438	1
13	23	576	1
15	23-38	397-536	3
16	24	513	1
Total Vessels			60

2017			
Incident	Near Miss	Hazard	No. of Vsls
0	30-35	724-982	3
1	26-62	736-991	4
2	22-39	637-1584	14
3	23-48	649-2279	11
4	22-36	643-1567	11
5	24-38	641-1898	3
6	20-33	492-1388	4
7	32-38	691-897	3
8	21-36	711-1354	4
10	35	1077	1
Total Vessels			58
Source: ABC Marine			

The status of incidents on vessels reporting the highest and lowest hazards are shown in table 4 below. 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.

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

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

Source: ABC Marine

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. Vessel V3 had the highest hazards in 2017 (2279) with 3 incidents, while in 2015 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 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 sixteen incidents. This reduced to six 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 seven to three 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.

On hazard reports, from the analysis of data we see that even though a large number of hazards are identified and reported this does not result in any significant reduction in the number of near-misses or incidents.

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

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

Source: ABC Marine

The vessel reporting 2279 hazards, reported 44 near misses and 3 incidents, while the vessel with the second highest hazards (1898) had 38 near-misses with 5 incidents. 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.

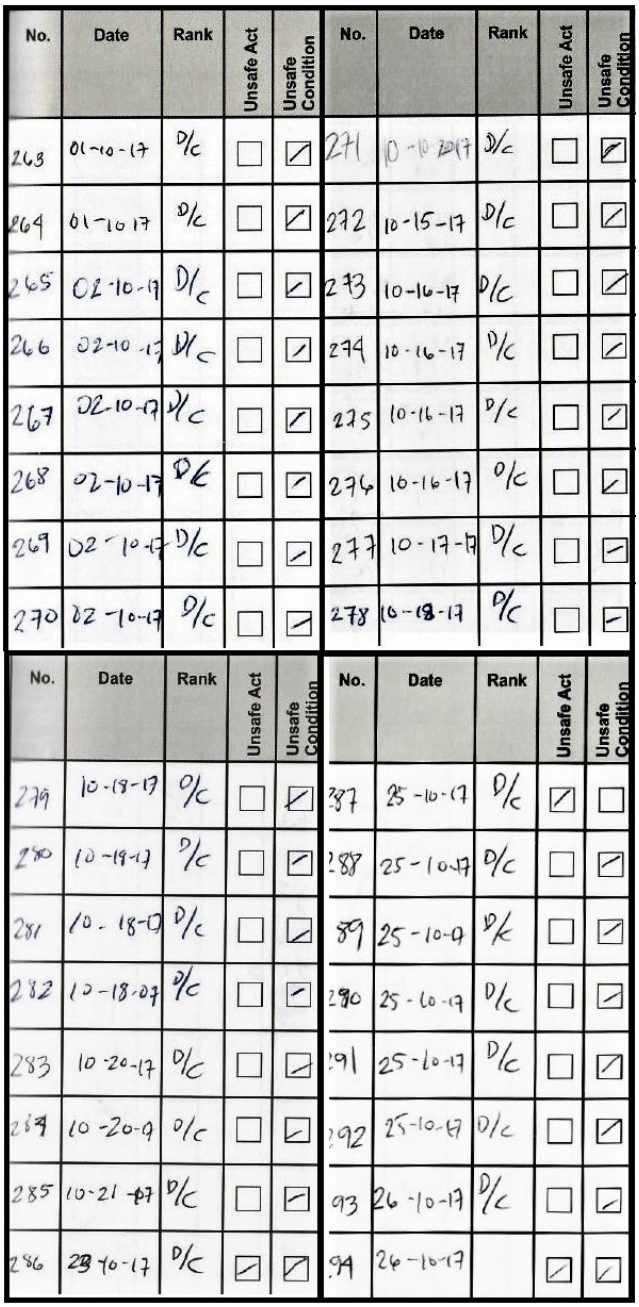
Safety research suggests that greater hazard identification should result in reduction in near-misses and consequent incidents (Fang et al, 2004). In view of this, the question arises whether a vessel reporting over 6 hazards a day consistently over a year, can be considered any safer even after the detection and correcting of so many deficiencies, as opposed to say a vessel reporting a third of the hazards. Noticeable is the fact that incidents in 2017 reduced by a third over the previous years. There is no specific reason attributable to this available from the given data. 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

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 of a random monthly hazard report from the deck department (figure 1) shows that over a month, nearly 40 hazards have all been reported by a deck cadet (D/C), 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.

5. Conclusion

The analysis and results show that an increase in hazard reporting has not resulted in a consequent decrease in incidents or near-misses, and thereby on safety performance. However, because of the limited data, it is difficult to generalize the results across the industry, but it may hold value in organizations that are looking at more numbers of reports to show the effectiveness of their safety culture without trying to improve it first. It provides insights into the effects of increased reporting just for an increase in numbers without any reduction in near misses or incidents.



No.	Date	Rank	Unsafe Act	Unsafe Condition	No.	Date	Rank	Unsafe Act	Unsafe Condition
263	01-10-17	D/C	☐	☑	271	10-10-2017	D/C	☐	☑
264	01-10-17	D/C	☐	☑	272	10-15-17	D/C	☐	☑
265	02-10-17	D/C	☐	☑	273	10-16-17	D/C	☐	☑
266	02-10-17	D/C	☐	☑	274	10-16-17	D/C	☐	☑
267	02-10-17	D/C	☐	☑	275	10-16-17	D/C	☐	☑
268	02-10-17	D/C	☐	☑	276	10-16-17	D/C	☐	☑
269	02-10-17	D/C	☐	☑	277	10-17-17	D/C	☐	☑
270	02-10-17	D/C	☐	☑	278	10-18-17	D/C	☐	☑
279	10-18-17	D/C	☐	☑	287	25-10-17	D/C	☑	☐
280	10-18-17	D/C	☐	☑	288	25-10-17	D/C	☐	☑
281	10-18-17	D/C	☐	☑	289	25-10-17	D/C	☐	☑
282	10-18-17	D/C	☐	☑	290	25-10-17	D/C	☐	☑
283	10-20-17	D/C	☐	☑	291	25-10-17	D/C	☐	☑
284	10-20-17	D/C	☐	☑	292	25-10-17	D/C	☐	☑
285	10-21-17	D/C	☐	☑	293	26-10-17	D/C	☐	☑
286	29-10-17	D/C	☑	☑	294	26-10-17		☑	☑

Source: ABC Marine

Figure 1: Extract from a hazard report log

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. Anderson's suggestion to double the required number of near-miss reports per vessel, 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 consider 2 - 4 near-misses per month acceptable 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 hazards and 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 such reports should decline once the causes have been eliminated. With more awareness, identification and rectification, the number of hazards and near-misses are 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.

The study from the data available thus reveals that the mandated increase of reports does not have any discernible impact on near misses or incidents. However, safety literature states that removal of hazards will definitely improve the working environment and go a long way in reducing near misses and incidents. This lack of a correlation can have a negative impact on seafarers in that they may feel that even through the reporting of high numbers of hazards, the numbers of near misses and incidents remain the same. This may result in them questioning the complete system with a negative impact on the safety climate on board. 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 ships.

6. Limitations and Directions for future research

The study suffers from the limitation that only three years of data was available for analysis. However, the important aspect of these years was that the data for years before and after a mandatory reporting increase were available, allowing insights into the effect of such an increase. More recent data may also have provided additional insights. The quality of reports was also not addressed as this is not part of the study and would require a different line of investigation. Future research in this area could collect data over a greater number of years, and look at the reports from a quality point of view. This would allow differentiation between useful and routine reporting and provide ways of judging the efficacy of the reporting regime.

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