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# Enhancing Company Safety Through Utilization of Safety related KPIs

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## ABSTRACT

All shipping companies are required to maintain the adaptation of the International Safety Management (ISM) which was introduced by the IMO in the late 1990s (IMO, 2019). The general aim of the ISM code is to provide an adequate level of operational safety for the maritime industry. Thus, the shipping companies are required to keep records of the Performance Indicators, including the KPIs, which can also be called the leading indicators for the accidents (OCIMF, 1997), as the leading indicators can be utilised to predict accidents before they happen. (Grabowski et al., 2007).

The leading KPIs are beneficial for taking proactive mitigating measures and predicting potential accidents. In this way, the shipping companies will have a tool to measure their safety culture level by comparing their KPIs with the standardised shipping KPIs (Rialland et al., 2014). Therefore, shipping companies are required to identify which KPIs to record with the aim of trying to identify the areas that need improvement. Consequently, the organisations which keep a close eye on the KPIs will achieve continuous improvement of their safety culture.

This paper presents a case study which includes screening and further analyses of the collected KPIs from a shipping company over the years and then compared to the KPIs listed by BIMCO (BIMCO, 2018), and are related to the environment, health and safety, navigational accidents, operation, and inspections.

The presented results will cover the gaps identified by the collected KPIs from the company and the effectiveness of these KPIs, together with further discussions. The paper will propose general improvements to enhance the company's safety culture even further, which are applicable to the whole industry.

**Keywords:** *KPI, Safety Culture, Shipping Company*

## 1. INTRODUCTION

Most of the complex organisations keep recording their Key Performance Indicators (KPI) to make their operation more resilient and to improve their performance accordingly. The shipping companies, which come under the Marine industry's umbrella, are one of the most critical domains, and they need to monitor and record their KPIs. Consequently, they need to implement intervention strategies to address the organisational challenges after utilising and analysing the KPIs and compare their KPIs with the standardised list which has been created by other organisations.

## 2. LITERATURE REVIEW

The concept of managing the indicators for any organisational performance has emerged in the 1980s as a reasonable response to several questions asked: "how is our organisation performing"? and "you cannot manage what you do not measure?" (Sharif, 2002). Thus, the importance of measuring the performance of any organisation leads to improving the weak point and increase the efficiency of the organisational outcome. (Konsta and Plomaritou, 2012) have described the performance indicators as an assembly of information which is utilised to measure and evaluate the performance of the organisation. Moreover, the performance indicators are giving the final evaluation of the efficiency and the effectiveness of the company. Therefore, the main purpose of the KPIs is to initiate a benchmark for the industry's performance (Konsta and Plomaritou, 2012). Besides those direct advantages, KPIs are considered a useful method for the stakeholders to monitor the constant improvement of the company's performance (Vukomanović, Radujkovic and Nahod, 2010). (Valdez Banda et al., 2016) have conducted a study on the categorisation of the

KPIs into two different categories. The first category is the so-called leading indicators, and the second category is the lagging indicators. According to (Reiman and Pietikainen, 2012), leading KPIs aimed to be measured continuously by monitoring identified input, which is required to achieve a planned safety target. As for the lagging KPIs are measurements that conduct reactive monitoring to identify the reasons for a delayed or not achieved planned objectives or goal (Øien, Utne and Herrera, 2011). Thus, to ensure resilient safety at the shipping companies, the leading indicators must be followed to flag up any insufficient performance. Moreover, the shipping companies should implement an assessment of their Safety Culture via conducting an improved methodology for assessing the Safety Culture to evaluate their current level of Safety, as mentioned by (Arslan, 2018). By then, the shipping company, which successfully conduct the Safety Culture assessment along with recordings of the leading KPIs, would be able to cope with any kind of safety threatening issues in an ample time. Thus, the resilience engineering concept will be achieved.

Key Performance indicators have gone through several improvement stages. (Volkan Arslan et al. 2016) have mentioned in their study that the Baltic and International Maritime Council (BIMCO) has provided the marine industry sixty-four KPIs to compare their business performance with other companies in the same field. Moreover, the classification society Lloyd's Register has provided seventy-three KPIs for the shipping companies specified in the Oil and Gas transport. Those seventy-three KPIs aim to improve operational safety. Leading performance indicators are safety metrics that are related and lead to an unexpected consequence such as an operational incident, Near Miss or personal injury. Tracking and improving these safety metrics help to maintain, monitor and improve safety performance (ABS, 2020). Thus, American Bureau of Shipping (ABS) has proposed thirty subsidiary KPIs and twenty-nine core KPIs to

achieve the monitoring, maintaining and improving the safety culture level of shipping companies, as mentioned by (Arslan et al., 2016). Therefore, any shipping company that has a set of KPIs that match any of the above-mentioned criteria should have a high safety culture level.

In 2010, the InterManager launched a standard for Shipping KPIs for general use. The databank for the shipping KPIs contains a set of data of more than 2000 ships as of the middle of 2013. Shipping KPIs are a set of standards and can be used as a benchmark to compare with other users (Riolland et al., 2014). So, it is accessible for the shipping companies to compare their performance based on a well-known standardised set of KPIs data.

All those efforts by the different organisations to set standardised and a list of proficient KPIs are being held in order to fulfil the requirement of the ISM in complying with the safety culture. In addition to that, an active recording for the leading and the lagging KPIs will provide a resilient system at any shipping company by overcoming any deficiency in any company's safety system.

### 3. METHODOLOGY

To accomplish this research with the mentioned aim above in the abstract, a set of KPIs were collected from an anonymous shipping company. The collected KPIs were evaluated to determine the company's safety performance through the KPIs assessment. The nature of the KPI data does not require an expert opinion to evaluate; it requires a statistical analysis (Ishak, Fong and Shin, 2019). This paper performs the statistical analyses by demonstrating two main points:

1. Comparison with other KPIs sets.
2. Trend analysis.

#### 3.1 Comparison between the shipping company KPI set with others

The company managed to record eighteen different KPIs of both categories, the leading and the lagging indicators. The number of KPIs that the shipping company records is less than half of KPI sets that were introduced by different organisations such as BIMCO and Lloyd's Register. Almost two-thirds of the KPIs set followed by the ABS, as shown in Figure 1 below.

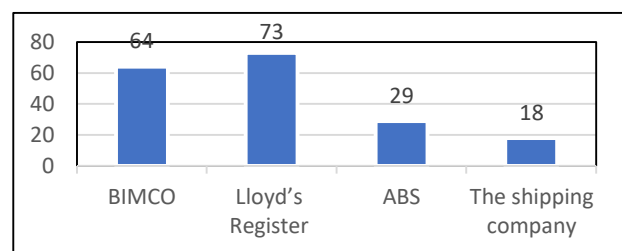


Figure 1 Number of KPIs sets by different organisations

#### 3.2 Trend Analysis

The trend analysis is utilised to capture the changes in each of the KPIs for the duration of a recent five years. Thus, the trend allows the researcher to highlight where the focus is required. Moreover, it gives indications and expectations on some of the other KPIs.

### 4. RESULT OF THE ANALYSED DATA

#### 4.1 The shipping company's KPIs trend

This section of the analyses explores the trend of the KPIs within the company as well as showing the performance of some of the safety aspects for a recent five years, whether leading or lagging indicators. The company managed to record eighteen different KPIs as follow:

##### 4.1.1 Lost Time Injury Frequency (LTIF)

LTIF is the number of lost time injuries occurring in a workplace per 1 million hours worked. The factors that play a role in the LTIF are the Number of Fatalities (FAT), Number of Permanent Total Disabilities (PTD) and Number of Lost Workday cases (LWC). The company needs to make sure those factors are at their minimum level to reach near-zero LTIF rate. The recorded LTIF for the company indicates a fluctuated trend rate, as Figure 2 shows. The first year had the lowest rate of LTIF, and since then, the rate has been increasing. This indicates possibly a non-satisfactory investment in safety as the company is required to monitor and decrease the numbers of PTD, FAT and LWC. Those factors can be maintained by implementing a more effective Near Miss Reporting (NMR) system to avoid the occurrences of those events. Thus, the safety performance of the company has room to improve compared with the benchmark of the LTIF rate for other competitive shipping companies. The benchmark of Shell oil tankers fleet is fluctuating between 0.2 and 0.4 LTIF per Million-man Hours (SHELL, 2019). In addition to that, (Wilhelmsen, 2017) has published the LTIF rate for the ships under its management, which was fluctuating between 0.35 and 0.67 per Million-man Hours. It is noticeable that the shipping company needs to put in more efforts to enhance the LTIF rate to match the acceptable benchmark of the other companies in the same sector.

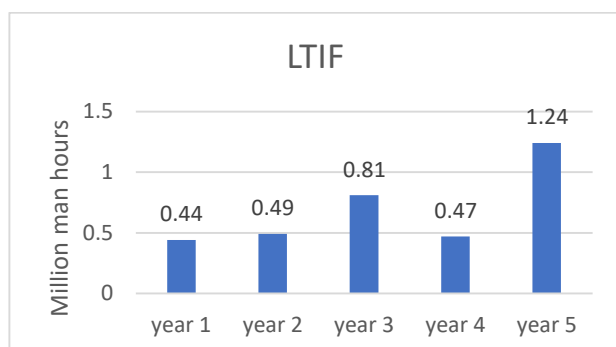


Figure 2 LTIF Per million working hours

#### 4.1.2 Total Recordable Cases Frequency (TRCF)

TRCF is the sum of all work-related fatality, lost time injuries (LTIs), restricted work cases/injuries (RWCs) and medical treatment cases/injuries (MTCs) multiplied by million hours then divided by man-hours. The company has recorded the TRCF for the past five years, and they need to increase their effort to achieve a rate close to zero. The fluctuation of the trend in Figure 3 indicates that even though the senior managers at the company are investing significantly in the improvement of the safety culture, it does not show the desired effect. The number of LTI, RWC and MTC needs to go to the minimum. This may suggest that adopted solutions to improve safety KPIs may not be the ideal solutions and shows the importance of collecting the right KPIs and accurate analysis of the collected data. A similar study was conducted by (Arslan, 2018) indicated that a high level of safety culture could be detected from the TRCF and the LTIF rate. His result gave the authors an indication on how to estimate if any shipping company is having a high level of safety culture or not. TRCF rate for a confidential shipping company was fluctuating between 0.17 and 0.15 per Million-man Hours. Moreover, (SHELL, 2019) has published the TRCF rate for its fleet for the period from 2010 to 2019, the maximum rate was recorded in 2012, and it was 1.3 per Million-man Hours. Afterwards, the rate was decreasing to reach 0.8 Million-man Hours. By comparing those results with TRCF rate for the shipping company, a more structured effort is needed the current TRCF rate.

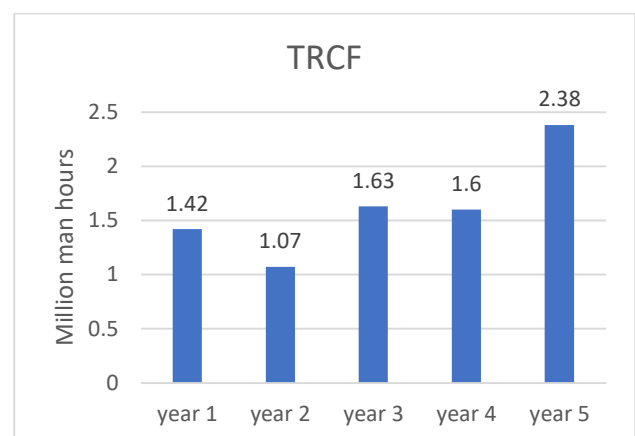


Figure 3 TRCF rate

### 4.1.3 Number of first aid cases (FAC)

Minor work-related injuries that require simple first-aid treatment come under this category. (OCIMF, 1997) has described FAC “as any one-time treatment and subsequent observation or minor injuries such as bruises, scratches, cuts, burns, splinters, etc. The first aid may or may not be administered by a physician or registered professional”. The increase of the FAC is an indication of the non-compliance with safety procedure by seafarers and a low level of safety culture. By studying Figure 4 and considering the number of the FAC cases in year 4, which was 42 cases, on average, 3.5 FAC cases occurred per month. This number is relatively high comparing to the first two years. The reduction of FAC in the last year, year 5 may be due to the increase in the number of safety meeting and the number of NMR coupled with the right safety interventions, as it will be shown in the following sections.

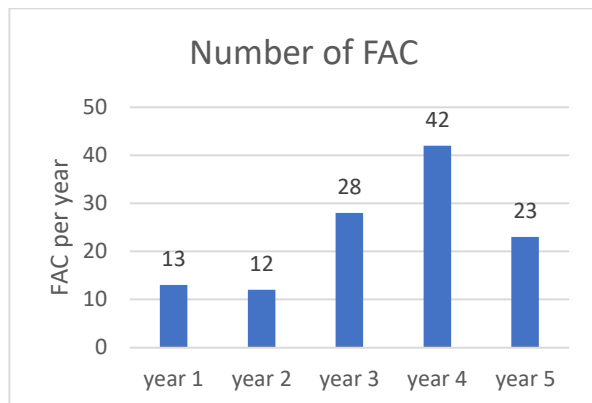


Figure 4 Number of First Aid Case (FAC)

### 4.1.4 Number of navigational accidents

This category relates to the event that includes steering failure, propulsion failure, navigational equipment failure, collision, grounding, or any other failure related to navigational practice. The trend for this category was almost steady during the five years, except for the second year, as shown in Figure 5. The rate of navigational accidents

recorded in the second year was more than double the rate recorded in the last three years. By considering the total number of ships at the company, then the rate of navigational accidents in year 2 is 0.088, and in year 3, year 4 and year 5, the rate was constant at 0.033. A more detailed analysis to identify the types of incidents that occurred and which types of ship were involved highlighted some operational accidents/incidents such as collision, Allision, touch bottom, Steering failure, and Tug contact. The Multi-purpose vessels, which carry RORO goods and containers, were free from any accident during the same period. This means the safety culture and the maintenance procedure is higher in the Multi-purpose fleet. The other fleets need to adopt the high-quality safety culture of the Multi-purpose fleet to mitigate the accidents as much as they can until they reach zero accident rate per year. It is advisable that the shipping company should standardise the qualifications, skills and capabilities of the fleets’ managers to match the practice of the Multi-purposes fleet. Subsequently, the good practice will impact the seafarers positively as well.

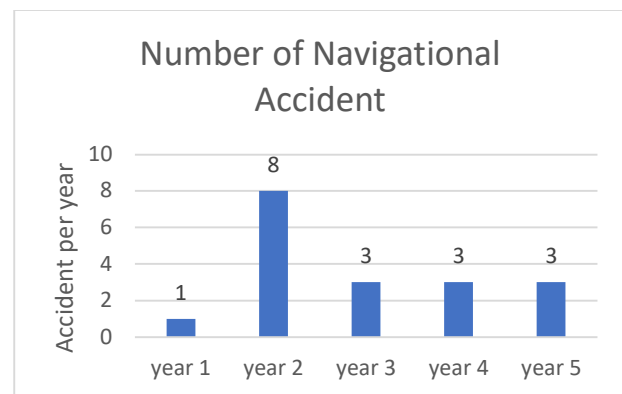


Figure 5 Number of Navigational Accident

### 4.1.5 Number of incidents

One of the KPIs that the company used to record is the number of incidents per year. The ideal situation is to find a zero-incident rate each year. However, we are not living in the ideal world yet. The company has noticed an increase in the number of incidents in the first three years, as shown in Figure 6. Then it started decreasing again. Even with the drop, the



number of incidents in each year still considered a high number compared to the number of incidents per ship per year in the UK, as mentioned in (MAIB, 2018). MAIB recorded 1.86 incidents per ship per year in year 3, and the shipping company has recorded 2.066 incidents per ship per year in the same year.

Another weakness with incident recording is that the shipping company did not categorise and classify the incidents. Thus, the company will find it difficult to identify which kind of incidents are occurring on what types of ships. Consequently, over the years, the company will find it difficult to contain those incidents and to track its root causes to eliminate them. Thus, it is highly essential for the shipping company to record those incidents along with its conditions and categorise them. The categorisation according to the types of ships that are involved in incidents and underlying causes of the incident, whether it is a human error, manufacturing errors or improper design and installations, is key to extracting the essential intelligence to identify and implement the tailored solutions. Moreover, classifying the incidents according to its potential safety consequences, as mentioned by (Wang, 2006) is essential as the incidents with high-risk safety potential should be given priority in the analysis. On the other hand, the potential low-risk safety to be rated as low priority. Subsequently, the shipping company will be able to capture which fleet has the highest incident rate and has been rated as high potential risk and what kind of incident has the highest frequency rate. By following this method of recording the incidents, the shipping company will improve the weak areas by enhancing the resilience among the ships with a high rate of incidents, along with its management.

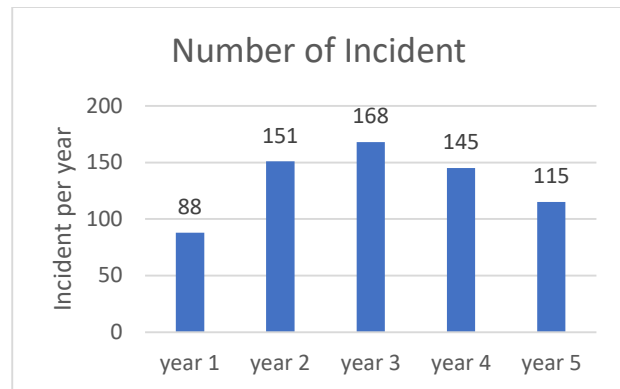


Figure 6 Number of Incident

#### 4.1.6 Number of Near Miss Report (NMR)

An event or chain of events that could potentially lead to an accident, injury, damage to the property or the environment or even fatality under specific circumstances come under this category. The company has been aware of the importance of this kind of reports, and they have encouraged all the seafarers within the company through the safety meetings, and other means of motivations such as award prize for best NMR to report as many safety-related issues as possible. In Figure 7 below, we can see the increase of the NMR from year to year. Bearing in mind that only nine vessels were added to the company's fleet in year 2, the admirable effort by the company explains the significant jump in the number of Near Miss reports for the period of the five years, and the positive response by the seafarers towards the company's commitment to safety and the encouragement. After that, the fleet number has remained the same, the increase in NMR has still continued. This is a valuable indication that the crew have been aware of the importance of the NMR and trying to achieve the company's goal. The company succeeded to collect the targeted number of NMRs in year 5. Keeping this number the same in the next year's NMR means staying on the same track. However, the quality of the report is more important than the quantity. This comes down to how the marine superintendents analyse the reports and classify the feasibility of each case. Unfortunately, the company does not have such a system to identify high-quality reports from

low quality and this is a common problem in shipping.

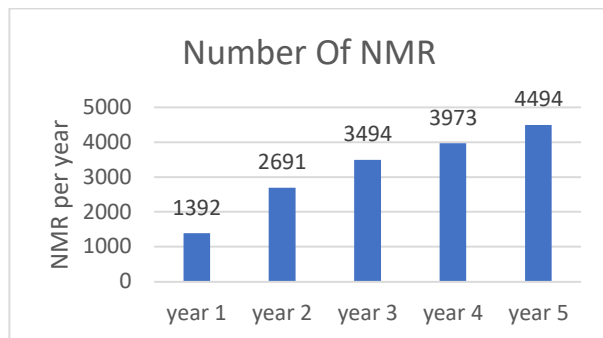


Figure 7 Near Miss Report Number

The percentage of the feedback given by the shore-based staff to the crew with regards to their NMR reports was 100% all along the five years. This was seventh KPI.

#### 4.1.7 Number of Port State Control inspection

Port State Control inspection is performed by a member of the port state control to check the validity of the ship's certificates and documents, and to make sure that the ship is complying with all the regulations that comes under the IMO such as the SOLAS, MARPOL, STCW, overall condition of the ship, its equipment and the crew qualifications (IMO, 2019). Based on the available data, the number of inspections by port state control increased for the first four years; then slightly decreased in year 5. According to (Rodríguez and Piniella, 2012), ships that are inspected by PSC every 5-6 months from the last inspection (twice a year) are categorised as high-risk. Standard risk ships are required inspection by the PSC every 10-12 months from the last inspection. Low-risk ships are required inspection by PSC every 24-36 months from the previous inspection. Based on the data, more than half of the company's fleet is treated as high-risk ships. This is a negative indication for the company as it may lose its reputation, and some of the vessels might be detained by the port state control, if the root problems are not addressed.

For this reason, the company started to record the number of PSC inspections with deficiencies as one of the KPIs, and the number of deficiencies found by PSC in the last two years. This is a very important KPI highlighting the safety levels and weak areas in practical ISM implementation in the company.

#### 4.1.8 Number of Internal Audit (ISM) non-conformities findings

Firstly, the definition of non-conformity needs to be addressed. It means an observed situation where objective evidence indicates the non-fulfilment of a specified requirement of the ISM code. By understanding the meaning, then this category includes all non-conformities identified by an internal audit, which is arranged by the company. The Safety Inspection is designed to inspect the application of international maritime safety and the environmental protection regulations by the vessels' crew. In addition to that, as per the ISM code, the internal audit needs to be carried out one month in advance before the anniversary for each ship from the date of its launching (Novaveritas, 2019). In some cases, due to the ship operation and location, the audit might be delayed up to three months. Figure 8 shows the total number of findings during internal audits each year. As it is noticeable, the number is within the acceptable number whereas, on average, the company is expected to perform one visit a year per ship. This gives almost one finding per visit on average if we consider that some ships had a delayed internal audit in year 4 to the next three months, which resulted in being in year 5 due to the scheduling issues. Thus, the number of findings is considered as an acceptable number. This gives an indication that the Internal Audit is not as strict as the PSC inspections. According to the authors' experience as a seafarer, the crew members of any ship usually prepare the ship for their safety audits, including all the safety checklists and documentation before the Internal Audit. Therefore, the auditor finds all the procedures and the ISM requirements comply without

deficiencies. This is the reason behind the acceptable number of findings. However, this highlights a weakness in the approach as company fleets experience more PSC inspections with deficiencies and findings. If the company adopts a stricter internal audit approach and identifies the deficiencies, then the company would address these deficiencies to minimise the deficiencies/findings identified by PSC inspectors. This will, in turn, increase the reputation of the company.

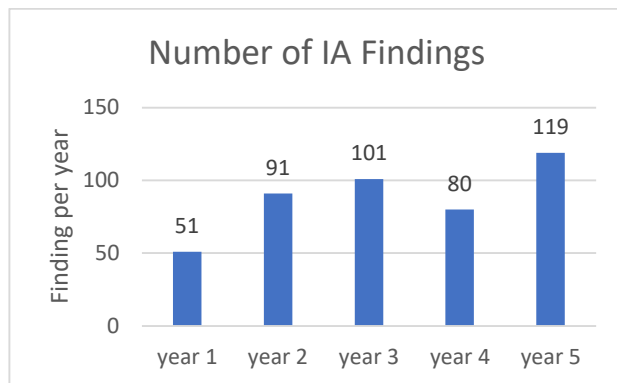


Figure 8 Number of Internal Audit (ISM) non-conformities finding

#### 4.1.9 Number of External Audit (ISM) non-conformities findings

The external audit is an arranged visit from the flag state to the company to go through the company's procedures and safety manuals. They also may conduct a drill on-board one of the company's vessels to evaluate the seafarers' response toward the simulated emergency. This category includes all non-conformities observed during the external audit. Figure 9 shows the trend during the five years. It is observed that there was an increase in the conformities first two years. Then a tremendous drop for the following three years. This improvement must have happened as a result of the successful internal audit effort as the seafarers learned how to deal with this kind of audits by keeping every single detail about the safety issues recorded in an appropriate logbook. Thus, the external audit found that all the records are organised, and the level of safety has increased. As a result, fewer findings were found during the external audit.

Moreover, the company possibly used learned lessons for the five years of the data and were more prepared for external audits. This kind of improvement is expected from a company that keeps recording its KPIs seeking safety improvement.

Linking the number of findings by the internal audit, external audit and PSC inspections, we can understand that the PSC inspection is implementing a stricter safety regime to make sure the ISM is applied correctly on each ship. Unfortunately, PSC findings are way more thorough than the audits, which mean there is a weakness in applying the ISM correctly by the seafarers and possibly by the internal audits. Moreover, the external auditor who is conducting the audit is possibly not as experienced or thorough as the inspector from the PSC. Thus, the External Audit must deal with the Auditing strictly and justly, as the more findings will help in enhancing the shipping company safety performance and better performance during PSC inspections.

By investigating the three different types of inspections along with their findings, we can see the difference in the number of findings from each type of inspection. The variation is significant, and this is the reason why this topic requires extra attention. The external audit findings are almost zero in the last three years. The seafarers and the company know the timing and schedule of the external audit, and the audit is done by a classification society that was chosen by the company itself. This gives us an indication that the seafarers are very prepared for this audit by showing the auditor their best practice and implementation of the regulations and conventions. However, during the internal audit, it is the company's and the masters' benefits to have stricter internal audits and to highlight some of the safety-related issues. Thus, in the next audit, those safety-related issues will be improved and passed issues.

Regarding the third type of inspection, which is by the PSC, it is supposed to be fair and does not rely on any kind of compliments. The number of safety-related issues recorded under this kind of inspection does not match the number of findings under the Internal or the External audit. Moreover, the number of findings by the PSC



started to be recorded in the last two years only after according to the highest number of inspections by the PSC. Such a deviation in findings between the external audits and the PSC inspections reflect that there is significant room to improve in terms of how ISM is implemented and, more importantly, the maturity of safety culture.

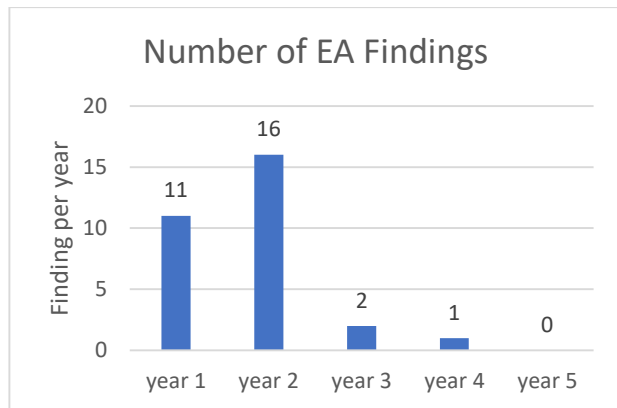


Figure 9 Number of External Audit Findings

#### 4.1.10 Number of safety inspection per annum by the marine superintendents

This category includes the total number of safety inspections performed by the marine superintendents. The company's requirement for the number of the marine superintendent is a visit every time the ship berths at her home port (port of the registration of the ship), and not less than two visits per year per ship. Figure 10 shows the exact number of inspections each year. The jump from year one to year two is due to the increase in vessel numbers within the company. In general, the trend is moving up over the five years period. The number of the visit has increased because of the increase in the number of NMR, FAC and the occurrences of navigational accidents. Thus, the company has succeeded in maintaining the minimum number of visits in year 4 and year 5. The more visits conducted by the marine superintendent, the more issues found and solved before the PSC inspection. Subsequently leads to fewer safety issues found by the PSC. This indicates

company's commitment to safety in principles and in practice. This also shows the right approach adopted by the company about the NMR campaign, superintendent visits and their findings.

As the total number of visits was increasing from year to year. Consequently, the number of issues found would increase, as well. Except for year 2, the safety issues found was less than the year before. This could be a result of the high number of findings during the internal audit. Thus, some of the safety-related issues were possibly addressed in year 2 before the visit by the marine superintendent.

Regarding the last two years, the number of findings during Marine Superintendents' visits has increased drastically. The increase is logical, as the number of the PSC inspection had increased as well. At that point, the marine superintendents possibly decided to increase their inspection criteria to make the inspection stricter. Thus, more findings will be addressed and solved. Subsequently, This will result in a decrease in the number of PSC findings gradually and the PSC inspection numbers.

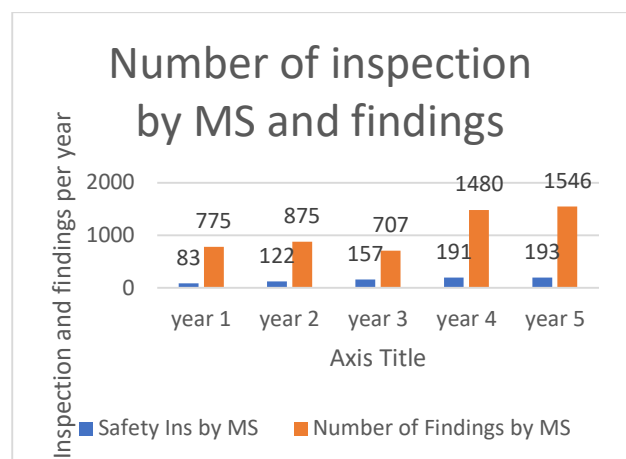


Figure 10 Number of inspection and findings by MS

As MS visit can be seen a successful strategy by the company, The company is recommended to schedule more visits to the ships by the marine superintendents, as it will encourage the seafarers to indulge with the ISM code requirement and motivate them to report more Near Misses and address any potential deficiencies. The result will reflect on the enhancement of the safety culture and

increasing the resilience gradually for the shipping company.

#### 4.1.11 Number of safety meeting

This category includes the total number of safety meetings that are held on-board the company vessels per year. Safety meetings are designed to discuss the Near Misses and any other safety-related issues occurred on-board the ship. However, the ratio of the increase is not steady, and this is normal. As the number of vessels increased in year 2, the number of NMRs and the FACs should increase as well. However, as per the company's HSE manual, the safety meeting is required to be conducted once a month, with the primary aim of identifying, minimising and controlling the hazards created during daily routine work on-board ships. By considering the total number of ships, which stands currently at 90. Then the number of safety meetings should be 1080 per year. Unfortunately, the company has not reached the target number, as identified in Figure 11 below. The more commitment by the master and chief engineer to have more safety meetings will impact positively on the rest of the crew with regards to safety. Thus, the company is required to encourage more safety meetings to be conducted to eliminate the possibility of latent conditions, which might lead to active failure.

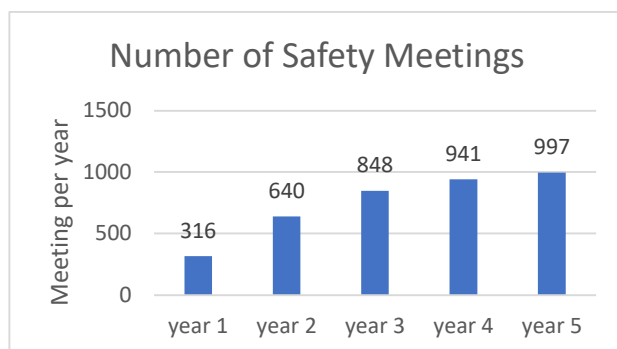


Figure 11 Number of Safety Committee Meetings

## 5. CONCLUSIONS

This paper has introduced the analysis of a shipping company's KPIs to measure the safety culture level. The analyses of the KPI or, in other words, the analyses of the leading indicators provide a general overview of the safety culture level within the company. Also, it gives an indication to the company in which areas need improvement. The acquired results from the analysis show that the company has identified the importance of the NMR and its outcome, as it can play a significant role in reducing the percentage of accidents occurring. Therefore, the number of NMRs was increased noticeably throughout the five years, and therefore, some other KPIs were also improved because of the increase in NMRs. However, the number of NMRs is not the only indicator to prove that the company is moving on the right track. The quality of the NMR is also extremely important.

In a nutshell, the study provides detailed insight into the safety of the company's fleets by using the company safety-related KPIs. The results also clearly show how important to collect, analyse the right KPIs and implement correct solution to enhance the safety of a shipping company. It is also recommended to follow the standardised KPI list used by the industry as it helps with benchmarking.

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