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IMPACT OF FATIGUE ON SEAFARER'S PERFORMANCE

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ABSTRACT

There is no doubt that the maritime transport is one of the most important means of the global transportations. Whereas the maritime transport represents around 90% of the global trade market, according to BIMCO (The Baltic and International Maritime Council) statistic. Maritime transport has several trends globally, among which is the transfer of cargo and its movement between different countries in the east and west, north and south as well as the transfer of drilling materials and equipment to the rigs, which do their part in the field of gas and oil exploration and search in the depths of the seas and oceans.

The human factor is considered one of the fundamental elements upon which the maritime transport depends. It has been demonstrated that this factor was the main cause of accidents and consequently the human and material losses (Berg, 2013).There are several other factors, such as the act of god, ships maneuverability, port accessibility, etc. therefore, it is important to study those factors which affecting to those who work in the field of maritime transport and the large workload undertaken by seamen.

Given the difficulty of labour on some cargo vessels and the continuous work periods without getting adequate rest, the seaman's health and psychological well-being may be negatively affected. Accordingly, human error occurs especially on large vessels operating on short trips including non-stop loading and discharging work.

There are several causes of fatigue to seamen, such as manning ships with the minimum crew members, the increasing of the operational and administrative burdens in the shorter trips, the seamen being distant from their families for a long time as well as the difficulty of getting enough time to rest and sleep because of the ship's positions and movement during sailing or loading, discharging and the noise.

International organizations such as the IMO (International Maritime Organization) and the ILO (International Labour Organization) were concerned with all the seamen's problems and the long working hours from which they suffer. They had issued several international agreements where they specified the maximum working hours and the minimum hours of rest, such as the International Convention on Standards of Training, Certification and Watch keeping for Seafarers (STCW), 1978 and the Maritime Lab or Convention (MLC), 2006.

This research paper addresses a study of the causes of maritime accidents of ships, including the fatigue factor and the impact on the marine environment and, subsequently, injuries and considerable economic losses. This will be achieved through a deep study of two ship collisions, one carrying general cargo, and the other carrying liquefied gas.

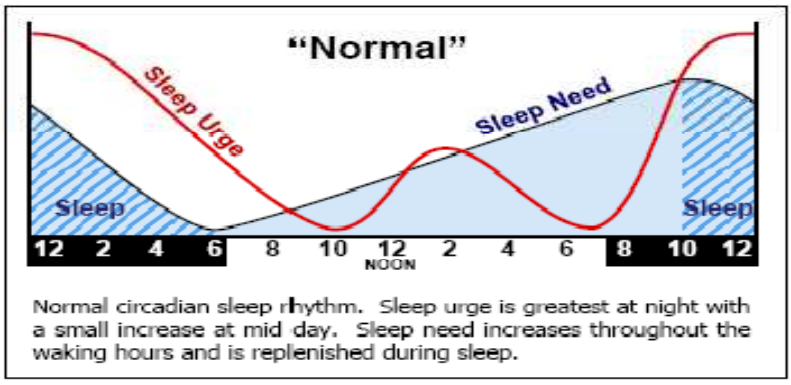
KEYWORDS: Fatigue on Seafarer's

INTRODUCTION

DEFINITION OF FATIGUE ACCORDING TO IMO

The International Maritime Organization (IMO) has defined fatigue as the diminution in the physical or mental capacity as a result of physical, mental or psychological exertion, which has weakened the physical abilities, includingstrength, speed, response time, hand-eye coordination and decision-making. (MSC, 2001)

There are many symptoms of fatigue, including general lethargy in an individual's activity, inability to perform a certain function as part of the natural abilities of a person or feeling muscular weariness resulting from a particular labour.All these symptoms are widely prevalent among people in everyday life; however, their severity varies depending on a person's stamina. Generally, the intensity of these symptoms relatively increases with the increase in work pressure over the normal limit. Similarly, the response to fatigue differs from one person to another with the differing conditions and situations. Under certain circumstances, an action can be considered fatiguing, while it may not be so in other circumstances. For instance, if a person runs for fear of danger, he/she will suffer from severe fatigue, whereas if the same person runs the same distance for the purpose of sports, he/she may not feel tired. Therefore, it is difficult to find a specific definition to fatigue. (Smith, 2006)



Source: https://www.normal.Circadian+Rhythms&tbm December 2014

Figure 1: Circadian Rhythms

THE INTERNATIONAL MARITIME ORGANIZATION'S (IMO) VIEW OF FATIGUE

The International Maritime Organization (IMO) adopts wide holistic view to identifying the causes of fatigue. It stipulates that it must be recognized that the seafarer is a captive of his/her work environment due to:

Firstly, while serving on board the vessel, there is no clear separation between work and recreation.

Secondly, the average seafarer spends between three to six months working and living away from home, on a moving vessel that is subject to unpredictable environmental factors (i.e. weather conditions).

Thirdly, today's crew is composed of various nationalities, and religious, cultural, and social backgrounds, who are expected to work and live together for long periods of time. All these unique aspects are a combination of possible reasons for fatigue. (Parliament of the Commonwealth of Australia, 2000)

Personal qualities play an important role in determining whether or not a person is susceptible to fatigue. For

example, two people may be exposed to a financial hardship. One may get over it, while the other may break down. There are people who have the ability to work under hard conditions and long hours due to their physical strength. (Wubbolts, 2005)

INTERNATIONAL CONVENTIONS CONCERNED WITH REDUCING FATIGUE

The International Maritime Organization discussed the problem of fatigue in order to find solutions to it and to lay systems concerning work and rest hours. This is done to provide the crew with comfort and to reduce the effects of fatigue, which may result in a lot of maritime accidents, and consequently human and material losses.

IMO / ILO's Concern with the Issue of Work and Rest Hours

Among the international conventions dealing with the issue of seafarers working hours is Convention No. 109 issued by the International Labor Organization (ILO) in 1958, concerning wages, working hours, and manning. This agreement proved to be futile, because only 15 of the Member States ratified it, and it was not put into practice.

In 1996, the Maritime Conference of the International Labor Organization adopted Convention No. 180 as an alternative to the Convention No. 109. Convention No. 180 applies to all the seafarers on board ships. In addition to what the International Labor Organization put forward, the International Maritime Organization (IMO) addressed the issue of fatigue, and work and rest hours through its convention of the Standards of Training, Certification and Watch-keeping (STCW), and the International Safety Management (ISM Code). The following is an explanation of these conventions:

- **Convention No. 147 of the Minimum Standards in 1976, and 1996 Protocol attached thereto (ILO 147)**
- **Convention No. 178 for the Inspection of Living and Working Conditions of Seafarers (ILO 178)**
- **The General Assembly of the International Maritime Organization Resolution A 481 (XII) (1981)**

Principles of Safe Manning

The Maritime Labor Convention (MLC, 2006) defined working and rest hours in the Regulation 2.3.Thehours of rest are any hours other than working hours and do not include short breaks, while working hours are the time when seamen are required to work on the ship.

Each of the member countries has agreed that the normal standard of the seamen's working hours is eight hours of work a day and one day of rest per week. This should not prevent member countries from taking procedures that would allow a collective agreement that specifies seamen's working hours. Then, each state advised to determine their own working hours to limit the risks resulting from seamen's overwork, especially those working in navigation safety, and the security and operation of the vessel. This convention has specified maximum of 14 hours of work in the course of 24 hours, and 72 hours per 7 days, and a minimum of 10 hours of rest per 24hours, and 77 hours in any7-day period. The length of each of the two periods shall not be less than 6 hours, and the interval separating between two consecutive periods of rest shall not exceed 14hours.A 15 minutes break should be allowed after each two hours of work. Distress calls and fire-fighting drills are done in a way that minimizes the rest periods and does not lead to fatigue. However, if the seaman had to work during a period of rest, he should be compensated for it with another one.

This convention has given the master the right to stop working according to the schedule of work and rest hours, to ask one of the seafarers to work overtime in cases considered by the master a necessity for the safety of the

vessel, people or cargo, compensate these seafarers for periods of rest whenever possible, and post work and rest timetables in visible places depending on the language of the crew.

The International Convention on Standards of Training, Certification and Watch-keeping for Seafarers (STCW)

The International Convention on Standards of Training, Certification and Watch-keeping for Seafarers (STCW) specified the same Maritime Labor Convention 2006 in terms of work and rest hours of rest. However, it recommended that the administration takes into account the risk resulting from navigators' overwork, especially those responsible for the safe and sound operation of the ship. All people assigned to work such as officers, their assistants and those who have certain duties like safety, pollution prevention, and security should get at least 10 hours of rest in the course of 24 hours, equivalent to 77 hours per week (Article A I / VIII of the Convention).Rest hours cannot be divided into more than two periods of not less than 6 hours each, and the interval between two consecutive rest periods cannot exceed 14 hours.

As for the fire-fighting, lifeboats drills and trainings stipulated by national and international laws, they are being conducted in a way that limits interrupting rest periods and does not lead to fatigue. For those who had their rest period interrupted, they would get a compensatory one.

The STCW has also stipulated giving the captain the right to demand at any given hours that seafarers perform work necessary for the safety of the ship, people or cargo.

There were some exceptions to this Convention; it has given the right to some of the parties to grant exemptions for the required rest hours provided that the rest period is not less than 70 hours per 7 days. These exceptions are explained as being set by the International Labor Organization on the Seafarers' Working Hours and Ship Manning (No. 180) in 1996.Rest hours can be divided into a maximum of three periods; one of them should be at least 6 hours, while any of the other two periods should not be less than one hour.

STCW obliged departments to post watch schedules in clear positions and the crew's language(s).

APPLICATION OF INTERNATIONAL CONVENTIONS ON SHIPS

With the existence of modern vessels, work increases on ships, causing considerable stress in the work environment. And with the changing patterns of trade and employment, the time spent by the seaman on the ship has increased. He may be away from home and family for 6 months or a year. Sailing between ports became a few hours instead of days. New legislations and continuous inspection increased, which aim at raising the level of safety. This adds to the seafarer additional responsibilities and burdens, without having an appropriate time to rest. Increasing security requirements on ships added a new burden on officers on all ships, which are the ship security officer. Shipping companies do not supply ships with those who do this job. For years, seafarers found themselves stuck in a lot of the most rapid and hard work, while the companies are reducing the number of crew members to the minimum. Therefore, the possibility of applying these agreements varies depending on the type, work nature, and sailing duration of the vessel.

Watch-keeping System

It is possible to correctly apply the provisions of the international conventions when the watch-keeping is applied in the wheelhouse, machines room, and daily work with 4 hours of work and 8 hours of rest system. This happens when a ship sails for long periods, so the total working hours is 8 hours and 16 hours of rest, in which the seafarer fights

against fatigue.

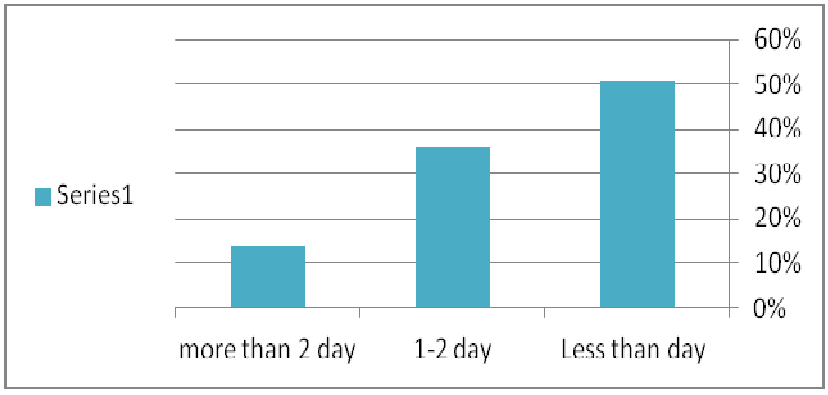
As for ships with less crew members, watch-keeping system of 6 hours of work and 6 hours of rest is applied, in addition to the administrative burdens carried out by the officers such as the follow-up of routine deck maintenance works done by the Chief Officer. The correction of charts and navigational publications - and the application of International Safety Management (ISM) system with all its paperwork and burdens is done by the Second Officer. Inspection of Fire Safety Equipment is done by the Third Officer..

In this case, it is difficult to achieve with the international conventions stipulated that working hours should not exceed 72 hours a week, and they become 84hours per week, and so rest hours decrease causing fatigue.

Sailing Periods Length

Seafarers' rest periods vary depending on the length of sailing periods. Long sailing periods give them an opportunity to get long rest periods and vice versa. In short rest periods, the mooring work begins as soon as the ship enters port, which requires preparing the loading and discharging holds and cranes, and the follow-up of shipping operations which extends to 24 hours. Officers are also required to prepare cargo documents, sign them, and follow up the process of loading or discharging. Then, the process of preparing the ship for sailing, and all the departments' watches begins. Some of these farers may have not taken any rest all day through because it was impossible to provide the rest period stipulated in the conventions.

When this happens, fatigue controls the crew causing them to lack eagerness to work, and to feel sleepy. As a result, many marine disasters occur. Figure (2) illustrates a study to the effect that the percentage of the number of days spent by ships at docks is divided into three categories: the first category is less than a day, where the percentage of fatigue reaches up to 51%, the second category reaches 36%, and the third category is 14%.The time a ship spends in port ranges from a few hours to several days. The interval varies according to the type of the vessel. It is shortest with modern vessels, and this limits the crew's rest periods.



Source: Survey data (Jayakody, 2008)

Figure 2: Days Spent by a Ship in the Port

Additional Burdens

The International Transport Workers' Federation (ITF) conducted research on the impact of applying the International Ship and Port Facility Security (ISPS Code) which came after the September 11 incident in the United States

of America. It identified ship security requirements, security plans, and raising the level of security for seafarers and officers, which led to increasing overtime, and a lot of negative effects on crew's performance. 96% of the seafarers on whom the research was conducted said that there was not any increase in the crew levels to deal with the additional workload. (ITF, 2005)

Individuals' Work Nature

Some provisions of the conventions are not implemented on some crew members. They are officers, engineers and seafarers who work according to the watch-keeping system, where they do not get adequate rest because their presence is necessary in the wheelhouse or the machinery room during sailing. This negatively affects those, causing fatigue.

The Quality of Rest

Sampson & Ellis conducted a study on a sample of seafarers. It showed that 23% could get adequate periods of rest on board the ship, 56%got somewhat sufficient rest in some cases, and 19% were unable to get the necessary rest periods.

The possibility of getting rest varies with the changing ship situations, either sailing or in port. 21% reported that this problem occurs while the ship sails in the open sea, 44% noted that the problem occurs while the ship in the port, and 35% said they were unable to get either when the ship sailed or was in port. (Smith, 2006)

THE RELATIONSHIP BETWEEN WORKING HOURS AND FATIGUE

- The effects of fatigue are particularly dangerous in the shipping industry. The technical and specialized nature of this industry requires constant alertness and intense concentration from its workers. The human element, in particular, is viewed as a contributing factor in marine casualties on a large scale. For example, the incident of the oil tanker, Exxon Valdez, which was one of the worst marine environmental disasters in the last century, is one of the many accidents that fatigue has been identified as a contributing factor in their occurrence (IMO, 2001). 60 ships have drifted around the UK coast over the past decade as a result of the officer falling asleep feeling sleepy during the watch. The officer became present in, yet absent from the wheelhouse. (NUMAST, 2004)
- On researches conducted in the last twenty years, the data indicate that those working with 4 hours of work and 8 hours of rest system show a considerable disorder in their sleep. The average sleep duration for all seafarers is 6.6 hours. Seafarers who keep watch get disrupted sleep periods of less than 5 hours and this leads to critical fatigue (fatigue is associated with weak performance and sleepiness).Researches have also proved that the situations in modern ships, where machinery is being remotely observed from the machinery room of the marine engineers' room by an Un-Manned System (UMS) expose them to fatigue, in which the engineer is summoned in unspecified times. Fatigue does not result from the times a seafarer spend away from bed only, but also through the indirect effects during sleep. (Torsval,1988)

Analyses have indicated that the largest percentage of drifting incidents and collisions occurs during the crew's watch periods from 0400 to 0800, where sleep becomes less than 4 hours per 24 hours. These individuals exhibit signs of fatigue and reduced levels of alertness.

The (ITF) has done the most comprehensive search on working hours and their relationship to the seafarers'

fatigue. It was based on the responses of 2,500 seafarers from 60 different nationalities working on 63 different flags to reveal the risks to the marine environment, health and safety. It has also shown that many seafarers are oblivious to the legal guarantees and legislation that have been made. Many ship-owners and employers are either unwilling to obey these regulations or are unable to comply with these regulations and legislations.

The (ITF) report has been to the effect that fatigue among seafarers is still unremitting, despite the international convention that was issued on identifying work and rest hours. One third of those seafarers reported that the average daily working hours is 12 hours or more, more than 5 % reported that the average daily working hours is 15 hours, nearly two-thirds of the total weekly hours of work amounted to more than 60 hours, and 25 % work more than 80 hours a week.

SHIPPING ACCIDENTS AND THEIR RELATION WITH FATIGUE

There is a universal concern about seafarers' fatigue and its potential environmental cost. It is widely evident in the shipping industry and oil extraction and transportation. This led ship owners, international organizations, especially the International Maritime Organization, and Protection and Indemnity (P & I) clubs all to pay attention to that fact that some vessel types may contain a fewer number of crew members. They are also vulnerable to adverse weather conditions, in addition to the heavy traffic in some areas, and the rapid port calls. Thus, we who find that and where is your source find that the seafarers work for long hours with insufficient time for rest. In these circumstances, fatigue and reduced performance levels may lead to shipping disasters, which could possibly lead to environmental damage, poor health and loss of highly skilled seafarers who are in increasingly dwindling.

FATIGUE AND SHIPPING ACCIDENTS

The American Bureau of Shipping (ABS) undertook a project to identify publicly available databases of marine accidents, review the database structures, and analyze the contents. The objective of the project was to better understand the role of humans in accident causation. With this knowledge, it is believed that ABS and vessel designers and operators can direct their efforts with regard to rulemaking, establishing design criteria and standards, planning operations, or directing future research development efforts. For vessel designers, builders, and operators, this effort will provide relevant information regarding the contribution of the human element in marine accidents. The analysis of accidents included those associated with commercial passenger vessels, freighters, tankers, tugboats, and offshore supply vessels. Accident data from the United Kingdom, Canada, and Australia were reviewed and analyzed in the second year of the project.

Among the main conclusions reached by the project were the following:

- Human fatigue is closely linked to dereliction in duties.
- Human error continues to be the dominant factor in marine accidents. It can be divided into direct and indirect human error. For example, the mistakes made by some officers in the wheelhouse in applying the rules of preventing collisions that lead to a ship colliding with another is a direct error, while an indirect error can be a collision resulting from lack of response from the rudder as a result of negligence in maintenance work.
- One of the most important causes of shipping accidents is the inability to assess situations. 70% of the recorded incidents are caused by human error. There is a common large percentage of this result between data and reports within the United States, the United Kingdom, Canada, and Australia.

- For all accidents, over the reporting period, approximately 80 to 85% of the accidents analyzed involved human error. Of these, about 50% of marine accidents were initiated by human error, and another 30% were associated with human error. This means that failures of human performance led to the failure to avoid an accident, or mitigate its consequences. In other words, conditions that should have been countered by humans were not adequately addressed. (Baker, et al, 2003)

Effect of Long Working Hours that Cause Fatigue Leading to Accidents

The risk of a collision increases with the increase in daily and weekly working hours From what has been shown in the previous section, some vessels employ a shift system for 8 hours of work, while others employ a 12-hour system. It was found that the risk of collision doubles in the case of the12 hours of work a day than that of the 8 hours system. Therefore, long working hours lead to fatigue that causes the loss of ability to work, which leads to the risk of accidents. (Berwick, 2003; Dong, 2005; Lombardi et al., 2010)

Similarly, those who work for 65 hours or more per week cause more accidents than those working for 40 hours or less per week by 88% (Verso et al., 2007). The results of studies carried out on 10,000 workers in the United States assert that there is a clear relationship between the number of daily and weekly working hours and the occurrence of accidents. This means that the more daily and weekly working hours increase, the more accidents abound due to the seafarers' suffering from lack of rest, which helps get rid of the fatigue of which they suffer because of the long working hours. (Dembe et al, 2005)

There is a close relationship between the shift time and the occurrence of fatigue that causes shipping accidents. The most common time for the highest percentage of fatigue is from 0400 to 0700.This time is at the end of the night period in which fatigue reaches a maximum degree. This time is often the shift of the Chief Officer, who is burdened with many obligations. Then, the percentage of fatigue slightly decreases from 0100 to 0400, becomes small and levels out from 1000 to 2000, and then increases from 2200 to 0100. (Dembe et al 2005)

Ship Losses Due to Accidents

With the continuous progress in the last few years due to the large number of vessels and cargo amounts, shipping accidents and losses, whether human or environmental increased as well. There is a clear relationship between the maritime safety and protection of the environment. The more the safety on ships increases, the lesser the environmental losses become.

The year 2012 was important for addressing maritime safety issues whereas the (IMO) has chosen a day in 2012 to be the World Maritime Day, celebrating the 100th anniversary of the sinking of the Titanic, and marking a watershed in maritime safety. Due to the large number of ship accidents in the last few years, it she delights on identifying and understanding the factors that caused shipping accidents. Data has shown the technical condition and size of the vessel, sailing region, the human element, as well as the weakness in the administrative complexity in the shipping industry, which is links to ports and dereliction in the ratification of conventions. The economic factors also have a direct impact on the safety of ships due to the frequent port calls in a short time, and reducing the number of crew members required to run the ship, causing rapid fatigue to the crew and therefore shipping accidents.

As for shipping accidents, the main criteria have been discussed by (Nickie Butt), through a revising the statistics of the victims all over the world during the past 15 years, and a review of all Port State Control (PSC) conventions and memoranda of understanding. Through a meeting with 6 stakeholders and shipping industry experts, including major insurance companies, the International Maritime Organization, rating bodies, and Protection and Indemnity (P & I) club, this is one of the first independent reports to consider in detail collective data associated with shipping accidents. The report showed unified evidence of the factors that contributed in shipping accidents through the past 15 years, giving rise to changes in marine safety regulations. The unremitting growth in maritime trade results in the increase of global shipping and cargo movements. It is necessary to take advantage of the economies of large vessels, while the ship management tends to reduce staffing and assistive technologies on board. At the same time, seafarers are under pressure to meet deadlines imposed by the shipping companies and to comply with a set of legislations related to safety, security and protection of the marine environment that are expected to be implemented without any additional labor force on board ships to bear the additional workload required to accomplish tasks in order to comply with the requirements of the shipping companies and regulations stipulated in international conventions and the administrative burdens associated with them. All these factors impose extra pressure, and can affect the safe functioning of the ship. (Pike et al 2013)

Accidents Due to Physical Fatigue of Crew Members on Board

Table (2) shows (ABS) reports obtained from the Canadian Safety Authority, which describes the causes of accidents of more than one hundred vessels. It has been shown that the causes of shipping accidents resulted from faults and malfunctions in machinery and devices, and human errors, where the number of these accidents reached 85.

Case Study of the Collision of Two Ships Due to Fatigue

At 1014 UTC on 24 March 2012, Netherlands registered cargo vessel Spring Bok collided with the Maltese registered liquefied petroleum gas (LPG) tanker Gas Arctic.

The collision occurred in visibility of less than 2 miles, 6nm south of Dungeness Lighthouse while the vessels were proceeding in the south-west lane of the Dover Strait Traffic Separation Scheme (TSS).

The Marine Accident Investigation Branch (MAIB) identified that the officer of the watch (OOW) of Spring Bok, which had been overtaken by Gas Arctic, was fatigued and had failed to see the other vessel before the collision. Although each vessel had detected and identified the other by both radar and Automatic Identification System (AIS), neither OOW made a full appraisal of the risk of collision, nor took the action required by the International Regulations for Preventing Collision at Sea 1972 (as amended) (COLREGS) to prevent the accident. Both vessels' Safety Management Systems (SMS) required that when the visibility was 3nm or less, a range of control measures be put in place to reduce the risk of collision. However, there was no lookout posted, or sound signal operating on either vessel at the time of the collision. There were no serious injuries or pollution, but both vessels suffered structural damage.

According to MAIB report, the crew of the Dutch vessel had not slept from 0700 o'clock the previous morning till then and that the main cause of the collision was fatigue.

Table 1: Causes of Marine Accidents and the Percentage of Human Error to the Machine Crashes

			Causal Factor	Count
Situation Awareness Group	Situation assessment and awareness	15	Task omission	16
	Knowledge, skills, and abilities	13	Situation assessment and awareness	15
	Commission	2	Knowledge, skills, and abilities	13
Management Group	Fatigue	3	Mechanical / material failure	6
	Communications	4	Risk tolerance	5
	Bridge resource management	5	Bridge resource management	5
	Procedures	5	Procedures	5
	Manning	2	Watch handoff	5
	Business management	3	Lookout failures	5
	Watch handoff	5	Unknown cause	5
Risk Group	Risk tolerance	5	Communications	4
	Navigation vigilance	3	Weather	4
	Complacency	3	Navigation vigilance	3
	Substance abuse	1	Complacency	3
	Task omission	16	Fatigue	3
	Lookout failures	5	Maintenance related human error	3
Maintenance Human Errors	Maintenance human error	3	Business management	3
Non-Human Error Group	Uncharted hazard to navigation	1	Commission	2
	Material failure	6	Manning	2
	Weather	4	Uncharted hazard to navigation	1
	Unknown cause	5	Substance abuse	1
Total causes identified: 109 Mechanical failures, etc: 16	Percent Human Error related: 85		Total	109

Source: (Clifford C. Baker& Denise B. McCafferty ATSB data)

CONCLUSIONS

This explanatory study tackled the problem of seafarers fatigue on board vessels. The heavy workload assigned to them, and the small number of crew members result in more working hours and deprives them getting adequate rest periods that would help get rid of the effects of strenuous work, whether physically or mentally and restore activity necessary for continuing work. Then, the movement of the ship caused by the weather and the noise produced by the operation of machinery and cranes deprives them of sound sleep needed by the human body for the healthy state of body and mind, which helps in doing work correctly. Living away from family for long periods due to the need for money and work, in addition to working with crews of different nationalities, customs and cultures cause psychological and social disorders. Unlike any type of vessel, work on supply vessels is particularly arduous due to the hazardous nature of their operations including excavators' towage and anchor handling that needs extreme alertness since an error would cause a fatal injury.

All of the above would cause fatigue on board vessels leading to seafarers' downfall. The symptoms of fatigue are manifested by lack of concentration, task omission, and the inability of making sound decisions in emergencies. If

fatigue is a reality that cannot be ignored or completely eliminated, solutions should be found to at least relatively reduce its consequences.

As a result of the spread of the fatigue phenomenon at sea, the International Maritime Organization and the International Labor Organization paid attention to the conditions of the seafarer. Several treaties and conventions were issued in an attempt to improve seafarers' conditions and mitigate the effects of fatigue by specifying rest and work hours. The study addressed the increased rates of marine incidents recently as a result of the increase in the number of global transport fleets, and the causes that lead to these disasters, which destroy the marine environment causing considerable human and material losses. The human element reached the highest percentage of the causes of accidents in which fatigue played a major role. The study then tackled two collisions of two supply vessels, which occurred because of the lack of proper situation assessment due to fatigue.

RECOMMENDATIONS

- Reconsideration of the international conventions governing the minimum rest hours and the maximum working hours
- Obliging ship owners to provide vessels with a sufficient number of crew members suitable to the nature of work on board. Providing appropriate accommodation for rest periods should be considered.
- Activating the role of educational institutions responsible for training seafarers to raise awareness among trainees of the dimensions of fatigue, its symptoms in the short and long run, including possible prevention precautions, specifically those related to marine navigation.

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