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A study on the preparation for the introduction of fatigue awareness course

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A STUDY ON THE PREPARATION FOR THE INTRODUCTION OF FATIGUE AWARENESS COURSE

BY

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DECLARATION

I certify that all the material in this research paper that is not my own work has been identified, and that no material is included for which a degree has previously been conferred on me.

The contents of this research paper reflect my own personal views, and are not necessarily endorsed by the University.

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ABSTRACT

Title of Dissertation: **A study on the preparation for the Introduction of Fatigue Awareness Course**

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Currently, competition in the marine transportation is intense, so reducing the number of seafarer onboard and replacing them with new technology is a new trend of the industry. However, the replacement of seafarer or reduce the number of them are making some serious problems. This trend adds the inevitable workload of the rest of the crew and that cause of fatigue onboard, which can lead to severe outcome.

Although IMO recognizes the importance and the harm from fatigue onboard, there are no conventions that fully protection crew from fatigue. So it is imperative that seafarer themselves must be caring, understand and know how to correctly deal with Fatigue effectively.

This Dissertation is a study of potential possibility and the needs of the seafarer in fatigue issue. There are hypothesizing to understand of seafarer and the need to study on fatigue. Readers will read different content in each chapter, start from study papers and researches from IMO and other international organizations. Then we will focus on real situation onboard through research as well as information from practitioners onboard. The information will be calculated in average score then use of statically computer program to calculate the relationship between different factors about fatigue. Finally we get the final results and lead to conclusion and recommendations.

KEYWORD: Awareness, Fatigue, Rest hours, Seafarer

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List of abbreviation

BIMCO	Baltic and International Maritime Council
EGG	Electroencephalogram
HTW	Sub-Committee on Human element, Training and Watchkeeping
ICAO	International Civil Aviation Organization
IMO	International Maritime Organization
ITF	International Transport Workers' Federation
KSS	Karolinska Sleepiness Scale
MA	Maritime Administration
MCA	Maritime and Coastguard Agency
MEPC	Marine Environment Protection Committee
MET	Maritime Education & Training
MFI	Multidimensional Fatigue Inventory
MLC	Maritime Labour Convention, 2006
MSC	Maritime Safety Committee
OSH	Occupational safety and health
PVT	Psychomotor Vigilance Test
SOLAS	International Convention for the Safety of Life at Sea
SPSS	Statistical Package for the Social Science
STCW	International Convention on Standards of Training, Certification and Watchkeeping for Seafarers

Chapter 1 Introduction

1.1 Background

Since the 20th century, the world is on the alert of occupational safety. Therefore, there is a large number of the investigation and construction in order to illustrate, to revise, and to suggest the method for decreasing the accident rate which will occur in the future as in maritime industry. Many methods were conducted to support maritime safety: convention enforcement was used to promote the secureness of the ship, seafarers, cargo, and the environment as well. Anyhow, those methods and theories can be controlled by external, the internal factor like seafarer himself will be omitted after all, and that would cause the other safety border.

The number of a seafarer, these days, seems to drop does and has not enough to serve the international market (BIMCO, 2015). Since a large number of an adult has no need to work in this area of career also people in the developed country and developing country are lacked interested in this job which generally caused by many factors such as a long distance from home, family, and the environment that they familiar with. The difficulty of changing the job to work ashore in the future is what they concerned as well. Although the total income in the most developed country has the less dissimilar between ashore and offshore career, workers still seek for the job which providing the equal monthly income as those seafarers who work far away from land.

Not only mentioned factors but also the problem of handling and management onboard that leads worker refused to be the seafarer. Nowadays seamanship is more considering as people who will be skilled in both navigation and engineering and that leads the shipping companies to need the skillful seafarer to serve their business.

Other than the human factor themselves, there is also a change of globalization. To be clearer, a rising of a competition in the world shipping market is more intense. Every shipping company has to make more benefit under pressure by cutting off an unnecessary cost to diminish the expenses in the high competition condition. However, cutting off the unnecessary cost is significant to the number of the employees. “About 30 percent of the expense of managing the ship is a manning” (Nakazawa, 2018) which means a big money spending on the wage. Technology comes in and takes part in the shipping business, also an autonomous ship. The autonomous ship is developed to decrease the number of human working onboard ship as well as an unmanned system is brought to use in engine room instead of the engineer. The study of Capt. Kuba Szymanski shows that the number of the seafarer in one ship was decreasing from 25 to 30 people in the year 1980 to be 14 to 18 people of the year 2014 on the average.

Since the company policy started to reduce the number of employees, it brings about a working load on the rest of them. Apart from the loaded and complicated work, the seaman had to face an unfamiliar working environment, a long working hour, and a strict management system which lead seafarers reaching a Fatigue state. “Fatigue is a defense mechanism of the body. It constitutes the human body’s signal that serves as an alert when bodily limitations are being surpassed” (Vagias, 2010). Moreover, Fatigue is a major reason that brings about an accident. So that, to monitor and prevent the sea worker from Fatigue might be a very important thing in order to control a risk at the origin.

Fatigue, however, is now broadly acknowledged and seriously recognized of its danger regarding a numerous number of the cumulative study. On the other hand, as a sea worker, Fatigue is not widely understood in practice. There is currently no law

or regulation used for preventing any causes of it practically. This dissertation, therefore, aims to explore the possibility of setting up the course to provide more in-depth information and make awareness of Fatigue.

1.2 Objectives

A study on the preparation for the Introduction of fatigue awareness course invented to serve the need of occupational safety which is currently significant. Since it directly has an effect on the organization policy and management. On behalf of the seafarer, they might prosper from data in this dissertation to discuss if Fatigue should be a one of mandatory course before start working onboard.

As for the MET institute which has a part in Fatigue educating, this dissertation can be a guideline to compile the curriculum of the course. Above all this paper is objected to integrate knowledge in all area of Fatigue for preventing the affectation of it on life, mental status, properties, and valuable resources.

This dissertation attempts to achieve the following objectives;

1. Observe and gather the information and knowledge of Fatigue in term of seafarer.

2. Identify the impact of Fatigue awareness course on the Maritime communities (e.g. Maritime administration, Maritime education and training institutions, shipping company and seafarers).

3. Study the possibility and the need of seafarers to invent a tutoring or a training course of Fatigue awareness correspondingly with the guideline of IMO.

4. Provide seafarers knowledge and recognition of cause and effect of Fatigue.

5. Analyze and search for the model of Fatigue awareness course to provide to people in Maritime communities.

The focus of the dissertation is to observe the need of seafarer on the fatigue awareness training course including other effects of the compilation in which it might affect the Maritime communities. In parts of learner expenditure, procedure, Maritime administration organization, and aspects of staffs in the other field will not be considered in this study.

1.3 Methodology

This dissertation explores the preparations for introducing Fatigue awareness course to permit the understanding of Fatigue correctly and also raise the attentiveness and precaution of seafarers as well. Data collection in chapter 2 in this dissertation is the theories and documents. The existing documents used for studying consist of IMO guidance on fatigue mitigation and management, Martha project, and Horizon project study along with news report and article from the countries involved with the topic, Fatigue awareness.

In chapter 3, there are situations and effect of Fatigue on the Maritime industry in many aspects e.g. international organization, ship owner, and seafarers. Importance and meaning of Fatigue in conventions related to people who work offshore will appear in this chapter. The comparison of onshore and offshore working hour will be marked in chapter 3 as well. The graphs and charts used for explaining the effect and severity of Fatigue state in today's situation. Eventually, the case studies of an actual event occurred by Fatigue state are the essential part of the study either.

In chapter 4, a Survey research employed a questionnaire to be a research tool in order to gain the data. Research samplings are conducted by using Simple Random Sampling technique. After that, data will be analyzed and explained by converting them into the number which is average and standard deviation (SD), average score and analyzed by static-computer program.

Chapter 5 will be the conclusion and discussion of the result shown in chapter 4 to examine of what will influence the Maritime communities which are an educational institution, involved government organization, ship owner, shipping company, and

seafarers. Other than that, this chapter is including the important process in which to push forward the Fatigue awareness course for actualization.

Finally, chapter 6, the conclusion of all data presented in chapter 2, 3, 4, and 5 combined with the useful recommendations for further study are demonstrating in this chapter of the dissertation.

Nevertheless, the study of the possibility to open the Fatigue awareness course generally goes along with a quality standard system which is responsible by the Maritime Administration. This is a requirement for any MET course conducting within the purview of the STCW convention so the quality standard will not be, anyhow, in any area of this dissertation.

CHAPTER 2 Study on fatigue

In terms of science, Fatigue means a state of tiredness or weariness of the body and mind. Human have the tendency to overwork and be under tremendous amount of pressure but usually for a short amount of time and is able to overcome. A prolonged weariness could take its toll on the body which affects the mood and mind. Weariness is a signal of a body lacking motivation could cause boredom, in some cases fatigue could be a health problem that requires medical attention. Majority of cases when conduct a back check discovered that certain daily activities or tiredness could come from three major factors are lifestyle, psychological problems, and medical problems.

However, Maritime Industrial, have a different view on the matter. Fatigue or weariness problem from working have been mentioned in numerous cases for the past few years due to it being a major factor that causes many accidents and losing lives, properties and environments within the maritime industry.

2.1 Definitions

Guidance on Fatigue, published by IMO, has stated that fatigue can be defined in many ways. However, it is generally described as *"a state of feeling tire, weary, or sleepy that results from prolonged mental physical work, extended period of anxiety, exposure to harsh environments, or loss of sleep. The result of fatigue is impaired performance and diminished alertness"* (IMO, 2001).

However, in Circular of IMO,(MSC/Circ.813/MEPC/Circ.330, in MSC/Circ.1014, 2001), have further explain on the state of fatigue is "*a reduction in physical and/or mental capability as the result of physical, mental or emotional exertion which may impair nearly all physical abilities including: strength; speed; reaction time; coordination; decision making; or balance"* (IMO, 2001).

From the definitions, IMO's vision of fatigue is the main cause of dysfunctional. However, in 2015, Propose, from Australia addresses the main cause and effect of the mentioned issue as follows: Fatigue, a state of physical and/or mental

performance impairment, resulting from factors such as inadequate sleep, extended wakefulness, circadian phase and physical, mental or emotional exertion that can impair alertness and the ability to safely operate a ship or safety-related duties. (Guideline of fatigue by Australia, 2015)

In conclusion, fatigue is a state of weariness from physical, mental, and emotion that causes the dysfunctional of body and mind, including decision making ability. Due to its importance have led to a widely research on the actual cause and effect of fatigue, which may vary in details depending on the departments. The verified results will be studied from the conducted conclusion from international organization such as IMO, research teams from major leagues universities from Project MARTHA, and lastly from the studies of EU nations in Project Horizon.

2.2 IMO Guidance on Fatigue Mitigation and Management

Developed by MSC (Maritime Safety Committee), seeing the importance of human fatigue, within the Guidance has divided the contents into individual modules to inform and further understand and the effects on each party in maritime industry. The modules are divided into individually for those who are interested to study accordingly to their field of work. However, guidance will recommend all party to study module 1, which contains general information of fatigue including general information about fatigue, cause and effects from fatigue.

2.2.1 Cause of fatigue

The Guidance mentioned about the status including the causes of fatigue varying from different roles within the maritime industry. Module 1, the essential information on fatigue, has divided the causes of fatigue into 4 categories are as follows:

1. Crew specific factor

2. Management factor

3. Ship specific factor

4. Environmental factor

2.2.1.1 Crew specific factor; Causes from the variety types lifestyle aboard the vessel of the individual such as

a. Sleep and rest (sleeping quality and quantity, duration, sleep disturbance, rest break)

b. Biological clock
c. Psychology / emotion factors
d. Health (illness, diet)
e. stress

2.2.1.2 Management Factor; Causes from issues within the organization such as Ship's operation, and Company's management (ashore) could be divided into two categories:

a. Organization factor; staffing, paperwork, rules and regulations, resources, etc.
b. Voyage and scheduling factor; frequency of port call, routing, weather and sea condition between voyages.

2.2.1.3 Ship Specific Factor; Ship's condition and different ship's design and layout, some play a negative role, count as another cause of fatigue; for example, sound and vibration from the ship itself, is accountable for:

- Ship design
- Level of automation
- Age of vessel
- Ship motion
- Physical comfort and accommodation spaces

2.2.1.4 Environment factor; Causes from natural occurrences such as temperature, atmospheric pressure, dampness which could cause discomfort to the operator. Environment Factor consists of 2 factors are External Environment such as the traffic at the port, climate; and Internal Environment such as Noise, vibration, temperature.

2.2.2 Effect of Fatigue

Fatigue condition do affect impair alertness, which is a vital role in controlling decision making. To those who are in a fatigue state could cause the performance to drop such as physically, emotionally, and mentally. Fatigue also have affect as follows:

- Memory and confidence.
- Decision making, which could lead to riskier decision.
- Responding to stimuli in understanding, interpretation, and reacting to slow down.

- Unable to solve complicated problems or new problems that arises.

In conclusion, Module 1, a vital part of fatigue, has summarized the cause and effect of fatigue through different scenarios and roles. Guidance have categorized into modules as follows:

Module 1 Fatigue

Module 2 Fatigue and rating

Module 3 Fatigue and ship's officer

Module 4 Fatigue and the Master

Module 5 Fatigue and the Training Institute and Management Personnel in charge of training

Module 6 Shipboard Fatigue and the Owner/Operator/Manager

Module 7 Shipboard Fatigue and the Naval Architect/Ship Designer

Module 8 Fatigue and the Maritime Pilot

Module 9 Fatigue and Tugboat Personnel

2.3 MARTHA Project

Background: A collaboration of studies and research from top universities across Europe and Asia, in collaboration with shipping companies and is funded by TK Foundation. The research took approximately 3 years, 2013 - 2016, about the effect of shipping company in which the management and the operation of ships resulting in fatigue both in short and long terms.

Objective; The aim of the study was to explore the levels of sleepiness and the psychological issues associated with long term fatigue and motivation, using the sample of volunteer seafarers in the naturalistic setting of work onboard their vessels.

Methodology; This project will divide the research into 3 parts as follows:

- Questionnaires of more than 1000 copies from both the managers and the seafarers, furthermore, an in-depth interviews.
- Onboard diary of constant data and activities recording from volunteers that working on the ship

- Actigraphy Data is a device to help record the data of activities at all times when boarding the ship (including sleeping time) for 2 weeks

2.3.1 Result from research

2.3.1.1 Result from questionnaire

- Potential consequences of fatigue: the effect of fatigue can occur in many forms, from studies showed the effects on the various health problems, fig.1, which also causes the dysfunction of organs and nervous systems (See Figure1).

Figure1; Potential consequences of fatigue
Source; Project MARTHA, 2016

- The Chronic health effects of fatigue could cause a long term health issues such as Insomnia, sleep apnoea, hypopnea. Cardiovascular disorders such as Myocardial infarction, stroke, hypertension. Metabolic disorder could also cause cancer.
- Competing factors onboard that contribute to the adverse health effects of fatigue, although the main cause of fatigue

occurs from lack of sleep, onboard ship's environment such as Nutrition; quality, quantity, smoking, alcohol, drugs.

- Differences between officers and ratings and differences between European company and Asian company from the result showed that the amount of resting time varies from operators, levels of command. Furthermore, the result of questionnaires found that ship's operators from European and Asian companies stress and sleeping quality differs, presented in Table 1.

Table1; The different of ranking and management's result in project MARTHA

Index	Onboard ship		Shipping Company	
	Officer	Rating	Europe	China
Sleepiness at work	1.7	1.4	1.4	1.75
Quality of sleep	1.2	0.9	0.93	1.25
Stress at work	1.2	0.9	0.705	1.4
Average sleep in a 24 hour period	7.8	8.4	-	-
Ideal sleep length in a 24 hour period	8.1	8.4	-	-
Age	-	-	38.5	34.5
Average years at sea	-	-	13.85	8.4

** The perceptions of item 1-3 are on a scale of 0 to 4, with the higher numbers indicating worse sleep or stress.

Source; Author

From the table, we could see that officer have higher working hours and stress from those in the rating, and interesting studies show that Chinese company has a greater stress and lower quality of sleep than those of European company.

Although the results are different from the different ranking within the ship and the company, on the matter of fatigue, founded that the majority of the operators have similar views about the cause of fatigue are job security, environmental issues, job demands, sleep quality, irregular working hours, and rest hours.

When extended the research, the results indicated a new relevance to the issue are new regulations and more requirements placed on seafarers, increased inspections and more paperwork, the bad condition of ship's accommodation, the lack of proper maintenance, work in port, working onboard a new ship, the quality and the professionalism of colleagues.

2.3.1.2 Results from field of study are data analyzed by the records of the volunteers covering various aspects of health and normal sleeping patterns. Furthermore, there are evaluation from KSS (Karolinska Sleepiness Scale) and MFI (Multidimensional Fatigue Inventory) showed that the working hours between ship companies from Europe and those from China is relatively equal, but the interesting summary as follows "With regard to all 110 seafarers in the sample, across both shipping companies and including seafarers of all ranks, the majority of seafarers (61%) consider that they are more fatigued at the end of a voyage than at the beginning". When further analyze discovered that the ship's captain have high tendency to be fatigue when at the end of the trip.

KSS (Karolinska Sleepiness Scale) from scale of 1 - 9, 1 being Extremely alert up to 9 being very sleepy, great effort to keep awake, the more hours need to operate (weeks), the high KSS will be. A KSS score over 7 indicate a high risk of falling asleep, from analysis discovered that very high level of sleepiness (KSS of 8 or 9) are apparent and increasing after 6 months onboard (See Figure 2).

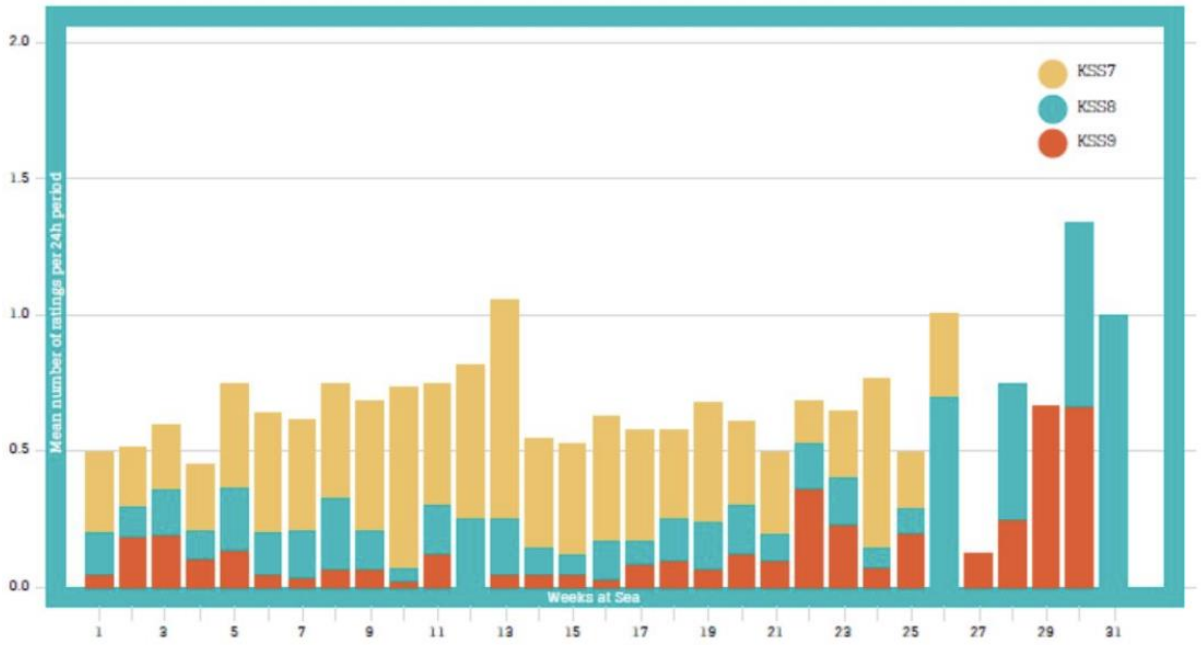

Figure 2; The relationship between KSS's score and time spend onboard Source; Project MARTHA, 2016

From analyzing the results of The Multidimensional Fatigue Inventory (MFI) indicates that it is motivation that decreases with time at sea. Reduced motivation may lead to complacency, individuals taking short cuts and "work-arounds", not

following the correct procedures. The results conformed to resulting in KSS value becomes higher when seafarer spent time on the ship.

2.3.1.3 Results from actigraphy; Conformed with data of questionnaires and daily records of individuals. Both the amount of sleep and the quality of sleep (the latter as measured by wake bouts) decreases over time for all crew. This finding supports the KSS numbers showing increasing levels of sleepiness over time.

Apart from the results of 3 methodologies of data sampling (questionnaire/diary/ Actigraphy) in Project MARTHA have further studied other aspects or other dimensions the operators could prevent/minimize fatigue such as

1. Vessel design and living environment (Noise and Vibration levels, Temperature, Quality of accommodation space)

2. Working conditions (Safe manning levels, Nutrition and good food aboard, hours of work and rest)

3. Operational issues (Being relieved on time and having a KPI to measure it, Communication between ship and shore, Timings of inspections onboard by external parties)

In conclusion, Project MARTHA, analytics and data are interesting due to it is recorded in real time from operators aboard the ship and those involved not matter the ship's size or nationality of the seafarers. The results indicate the cause of fatigue from the seafarer point of view are similar, and the risk of fatigue of the operators may varies depending on the type of ship, the management, and the duration of the operators on board the ship. The longer they spent time on the ship, the more prone to fatigue they will be.

2.4 Horizon project

Background: Founded through cooperation between organization from Europe, such as Universities or companies from the maritime industry. Research initiative to investigate the impact of watchkeeping patterns on the cognitive performance of seafarers.

Objective: Delivering empirical data to provide a better understanding of the way in which watchkeeping patterns can affect ships.

Methodology: The studies were carried out using the simulators at Warsash Maritime Academy in the UK and Chalmers Technical University in Sweden by dividing the studies into two universities as follows:

- Warsash Maritime Academy carried out the testing and collect data through 6 on / 6 off watch duty, by collecting data from 2 departments are Bridge watch keeper and Engine room watch keeper.

- Chalmers Technical University will collect the data through different type of operations both in normal duty hours (4on / 8off) and 6 on / 6 off and will collect only those working the bridge.

The participants will be in the simulation of real working hours by having off-watch disturbance occasionally to observe the effect on the body. Furthermore, the participants will be given the workload such as paper works to simulate real world event as much as possible.

The following data were collected:

1. Using Actigraphy device that is with the participants at all time to help collect the activity data both in working and resting hours.
2. Electroencephalogram (EEG) is used for collecting brain activity, heart rhythm, and eye-movement.
3. Psychomotor Vigilance Test (PVT) is for testing the changes in reaction time of the participants both before and after watchkeeping duty.
4. Karolinska Sleepiness Scale (KSS)
5. Stroop Test is a test for reaction time.
6. Work/Wake/Sleep diary is a journal and analytics from the activities the participants have recorded throughout the day, e.g. waking time, sleeping time.

There are many more tests taken;

2.4.1 Result from research

- Chalmers Technical University is taken with 4 on/ 8 off system, from the analytics found that the KSS result at peak is at the scale of 4.1, which is approximately 04:00 - 08:00 when compared to those of 08:00 - 12:00, KSS result is at 3.8. While the peak time is at the end of watch, at approximately 00:00 - 04:00 resulting in a high score of 5.1 out of 9.

- Studies on 6on / 6 off system discovered that from 00:00 - 06:00 have KSS result at 4.6, the second interval is 4.0, the tendency do improve when starts working from the

first hour. For the test of watch-disturbance, when tested with 4on / 8 off and 6 on / 6 off system found that 4 on/ 8 off system resulting in Sleeping level increases after watch duty and is interrupted resulting in a 6.5 while 4.2 is the average state. On the other hand, with 6 on/ 6 off system, found that sleeping level increases watch duty was interrupted having a 6.7 while the average state is 4.6. However, no interactions were observed, indicating that the effect was similar in all watch teams and 6on/6off method made the participants sleep longer than those with 4on/8off trials.

Warsash Maritime Academy, conducted a 6on/ 6 off with only those working on the bridge and engine room found that the results are similar in some areas (Using results from KSS 1-9) (See Table 2).

Table 2; Different results between Deck and Engine department.

ITEM	DECK		ENGINE	
	Highest number	Lowest number	Highest number	Lowest number
sleepiness scores	4.3	3.1	4.3	3.5
Watch keeping time	5,6th day of week	1st day of week	2nd day of week	7th day of week
Watch period	00.00 – 04.00	-	00.00-04.00	-

Source; Project Horizon, 2012

2.4.1.1 Results from Wake-Work-Sleep Diary

Through analyzing the diaries discovered that there correlation between Wake Diary, Sleep Diary, and Work Diary. Through using 4on / 8 off system gave the participants less sleepiness, chances of fatigue minimized than 6on / 6 off system. Also, those working in 4on/8 off system received better rest than those with 6 on/ 6 off systems. Heavy eyelids and gravel eyes were more abundant in the 6on/6off system than the 4on/8off system (See Figure 3).

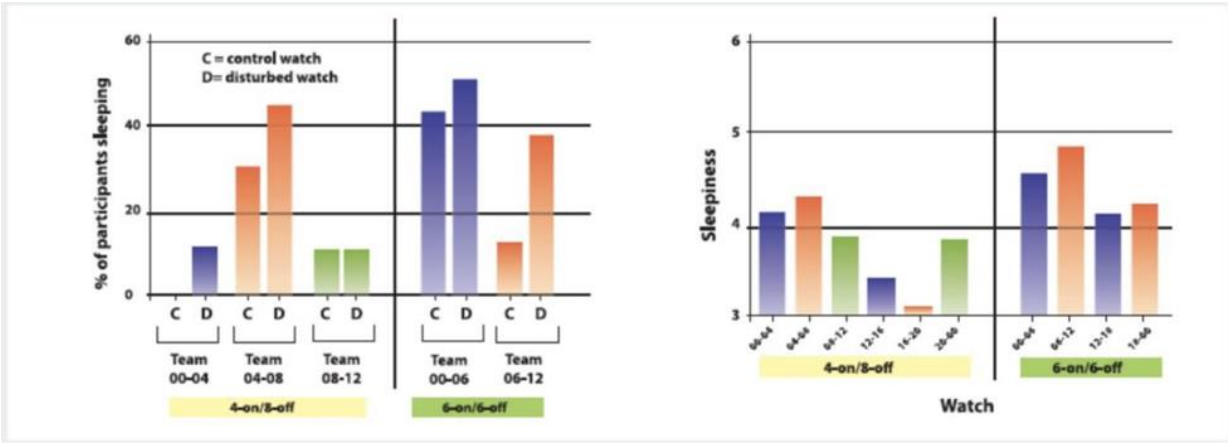

Figure 3; Different results of sleepiness and percentage of sleeping between 2 watch keeping systems.
Source; Project Horizon, 2012

In comparison between those working as Deck officer and Engineers discovered that there is no significant difference although the workload of working on the bridge is more demanding than in the engine room. One important observation is negative results show on the first watch of the day in both 4on/8off system (00:00- 04:00) and 6on/6off system (00:00-06:00).

2.4.1.2 Result from activity and electrophysiological

From the result using PVT have concluded the reaction time of the participants to be slowed down when operating in the first shift of the day. Generally, the reaction time when compared between before and after operation tends to have worse PVT performance at the end of the watch compared with the start. However, the data did not show any significant difference between those working on deck and those in the engine room.

In summary, Horizon Project is a trial set to test the fatigue and the performance of the seafarers while working in different systems (4on/8off and 6on/6off). From test results using various types of trials found that those in 6on/6off systems do have a long term effects on the participants than those in 4on/8off system, such as reaction time in various stimuli or decision making, and the sleeping quantity and quality also. However, there is no significant difference between those working the Deck department and those working Engine Department.

2.5 Comparison between the studies

A comparison of the study is shown in the Table 3 and Table 4, third table will show the way of study between Warsash Maritime Academy and Chalmers Technical University which appear in Horizon project. Fourth table will show the difference of study between MARTHA and HORIZON project.

Table 3; Comparison between Warsash Maritime Academy and Chalmers Technical University

	Warsash Maritime Academy		Chalmers Technical University		Remark*
	4/8	6/6	Deck	Engine	
Karolinska Sleepiness Scale	4.1	4.6	4.3	4.3	*Highest number
Stress scale	Very low	Very low	2.1 – 3.1	3.1 – 3.6	*Highest number
Wake diary	2.3	3.2	not differ	not differ	*Recuperation/ sufficiency of rest
Work diary	Normal	more difficulties focusing the eyes and higher incidence of tired eyes	not differ (higher rate of experiencing heavy eyelids, gravel eyes)	not differ (higher rate of experiencing heavy eyelids, gravel eyes)	
Sleep on duty	Maximum in First watch (00.00-04.00)	Maximum in First watch (00.00-04.00)	18.00 – 00.00	00.00 – 06.00	
Activity/Electrophysiological measurements	not differ	not differ	not differ	not differ	Reaction time / PVT
Stroop test	Normal	00:00-06:00 Make more mistake	not differ	not differ	
Naturalistic performance	Comparative analysis was not possible	Comparative analysis was not possible	not differ	Team working 00.00 – 06.00 performed slightly better	

Table 4; Comparison of study on fatigue in MARTHA project and HORIZON project

	MARTHA project	HORIZON project
Year of study	2013 - 2016	2009 - 2011
Founder	Shipping Organizations and Universities in Europe and Asia	Shipping Organizations and Universities in Euro-group
Purpose of study	- to explore the levels of sleepiness and the psychosocial	- To measurement of fatigue in various realistic seagoing scenarios
Methodology	- Questionnaires and interviews - Onboard diaries of volunteer seafarers - Actigraphy data from selected volunteers.	- Using the simulators - Dynamic and Electronic data collections - Sleep and wake diary
Number of participant	- 1,000 Questionnaire - 110 Seafarer	- 90 Officers
Who is participant	- Managers (Ashore) - Seafarers (Onboard)	- Officers in Deck and Engine department.
Where to study	Onboard cargo ships	- Warsash Maritime Academy (UK) - Chalmers Technical University (Sweden)
Participant's nationality	International (Europe, Asia)	International (west and east Europe, Africa and Asia)
Differences of view	Differences between officers and ratings	Differences between 6on/6 off duty And 4on/8 off duty.
Most positive result	- Rating sleeps more and higher quality than officer.	-Watch keeping on 4on/8off system
Most negative result	- Fatigue is higher at the end of a voyage - Very high sleepiness increasing after 6 months onboard. - Captains are more at risk of fatigue than other ranks	- Working in 6on/6off duty makes more negative results in sleepiness and fatigue. - No significant difference between working on Deck or engine room.

CHAPTER 3 Fatigue at sea

3.1 Main cause of fatigue at sea

The results of the research from the aforementioned and from IMO's Guidance discover the correlation between the views of the seafarers and the cause of fatigue although the results vary in ranks and department (deck and engine). From the table below is the recorded studies from different researches (see table 5).

Table 5; Main cause of fatigue at sea

Main causes of fatigue at sea		
IMO guidance	MARTHA project	HORIZON project
1.Crew-specific Factors; Sleep and Rest ,Biological ,Psychological and Emotional Factors including stress **2. Management Factors (ashore and aboard ship);** Company culture and Management style ,Rules and Regulations **3. Ship-specific Factors;** Ship design, Age of vessel **4. Environmental Factors**	1. Job security 2. Environmental issues 3. Job demands 4. Sleep quality 5. Irregular working hours 6. Rest hours 7. New regulations and more requirements 8. Increased inspections and more paperwork; 9. The bad condition of ships' accommodation 10. The lack of proper maintenance 11. Work in port; 12. The quality and professionalism of Work colleagues.	1. Lack of sleep, poor quality of sleep 2. Working at a times of low alertness 3. Long working hours and prolonged work periods. 4. Insufficient rest between work periods 5. The impact of watch keeping pattern (6on/6off) 6. Frequent port calls and associated cargo work 7. Stress and excessive workloads. 8. Tour lengths 9. Noise, Vibration, Motion and Medical conditions.

Source; Author

From the table above, even though there are many different sources but the causes of fatigue are relatively similar one being lacks quality and quantity of rest.

3.2 Case study of accident related to fatigue at sea.

Apart from different types of studies and academic researches, a case study is the best way to demonstrate the problem at hand due to it represents the data from real situations. The samples shown are the cases of accidents occurred with the seafarers, ships, and the environmental effect it has due to fatigue.

3.2.1 Exxon Valdez

The tanker disaster in 1989, The US National Transportation Safety Board found that in the 24 hours prior to the grounding of the ship, the watch keeper had only had 5 or 6 hours of sleep. The US National Transportation Safety Bureau's (NTSB) accident investigators concluded that the EXXON shipping Company's manning policies "Did not adequately consider the increase in workload caused by reduced manning" (MCA,2010)

3.2.2 Shen Neng 1

The grounding of the bulk carrier on the Great Barrier Reef in April 2010, The Australian Transport Safety Bureau investigation found that the grounding occurred because the chief mate did not alter the ship's course at the designated position. His monitoring of the ship's position was ineffective and his actions were affected by fatigue. Investigations showed that he had only two and a half hours sleep in the 38.5 hours prior to the casualty.

3.2.3 Thor Gitta

The Danish-flagged general cargo ship, Filipino AB fall onboard and dead in May 2009. Investigators who used FAID fatigue assessment software found that the seafarer's 6-on/6-off work pattern was at a score of 111 on the morning before the accident – a level considered to be in the very high range.

3.2.4 Pasha Bulker

The grounding of the bulk carrier near the port of Newcastle in Australia in June 2007, Investigation report stated that the master became increasingly overloaded and affected by fatigue and anxiety.

3.2.5 Royal Majesty

Attributed to "*the master's impaired judgment from acute fatigue, which led to his decisions to decrease the bridge watch and attend to nonessential tasks during a crucial period in the ship's"* (The National Transportation Safety Board, 1989) The mariner had, except for a few brief naps, been on duty for 35 hours through the time of the accident.

3.2.6 Jambo

In 2003 grounding of the general cargo ship was attributed to the chief officer's missing a key waypoint because he had fallen asleep on the bridge.

There are many more events that happen due to fatigue which causes devastation to the facility, and lives "fatigue was a contributing factor in 16% of critical vessel casualties and 33% of personal injuries (United States Coast Guard).

3.3 IMO and other Instrumental related to fatigue mitigation

The awareness raised by IMO on fatigue of those operating offshore on ships has created Guidance on fatigue Mitigation and Management to inform and better prevent fatigue. However, due to the guidance is not binding into the law or any agreements to enforce the use of the guidance.

Although the Guidance of Fatigue mitigation and management is not enforced but there are other IMO's convention details to help the mitigation of fatigue in SOLAS, STCW and other agreements explained as follows:

3.3.1 The International Convention for the Safety of Life at Sea (SOLAS); SOLAS is an international maritime treaty which sets minimum safety standards in the construction, equipment and operation of merchant ships.

Chapter V in SOLAS within Regulation 14 has stated the importance of manning:

1. *"Contracting Governments undertake, each for its national ships, to maintain, or, if it is necessary, to adopt, measures for the purpose of ensuring that, from the point of view of safety of life at sea, all ships shall be sufficiently and efficiently manned"*

2. *"Every ship to which chapter I applies shall be provided with an appropriate minimum safe manning document or equivalent issued by the Administration as evidence of the minimum safe manning considered necessary to comply with the provisions of paragraph 1."*

Regulation 14 is the evidence of the government, being the coalition, must be decide the appropriate minimum use of seafarer onboard including flag must issue "a minimum safe manning certificate". Due to the government is in charge of deciding the amount of seafarers onboard at any given time will help reduce the workload that may occur during the operation.

3.3.2 Resolution A.772(18) on fatigue factors in manning and safety

At its 18th session in November 1993, the IMO Assembly adopted this resolution. There is no universally accepted definition of fatigue but draws the attention of all parties involved in ship operations to the factors which can contribute to fatigue. Resolution A.772(18) have stated the classification of fatigue into 4 factors are 1. Management ashore and onboard ship 2. Ship Specific factor 3. Crew-specific factor and 4. External Environmental Factor

3.3.3 Guidance on Fatigue mitigation and Management

The documents consists of nine modules with detailed information and recommendation including the mitigation of fatigue from working onboard ship categorized by job description, rating, operational level, and management level. Furthermore, the guidance also state those involved within the maritime industry such as pilot, tug man, and ship's architecture.

3.3.4 Guidelines for the Application of principles of minimum safe manning (Resolution A.890 (21)-1999, Resolution A.995 (23)-2003 and reviewed in A27/Res.1047 -2011)

These Guidelines should be used in applying the principles of minimum safe manning set out in section 3 to ensure the safe operation of ships to which article III of the 1978 STCW Convention, as amended, applies, and the security of ships to which chapter XI-2 of the 1974 SOLAS Convention, as amended, applies, and for the protection of the marine environment.

The essence of the Guidance are:

1. State which is going to issue minimum safe manning certificate must understand that there are among of items to be concerned.

2. Number of safe manning must be relied on performance of the functions at the appropriate level(s) of responsibility, as specified in the STCW Code, which include; Navigation, cargo handling and stowage, operation of the ship and care for persons on board.

3. Responsibilities of companies

4. Process to evaluation the proposal by administration.

3.3.5 The International Convention on Standards of Training, Certification and Watchkeeping for seafarers (STCW)

Setting minimum qualification standards for masters, officers and watch personnel on seagoing merchant ships. Most of the details in STCW refers to the various qualification, but in chapter VIII -Standards regarding watchkeeping have mentioned about the fitness for duty which includes minimum of rest hours and fatigue as follows:

"1. Administrations shall take account of the danger posed by fatigue of seafarers, especially those whose duties involve the safe and secure operation of a ship.

2. All persons who are assigned duty as officer in charge of a watch or as a rating forming part of a watch and those whose duties involve designated safety, prevention of pollution and security duties shall be provided with a rest period of not less than: 1. A minimum of 10 hours rest in any 24 hour period; and 2. 77 hours rest in any 7 day period." These two conditions fall with the agreement of Maritime Labour Convention, 2006.

3.3.6 Maritime Labour Convention (MLC)

MLC is an International Labour Organization Convention, number 186, established in 2006 as the fourth pillar of international maritime law and embodies. MLC states the general terms including rights of those working onboard in various ways, however the agreement of MLC have content dealing with mitigation of fatigue in two categories are:

1. Regulation 2.3 hours of work and hours of rest

    a. Minimum hours of rest shall not be less than:

        i. Ten hours in any 24 hour period

        ii. 77 hours in any seven-day period

b. 6. Hours of rest may be divided into no more than two periods, one of which shall be at least six hours in length, and the interval between consecutive periods of rest shall not exceed 14 hours.

Regulation 2.7 – Manning levels; To ensure that seafarers work on board ships with sufficient personnel for the safe, efficient and secure operation of the ship.

Other regulations of MLC also has benefits to help prevent fatigue such as regulating the accommodation of seafarers, nutritious food, medical care, etc.

3.4 Current discussion on Fatigue

Although there has been awareness raised and prevention methods on fatigue that Guideline on Fatigue put in place by IMO (annex to MSC/Circ. 1014) to inform about the cause and effect on fatigue, there are continuous studies to further address the issue which drive the interests at all times.

3.4.1 Role of the Human element Manning and Seafarers Fatigue

Document; HTW 4/7

Year; 2016

A proposal presented by the member state in cooperation with the affected industries such as New Zealand, International Federation of Ship Masters' Associations (IFSMA), International Ship Managers' Association (InterManager), International Transportation Workers Federation (ITF), and the Nautical Institute (NI) the essential information on fatigue and Overload of working of watchkeeping. To be considered the elimination of the Master/Chief Mate two-watch system, and to ensure that a ship's Master is not considered part of the normal watchkeeping capability of the vessel.

3.4.2 Revision of the Guideline of fatigue

Document; HTW 4/8/1

Year; 2016

This document aim to increase those involve in Module 7. Normally Module 7 is a topic about Shipboard Fatigue and the Navel Architecture, which in the revision have requested more involved parties, in previous Module 7 contains practical information intended for the Naval Architect/ship Designer have now included “Stakeholders” which includes those involved within the Maritime industry as follows:

1. Classification societies;
2. Non-State regional and local port authorities;
3. Industry/commercial parties (e.g. charterers, shippers, oil majors);
4. Third-party/independent representatives (e.g. cargo surveyors, marine surveyors, auditors, insurance representatives);
5. Suppliers of bunkers, stores and services;
6. Cargo handlers and terminal operators;
7. Shipyards and repair contractors;
8. Ship's agents
9. Non-governmental organizations.

Apart from those involved in Module 7 need to study Module 1 (Overall information about Fatigue) for the stakeholders to become familiar with Module 1 to 6 of the guidance as appropriate.

3.4.3 Minimum Manning and seafarers fatigue

Document; HTW 3/7

Year; 2016

The Nautical Institute submitted document HTW3/7, co-sponsored by InterManager on Minimum Manning and Seafarer Fatigue with the importance of removal of master/ chief mate two-watch system and to ensure that the ship’s master is not considered part of the normal watchkeeping capability of the vessel.

In the ensuing discussion, views were expressed that:

1. Fatigue has a linkage to manning levels on ships;
2. flag States understand the implications of fatigue when agreeing manning levels with companies;
3. The linkage between fatigue and manning should be taken into account during the revision of the guidelines on fatigue mitigation;
4. The proposal lacked proper justification;
5. The issue of manning of ships is outside the scope of the assigned output;
6. The Sub-Committee must adhere to the clear instruction of the Committee (MSC) that the principles of safe manning should not be amended.

3.4.4 Guidelines for the Application of principles of minimum safe manning

Document; A 27/Res.1047

Year; 2011

This document not directly mitigation of fatigue but should be used in applying the principles of minimum safe manning. In anyways, the guidance still supports the mitigation of fatigue by ensure that a ship is sufficiently, effectively and efficiently manned to provide safety and security of the ship, safe navigation and operations at sea which includes health of seafarers through the avoidance of fatigue.

3.5 Working hours of seafarers and other transport industry.

We could conclude the parameters and solutions through previous gathering of information including the mitigation on fatigue that has the effect on the seafarers. However, it is still an interesting topic to further study into the another transport industry to find out the awareness on the cause and effect of fatigue and how it is handled. Through studying the reports from ITF (International Transport Workers'

Federation) by studying those involving transportation which consists of 3 types are 1. Road transportation, 2. Rail Transportation, and 3. Air Transportation, with the results as follows:

3.5.1 Road Transport

The results from the research on fatigue for road transportation showed many significant evidence confirming fatigue do increases the risk of road accident. Most of the researches were sent from Europe, America, and Australia. The results from NTSB (National Transportation Safety Board) in the USA indicated "52% of single vehicle accidents involving heavy trucks were fatigue-related" (Phillip and Akerstedt, 2006).

The Countermeasure of fatigue;

1. A change of pattern, such as reducing night driving and early starts.
2. Introducing naps or rest breaks.
3. Recommend consumption of caffeinated beverages.
4. Using technological devices to detect fatigue and give the driver a warning.
5. Methods of auditing potential risk factors have also been established.
6. Creating and revising of regulatory to prevent driver fatigue.

3.5.2 Rail Transport

There has been a long term studies on fatigue within the rail industry, such as Grant, 1971 have studied fatigue and extreme accidents occurred. The approach to driver fatigue has been very similar to that seen in road transport. The test were conducted through simulators and found that drivers ability to maneuver is reduced due to fatigue. An important research on fatigue in rail industry was conducted in the year 2000 by The Federal Railroad Administration's Fatigue Research Program. In conclusion, the cause of fatigue due to long working hours such as 24/7, being on

call, long working hours with minimum breaks, and issues from reduced sleeping quality and quantity.

This program adopts a non-prescriptive approach to:

1. Developing better data collecting methodologies.
2. Developing better measurement and evaluation tools.
3. Developing more effecting fatigue countermeasure strategies.

Another research and development to solving is the use of application of the HSE fatigue index (Spencer et al., 2006) from the UK to be conducted in rail transportation industry. The research consisted of diary studies of factors influencing fatigue.

On the basis of the results, the following recommendations were made:

- A reduction in shift length by limiting by and early shifts to 10 hours would mitigate fatigue.
- Continuous periods of driving should be restricted to four hours.
- Limiting maximum hours over a rolling week to 55 would allow sufficient recovery time between shifts.
- Consecutive night shifts should be limited to three before a rest day, early shifts to five before a rest day, and other shifts to seven before a rest day.
- Controlling the variability of shifts will reduce fatigue and a rapid change from a late finish or night shift to an early start should be avoided.
- A rest period of 14 hours between consecutive night shifts is desirable to allow sufficient recovery.
- A change from nights to early should incorporate at least two rest days. All other shift changes should incorporate at least one rest day.
- The HSE Fatigue Index is currently the best option for use in assessment of the shift patterns of safety critical rail workers.

3.5.3 Air Transport

In Air transport industry, fatigue is a major potential problem for many parts. Studies conducted on fatigue, long since World War II, studies from the first part shown that prolonged flying resulted in performance decrements (Welford et a;., 1951). Continuous studies have also shown other issues that could cause fatigue such as overnight cargo and long haul flights. However, ICAO (International Civil Aviation Organization) has regulated the restriction to prevent fatigue as follows:

1. Reducing the duty hours in the case of extended flight requirements.
2. Reducing the night-flying hours
3. Defining the time necessary for rest in order to prevent the accumulation of fatigue all the ICAO member states provide restrictions to the total flight time per week, month and year.

In Germany, Switzerland, USA, and Croatia the law on air traffic restricts the annual flight operations of a pilot to 1000 hours, and duty period of up to 1600 hours. Crews of other countries have shorter annual operations in a range from 700 to 800 (Russia and Japan) and 900 – 935 (Great Britain and France), (Smith a.,2007).

3.6 Comparison of working hours on seafarers and ashore worker as EU standard.

From the previous examples of different types of transportation industries have studies and made aware of the risk caused by fatigue. Although the awareness have made visible including regulating laws to prevent fatigue towards the operators, but in Maritime industry still has exceptions with significant differences, as sample of directives used within the EU which goes by the name of Working Time Directive (2003/88/EC).

Working Time Directive is the restriction used within the EU “to protect workers’ health and safety, working hours must meet minimum standards application throughout the EU” (European Commission, 2003) stating the importance of working and resting hours for the workers as follows:

1. A limit to weekly working hours, which must not exceed 48 hours on average, including any overtime.
2. A minimum daily rest period of 11 consecutive hours in every 24 hours.
3. A rest break during working hours if the worker is on duty for longer than 6 hours.
4. A minimum weekly rest period of 24 uninterrupted hours for each 7-day period, in addition to the 11 hours' daily rest.
5. Paid annual leave of at least 4 weeks per year.
6. Extra protection for night work, e.g.
   6.1 Average working hours must not exceed 8 hours per 24-hour period
   6.2. Night workers must not perform heavy or dangerous work for longer than 8 hours in any 24-hour period,
   6.3. Night workers have the right to free health assessments and, under certain circumstances, to transfer to day work.
7. At least 24 hours of uninterrupted weekly rest every 7 days, over a reference period of 2 weeks

Although the Directives stated the restrictions for the workers working in the EU, there are still some industries falling into the exceptions which is not stated in the directive such as doctors in training, offshore workers, sea fishing worker and people working in urban passenger transport. An important factor to keep in mind is although the pressure of the environment of the seafarers may differ from those working ashore that has higher pressure, but there is a significant difference in resting hours as below (See Table 6)

Table 6; Different of rest and working hour between EU standard and MLC

	Items	Working Time Directive (EU standard)	MLC	Difference hours
WORKING HOURS (Max)	In 24 hours	8 Hours	14 Hours	6 Hours
	In 7 days	48 Hours	72 Hours	24 Hours
REST PERIOD (Min)	In 24 hours	11 Hours	10 Hours	1 Hour
	In 7 days	101 Hours*	77 Hours	24 Hours
	Break	A rest break during working hours if the worker is on duty for longer than 6 hours	Nil	

*The minimum rest period in 7 days as Working Time Directive include 24 hours of uninterrupted weekly rest every 7 days.

3.7 Fatality rate at Seafarer work

Another important evidence in raising awareness of fatigue could cause the risk of accidents, data and research gathered by U.S. Department of Labor in America and Health and safety executive in England, results as follows:

3.7.1 National Census of Fatal Occupational Injuries in 2016, US. Department of Labor

Studies have shown 5,190 fatal work injuries recorded in the United States in 2016, a 7% increase from previous year. Work injuries involving transportation incidents remained the most common fatal event in 2016, accounting for 40 percent (2,083). (See figure.4)

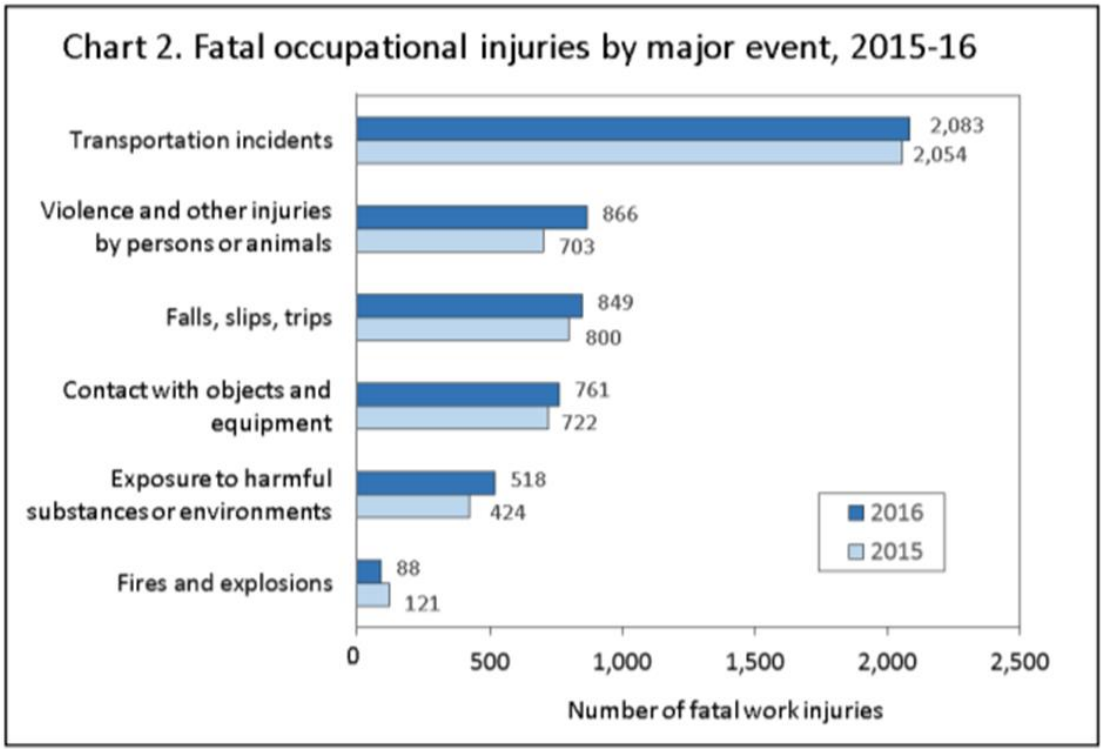

Figure 4; Fatal occupational injuries by major event in US.

Source; Bureau of labor statistics, 2016

In 2016, fatal injuries among transportation and material moving occupations increased by 7 percent to 1,388, the highest count since 2007 and accounting for more than one-quarter of all work-related fatalities.

3.7.2 Fatal Injuries arising from accidents at work in Great Britain 2017, Health and Safety executive.

Results from Great Britain differs from USA, the fatality rate from workers in Transportation Sector is approximately 14% from all aspects of working in 2016, totaling 137 deaths. Although 14% may seem small when compared to deaths from Construction sector (30%) and Agriculture Sector (27%), in both the manufacturing sector and the transportation and storage sector the fatal injury rate is around twice the all industry rate. (See Figure 5)

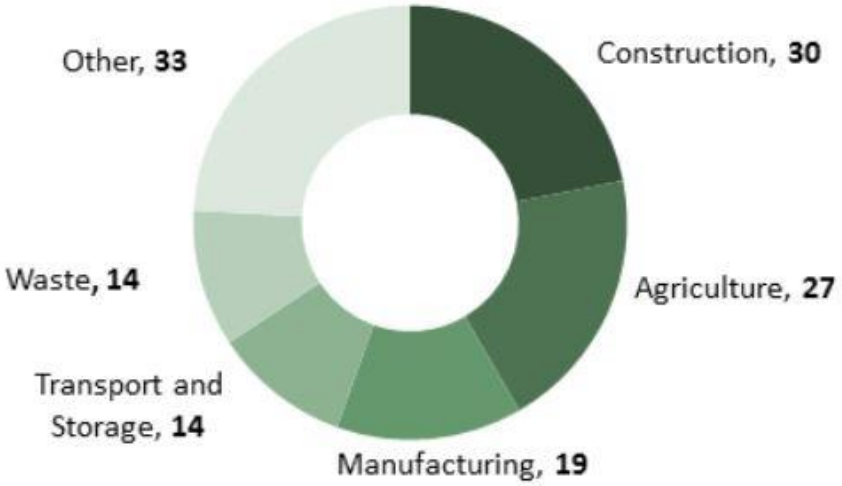

Figure 5; Fatal injuries to workers by main industry in UK.

Source; Health and safety Executive

CHAPTER 4 Survey research

4.1 Conduct the research

This research is a survey research which collecting information's tool is a questionnaire by using a simple random sampling method. A target respondents of the questionnaire is group of workers which are working in maritime industry especially seafarer including student in MET institution for 200 questionnaire.

This questionnaire is set up the correlation score between independent variable and dependent variable at 0.80 and level of significant at 0.05. The hypotheses of research are;

1. Seafarer and worker in maritime industry are lack of awareness and less understands about fatigue.
2. Seafarer and worker in maritime industry want to be educated about fatigue in general.

4.1.1 Making of questionnaire

1st step; Study a relevant research papers relate to fatigue in maritime industry and documentaries to be a guideline for making a questionnaire.

2nd step; Divide a questionnaire into 4 categories as followed

- General information of respondents
- General knowledge about fatigue
- Fatigue onboard
- Needing of fatigue course

3rd step; Checking objectives and concordance of questionnaire, wording, and content validity. Then enhance the contents again and try out the questionnaire by 30 set of questionnaire with another group of respondents. The questionnaire will be analysis with computer program SPSS (Statistic package foe special science) to

check the correlation with is indicated positive and negative between independent variable and dependent Variable.

4th step; Checking try out results and improve once again then start to public questionnaire to 200 respondents.

4.1.2 Collecting questionnaire

Using of the Google form to conduct questionnaire and public on social media by 200 respondents

4.1.3 Analysis of information

This survey is a descriptive statistic to analysis and assessment of fatigue to seafarer and related occupation. Researcher checking and collecting the accuracy of answer by using SPSS program by these means;

Part 1; Respondent's information mostly are in qualitative data, researcher use average and percentage to analyst all collected information.

Part 2,3 and 4; General knowledge of seafarer on fatigue to estimate knowledge and understanding. This questionnaire can be divided into 3 dimensions as study from IMO, MARTHA project and Horizon project. Information in the section is in quantitative data and qualitative data. Qualitative data collected and analyzed as mention in Part 1. Quantitative data had a code of information in 5 pointed linker scales so research are use average (mean) and standard deviation and average score from mean can be described as followed;

Score level	Explanation
4.21 – 5.00	Very high
3.41 – 4.20	High
2.61 – 3.40	Moderate
1.81 – 2.60	Less
1.00 – 1.80	Least

4.2 Result of survey research.

4.2.1 Result from Section 1; General information of Respondents.

The Survey Research was conducted on group of respondents who are people working on board or in maritime related business, including students in MET institution. From 200 surveys, there are 121 Deck Officers, 29 Engine Officers, and Student and Other occupation related to maritime industry of equal number, 25 from each group. (See figure 6)

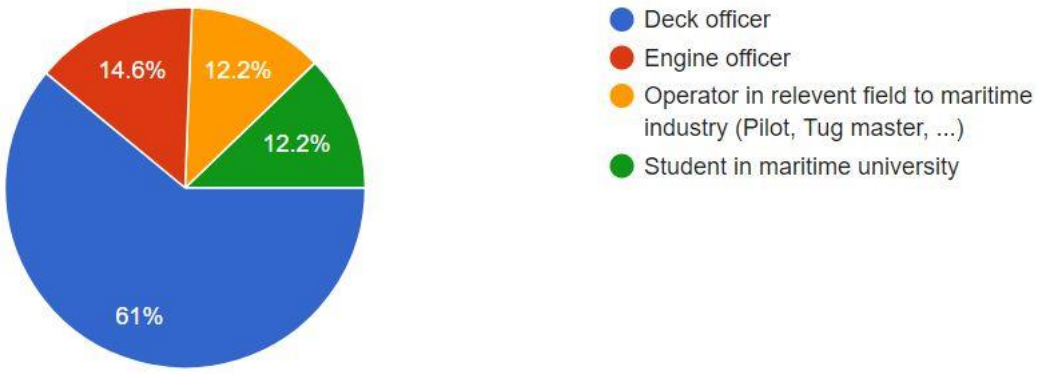

Figure 6; Proportion of respondent's occupation.

Respondents from group number 1 and 2 which are working onboard most of them are in the Operational level (3rd/officer, 2nd/off, 4th/eng, 3rd/eng) for 56.1% only 7.3% in management level (Master, Ch/off, Ch/eng, 2nd/Eng) (See figure 7).

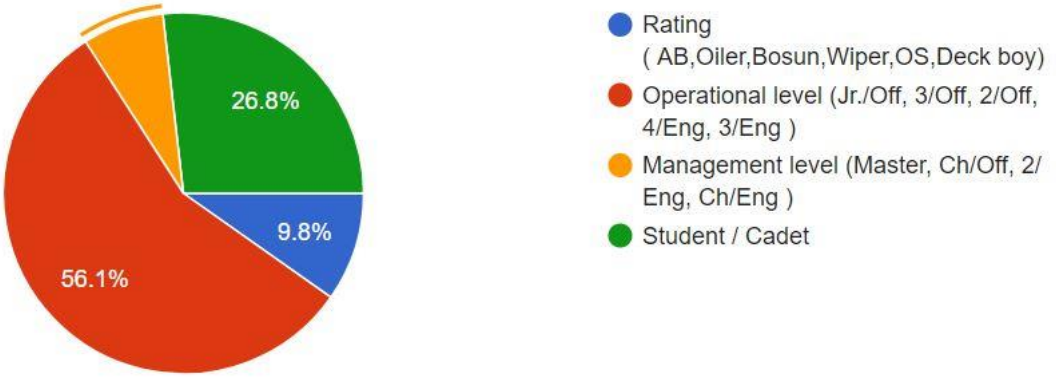

Figure 7; Percentage of respondent's onboard ranking

From the conducted information, majority of the respondents are working in Tanker ship (Oil, Gas, Chemical) at the number of 102 people, followed by Bulk carrier at 49, and Tug boat at 5 people (See figure 8).

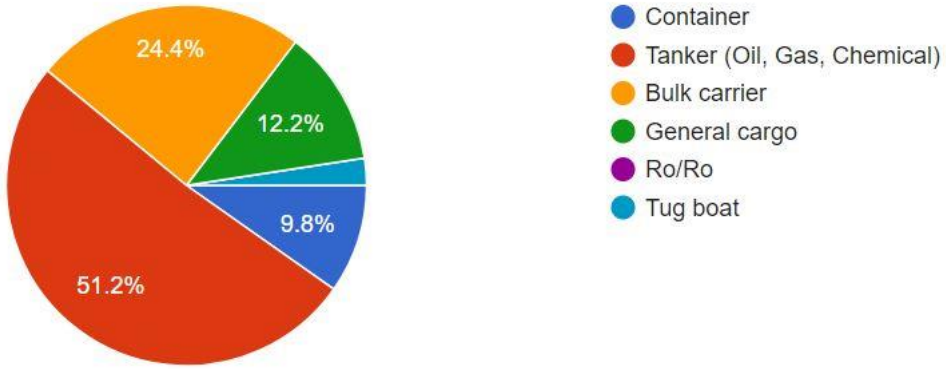

Figure 8; Percentage of ship types which respondents worked.

78 out of 200 respondents have been working in the ship for 1-2 years, while 73 have been working in the ship for 3-5 years, and 29 have been working in the ship for more than 5 years. The rest of the respondents (20) have been working onboard for less than 1 year.

4.2.2 Result from Section 2; General knowledge of fatigue.

This section based on respondents' general knowledge about "Fatigue" and its relevant factors. The results are as followed:

1. More than half of the respondents (112 of 200) have never heard of the word Fatigue before answering the questionnaire. Even though 88 of 200 respondents have heard of the word, there are only 49 people who were educated on Fatigue issue (See figure 9).

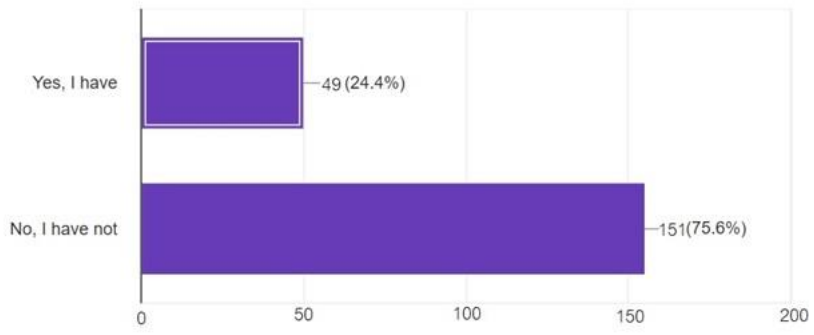

Figure 9; Number of respondents who have heard about fatigue before

By testing basic knowledge of rest period according to MLC, the results are 107 people answered correctly, while 82 chose incorrect answers, and 11 respondents answered "I don't know".

48.8% of survey's respondents claimed they have rest hours lower than MLC average; only 31.7% have rest hours as required by MLC standard, and the rest have their rest hours above standard. (See figure 10)

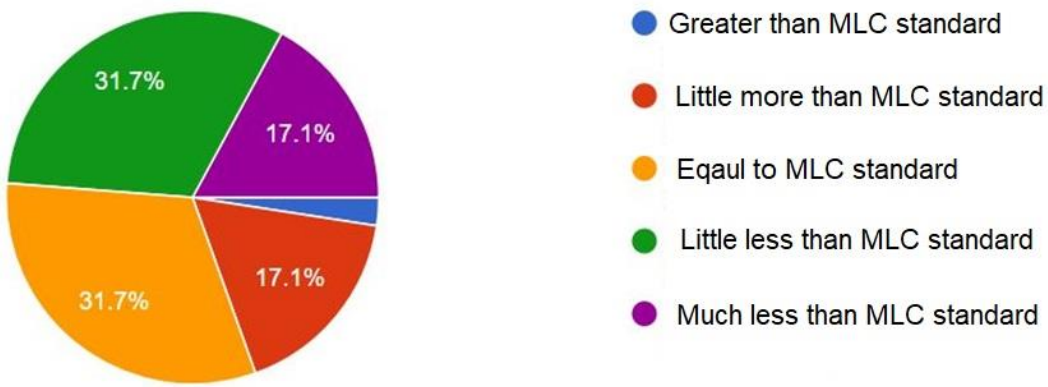

Figure 10; Proportion of hour of rest onboard as per MLC standard

The questionnaire about the factors causing fatigue issue was created with the framework of MSC/Circ.1014, GUIDANCE ON FATIGUE MITIGATION AND MANAGEMENT, divided the factors into 4 categories; Crew-specific Factors, Management Factors (ashore and aboard ship), Ship-specific Factors and Environmental Factors.

Sleep and rest has made the most influencing factor in category **Crew-specific Factors** of 132 respondents, followed by workload, stress, health and age accordingly.

Management factor that majority of the respondents claimed it's the most influencing is organizational factors.

Ship-specific factors; most of respondents of 122 people said the most influencing factor is the age of vessel, followed by Equipment reliability of 58 people.

Environmental Factors, Respondents' opinion is in the same direction that sea condition is the most influencing factor at 146 people, 73.2%. Followed by excessive noise level, temperature, and humidity accordingly.

In summary, comparing those 4 factors to see which factor category influence to fatigue the most, the result showed that 122 people (56.1%) think management factor is the most influencing one. While environmental factor ranked the least influencing of 9.8% (See figure 11).

Figure 11; Respondents opinion on the most influence factor of fatigue

The respondents were asked about inverse relationship between motivation and time spent onboard; 68.3% agree, while 19.5% disagree, and 12.2% were not convinced. When continue asking about when did the motivation start to decrease significantly, 58.5% said 7-9 months onboard, while 19.5% said 4-6 months, 14.6% said 10-12 months, and 7.3% said the motivation decreases since the first 3 months. (See figure 12)

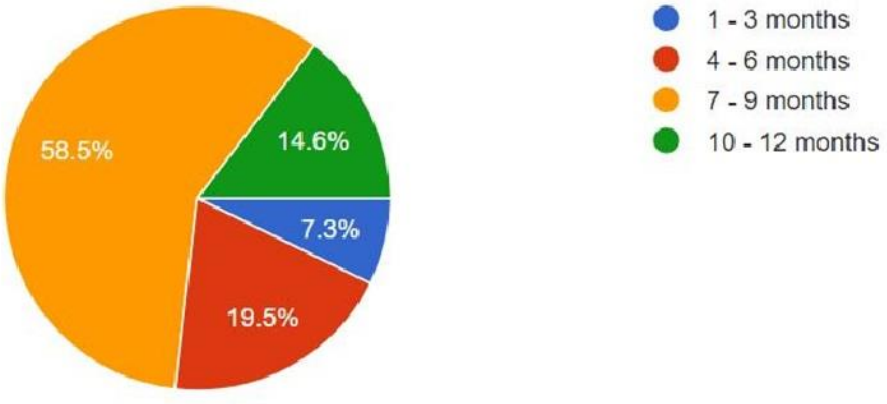

Figure 12; Opinion of inverse relationship of time spend onboard and motivation

4.2.3 Result from Section 3; Fatigue during ship operation

This section, respondents will ask question about fatigue onboard and effect on fatigue in practically, respondents also asked about fatigue during watch keeping duty as well.

From survey research 92.7% agreed that 6on / 6off duty is cause of fatigue than 4on / 8off duty. Fatigue also showing in sleepy during work especially during cargo operation result showing average score of sleepy during watch duty is 3.05 out of 5.

Correspond with another answer from 58.5% of respondents that cargo operation (which taking on 6on/6off duty) is a most operation influencing to fatigue onboard (See Figure 13)

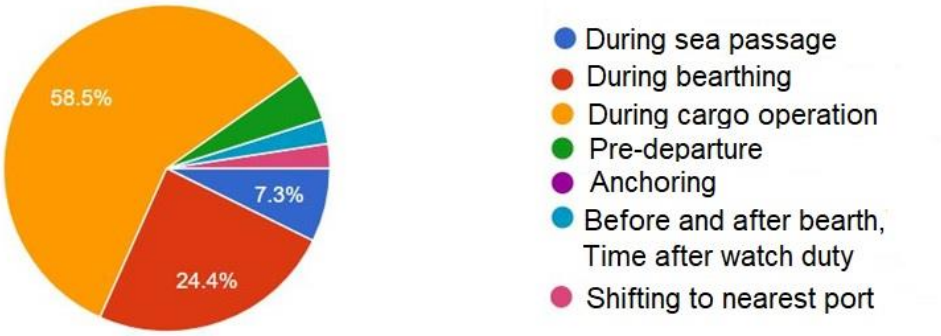

Figure13; Percentage of ship's operation which can be a cause of fatigue

As well as average point of fatigue while doing a watch keeping duty in 6on/6off system is 3.88 means respondents are in fatigue easily during cargo operation.

Next question respondents were asking about rest and work hour that record onboard; 24.4 % said this document are not much accurate. Average point is 2.47 means less reliability.

Respondents have same opinion about impact of fatigue and working performance. 12.5% think fatigue is extreme impact to working performance while average point is 3.58 out of 5 mean “high impact”

36.6% of respondents (73 people) said they had been asked for working while they were in rest period, average score is 3.95 out of 5 means most of them were interrupt by work during sleeping hour.

Respondents have different opinions about impact of fatigue on accident and near-miss situation. Average score is 2.54 out of 5 means fatigue can be influence to work performance.

4.2.4 Section 4; Need of fatigue course.

In this section respondents have been asking question about fatigue awareness course in needing and course outline.

Almost 200 respondents (95.1%) want MET institution to establish fatigue awareness course for seafarer. (See figure 14)

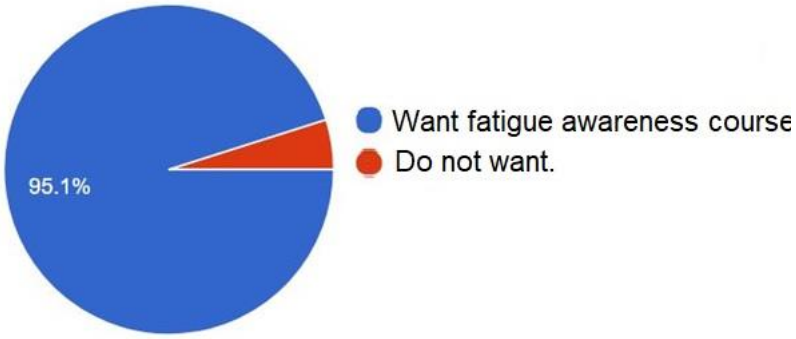

Figure 14; The respondent’s opinion on establish of fatigue awareness course.

Continued question about proper study hour 51.2% of respondents want study hours base on contents of fatigue. While 29.3% (58 people) want this program take 3 hours or half a day and 17.1% said 6 hours is a proper study time for the program.

68.3% of respondents (136 people) want fatigue awareness course as mandatory course in MET institution and the rest 31.7% want this program as additional course. (See figure15)

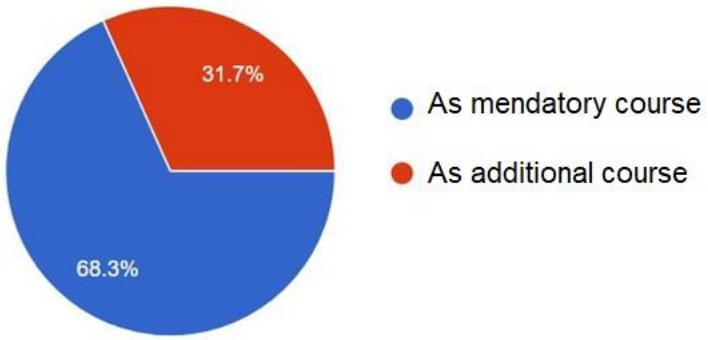

Figure 15; The respondent's opinion on conduct of fatigue awareness course.

4.3 SPSS data analysis

Contents of this section will be taken from the questionnaire. The analysis was done by SPSS program to find out the relationship from different variables and which variables have the most effect to dependent variable. The details are as follows.

Hypothesis

H_0 : Fatigue from inadequate sleep has on impact to seafarer's working performance and increase chance of accident

H_1 : Fatigue from inadequate sleep has impact to seafarer's working performance and increase chance of accident

Independent Variable

1. Level comments of fatigue during daytime operation
2. Level comments of fatigue during nighttime operation
3. Level comments of frequently sleepy during cargo operation
4. Level comments of fatigue during working 6on/6off system
5. Level comments of requesting to do job while you are in rest period

Dependent Variable

F1 = Level of comment to the impact of fatigue on working performance and increasing chance of accident onboard.

Table 7; SPSS summary - Model summary

Mode 1	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.714[a]	.510	.495	.53377

a. Predictors: (Constant), fatigue during night time operation, fatigue during working 6on/6off system, fatigue during daytime operation, requesting to do job while you are in rest period, frequently sleepy during cargo operation.

From table 7 showing that Dependent variable and independent variable are in linear equation Which R=0.714 or 71.4 % and variation is 0.53377 mean the results of analysis has significantly relation to hypotheses.

Table 8; SPSS summary - ANOVA

ANOVA [a]

Mode 1	Sum of Squares	df	Mean Square	F	Sig.
Regression	57.331	6	9.555	33.537	.000[b]
Residual	54.989	193	.285		
Total	112.320	199			

a. Dependent Variable: F1

b. Predictors: (Constant), fatigue during nighttime operation , fatigue during working 6on/6off system, fatigue during daytime operation, requesting to do job while you are in rest period, frequently sleepy during cargo operation

As table 8 ,ANOVA, say about significance of those independent variables that can influence to dependent variable. From the table show that both variable are significantly related to each other at 0.05

Table 9; SPSS summary – Coefficients

Coefficients [a]

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. error	Beta		
(Constant)	.550	.449		1.225	.222
fatigue during daytime operation	.158	.037	.268	4.260	.000
frequently sleepy during cargo operation	.275	.050	.403	5.467	.001
fatigue during working 6on/6off system	.126	.038	.190	3.340	.001
requesting to do job while you are in rest period	.351	.053	.434	6.588	.000
fatigue during nighttime operation	-.210	.070	-.266	-2.990	.003

a. Dependent Variable: F1

Table 9 illustrated that the analysis of SPSS program accepted hypothesis (H1) said "Fatigue from inadequate sleep has significantly impact to working performance and increasing of accident" Which have a S = 0.05 and R = 71.4. Each independent variable can be described as followed;

1st variable; Level comments of requesting to do job while you are in rest period has a statically significant impact to decreasing of working performance and increasing of accident by (t(193)=6.588;P-Value(.00)<.05)

2nd variable; Level comments on frequently sleepy during cargo operation has a statically significant impact to decreasing of working performance and increasing of accident by ($t(193)= 5.467$;P-Value(0.000)<0.05)

3rd variable; Level comments of fatigue during daytime operation has a statically significant impact to decreasing of working performance and increasing of accident by ($t(193)= 4.260$;P-Value(0.000)<0.05)

4th variable; Level comments of fatigue during working 6on/6off system has a statically significant impact to decreasing of working performance and increasing of accident by ($t(193)= 3.340$;P-Value(0.001)<0.05)

5th variable; Level comments of fatigue during nighttime operation has a statically significant impact to decreasing of working performance and increasing of accident by ($t(193)= -2.990$;P-Value(0.003)<0.05)

According to analysis from SPSS, the most factor which can impact to working performance and increasing chance of accident is sleep interrupted or seafarer are asked to do work during rest period. Followed by the rest of factors which are sleepy during cargo operation, fatigue during daytime and night time of the watch, fatigue during work in 6on/6off system and fatigue during night time operation accordingly.

4.4 Summary

By conducting the survey in chapter 4, the result shows several dimensions of response to questionnaires, and also confirms both of the earlier mentioned

1. Seafarers have low understanding in fatigue issue; refer to question 2.1 and 2.2 (See appendix) as 75.6% of seafarers, or people working in related fields, have never been educated or informed about fatigue before. Moreover, when asked about their minimum rest hours, 41.4% of the respondents cannot answer correctly, and other 4.9% do not know the standard required rest hour from MLC.
2. Respondents have inadequate awareness of fatigue; from the conducted questionnaires, even though, average score shows that seafarers acknowledged the impact of fatigue on their working performance, they still take the risk working under fatigue condition. At the average score of 3.95 out of 5, seafarers' rest hour has high rate of interrupts, but still think they can still work effectively, even without adequate rest hour.
3. Cargo operation is the most period to cause fatigue according to the survey result at 58.5%; practically, watch keeping system 6on/6off that is a normal duty during cargo operation, Also another result with 3.88 out of 5 is the score of fatigue during watch keeping in 6on/6off system that is a high level of fatigue.

4. Fatigue might be cause of accidents, or near-miss situation; the respondents claim that fatigue might be the cause of accidents, with the moderate average score (2.54/5). Even though the score is not very high, the survey also shows that the OOW gets high rate of sleepiness and fatigue during night watch keeping duty (3.39/5), which could be one cause of accident.
5. The need of fatigue education program; the majority of respondents have similar opinion that there should be a program educating on fatigue (95.1%), the content of the program should include general knowledge on fatigue, fatigue mitigation, and danger caused by fatigue.

Chapter 5 Summary

5.1 Dissertation summary

The results from the questionnaire and analysis of SPSS program found that the two hypotheses which are

1. Seafarer and worker in maritime industry are lack of awareness and less understands about fatigue.
2. Seafarer and worker in maritime industry want to be educated about fatigue in general.

Both two hypotheses are factual, there are details which support those hypotheses as follows.

1st Hypothesis; The results from questionnaires spotlight that 46.3% of seafarer have not known about minimum of the rest hour as MLC requirement and 75.6% of respondents have never been educated about fatigue before. There are also some observations that seafarer think that they can do a watchkeeping duty even they have not enough rested time. From SPSS analysis showing that inadequate sleep has a significantly impact to working performance and increasing chance of accident.

2nd Hypothesis; The second hypothesis clearly found that 90% of respondents wanted to be educated about fatigue in general. There are other details, such as the hours of instruction should be based on the content. And the subject of training should be the mandatory training in the MET institution.

Apart from the conclusion of the two hypotheses, there are other interesting details, such as most of seafarer have been interrupted during their rest hours and feeling sleepy during a watch keeping time not only the night but the daytime also, especially during cargo operation. Also seafarer has the same opinions that the records of rest hour onboard are inconsistent with reality. Those facts might be a

sight and leading to further study and finding the way to mitigate fatigue in the future.

However from the results and summary of study there are suggestions for action should be given to the maritime communities and the impact to each maritime communities if they are willing to drive Fatigue education and training to be real.

5.2 Impact of the introduction of fatigue awareness course on maritime communities

More than 90% of respondents requests to have training on fatigue mitigation (as results in chapter 4), but other considerations needs to be made prior. Proposing new training must passed through consideration due to it may effects many essential aspects of the organization, affecting from the trainers to departments within the government in charge of certifying to those enrolled in the program, enrolled fees may be collected, time will be affected from the studying hours. The aforementioned reasons that needs to be taken into consideration when preparing a training course on fatigue for the seafarers.

MET institution, Maritime Administrator and Shipping companies are the main communities that constitute the maritime industry. Nakazawa, (2004) had described the independence of these three communities, which is illustrated in Figure 16

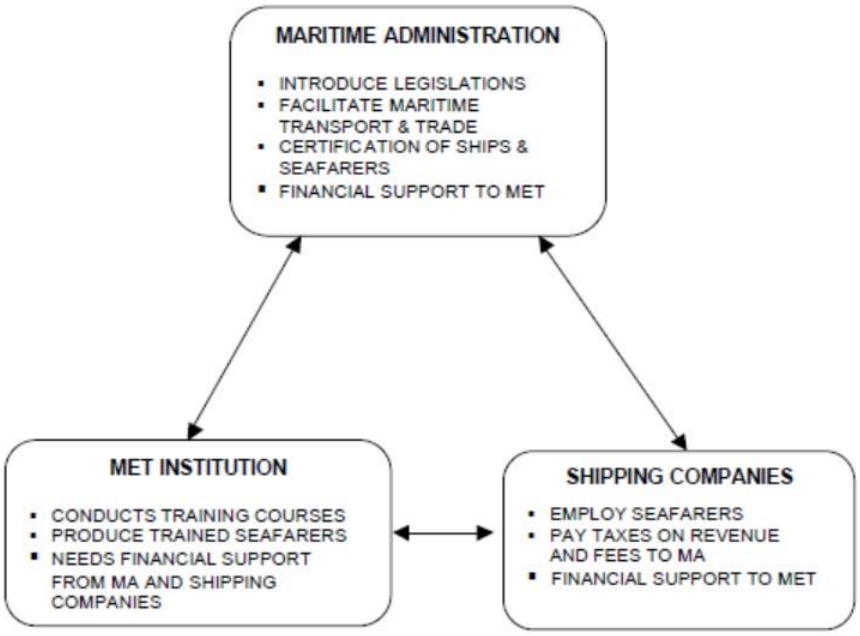

Figure 16; Interdependence of maritime communities
Source; Nakazawa, 2004

Generally, MA (Maritime Administration) is in charge of enforcing the law and regulations, supports the coalition departments, create basic template for sea transportation including certifying the seafarers. Shipping company will select the seafarers from MET (Maritime Education and training) institute to work within the company and train the trainees onboard. The company also is responsible to pay tax from profit they've gained to Maritime Administration. Met Institution is responsible for train various course for those working onboard the ship and be in the standards set by STCW or other agreements both domestic and international. On the other hand, MET institution do received support in funding from the government (MA).

Due to procedure in training are correlated in three parts are Maritime Administration, MET Institution, and Shipping company, the studies of impact that may occur to the maritime communities are to follow.

5.2.1 Impact on maritime administration

It is known that MA (Maritime Administration) is responsible for regulating and enforcing regulations. The training of fatigue awareness is depended on the government's view of the matter either Mandatory course or Additional Course. Although there has been more awareness of the fatigue but due to it's not constituted as basic knowledge according to STCW 2010, the poll results proved that more than 90% of seafarers demand the course on fatigue mitigation be instated in MET. Therefore this topic becomes the basic course that MA instate this course as a mandatory course and certify those enrolled, from information gathered on the impact of training as follows:

1. **Approval and conduct of the fatigue awareness course**
    a. Approval, MA needs to declare the standards for learning facilities in training including the control of standards of the course throughout and criteria for those enrolled. However, fatigue is considered as general topic and cannot be used with specific group of people, therefore it can be instate to all level, rating, operational level, and management level.
    b. Rules and regulations: MA is responsible in setting standards and creating minimum criteria for learning facilities to certified those enrolled do receive adequate knowledge about fatigue by STCW, though it is not required to have certification.
    c. Certification; though Fatigue course is not required by STCW 2010, but because of MA propose to have the training and the MA could give certification in the name of National Regulation to certify that the

individual received the knowledge and training by the standards of STCW 2010, which can be used in other line of work in the future.

2. **Established rules and regulation**

From the research on Fatigue, Contract State has to have regulations referring to MSC/Circ.1014 (Guidance on fatigue mitigation and management) by using it as guidelines to regulate and mitigate on fatigue to those affect such as ship's master/ chief, ship operation, rule for naval architect, or regulating the resting and working hours to the standards of MLC.

3. **Construct facilities to mitigate fatigue**

One essential factor on fatigue is lack of sleep, results from poll indicate cargo operation base. MA needs to construct facilities to help reduce the workload or to enhanced convenient at the port such as mooring machine, cargo equipment which can load and discharging of cargo efficiency is a way of minimizing the seafarer workload.

5.2.2 Impact on MET institution

MET, responsible for the training courses, have many aspects to consider, however, IMO have recommended the scope and essential topics to train by referring to MSC/Circ. 1014 (Guidance on Fatigue mitigation and management) in Module 5: Fatigue and the training Institution and management personnel in charge of training, has effect to MET as follows:

1. **Approval and conduct of the fatigue awareness course**
    a. Approval, training facilities has to propose the course syllabus including course outline and timetable for MA to consider.
    b. Course Design, objective is referred to module 5 from Guidance on Fatigue mitigation and Management which consist of 3 main categories:
        i. Student should be able to define fatigue, relate to fatigue on a personal level, and recognize the signs of fatigue.
        ii. Student should be able to understand and recognize the characteristics of short term and long term fatigue.
        iii. Student should be able to integrate their knowledge of fatigue and preventive-measures/mitigate-techniques into the workplace.

2. **Selection of trainees and instructor**

Although Guidance on fatigue mitigation and management did not state the standards of trainees and instructors, selecting the trainees to train in this course

should be the one that is familiar with the task onboard the ship to better understand the overall training. Therefore, working and performance onboard cargo ship or in relevant occupation to maritime industry.

In the part of Instructor, should coincide with the criteria set by IMO, required those instructed the course of STCW must surpassed the training IMO model course 6.09 (Training for instructors). Although training on fatigue is not required by the standards of STCW but having trained the same standards to help elevate the quality of the trainees.

5.2.3 Impact on shipping company

Shipping company being the employer of the seafarers, it is consider a good investment the employees are well trained in fatigue mitigation which greatly helped reduce the risk of property damage. Guidelines on Fatigue Module 6; Shipboard fatigue and the owner/operator/manager have mentioned guidelines for mitigation of fatigue for company to follow, the impact can be declared as follows:

1. **Management (ashore and onboard)**

Shipping company needs to improve on the structure (in some cases) or adjust the procedures accordingly to reduce issues that may occur due to fatigue. For example, declared a well-balanced working and resting hours or choosing appropriate schedule for the ships and well managed frequency, reduce complicated workflow, reduce the workload from paperwork.

2. **Design of ship and accommodation onboard.**

This factor is important to the shipping company in providing the facilities including facilities for leisure to accommodate the standards of MLC and provide the most sufficient rest. Furthermore, choosing the structure of ships with the effect of noise, vibration, and heat from engine room in mind.

3. **Manning**

Sufficient manning is another important task for the shipping company to sort the appropriate candidate. Even though all ships must have minimum safe manning certificate, this certificate mentions how many minimum crews need to be on board to run the ship (Rajeev, 2017). In reality, each ship has its own needs for manning differently, in some company is obligated to manning the ship with the most sufficient manning rather than minimum safe manning to reduce the workload onboard to avoid fatigue and stress on the operators also.

5.2.4 Impact on seafarers

Even seafarers are not mentioned in maritime communities, but they are the undeniably the core structure and they are the ones affected by Introduction on fatigue awareness course in both studying and the new regulations as follows:

1. Education & training

Seafarers including trainees in the related fields of maritime industry should receive training on fatigue awareness. In summary from the majority of votes sees fit to be instated as basic course within the school. This will result in an extended time of study to increase the understanding of student on Fatigue.

2. Tuition Fee

Another factor that may affect seafarers due to the course is designed to fit the standards and be certified from MA, each curriculum requires time and tuition for the facilities and training, tuition fee will become a part for seafarers to supply.

3. Working onboard

If seafarers are well educated about fatigue, the first impact will be the rights for the seafarers, by law and convention (MLC, STCW, SOLAS) means that seafarers will have to adapt the new lifestyles onboard to fit in and avoid fatigue. From chapter 4, we learned that more than 48.8% of seafarer actual resting time is far less that is stated in MLC. Therefore, if seafarers received better education, the rights and the working condition onboard must be adapt to best fit the appropriate requirement also.

5.3 Step to be taken upon the introduction of Fatigue awareness course by the Maritime Communities

In this topic, there will be an analysis of what is the step to be taken by the Maritime community as if that is possible to conduct the Fatigue course. In that, the results are divided into four parts which are the step to be taken by Maritime Administration, MET Institution, Shipping Company, and step to be taken by Seafarer. Results are presented as follows.

5.3.1 Step to be taken by Maritime Administration

The MA operation is the primary procedure and will influence the other Maritime communities as well. The procedure of MA operation can describe as follows.

National perspective

- MA works on approval and conducts Fatigue awareness course by announcing it under the national law which will be the obligation of the ship which raises their flag so that seafarer acquires training course and get the letter of certification to certify the knowledge on Fatigue awareness.

- MA works on inspection of the training institute that teaching the Fatigue to consider if the institute has a proper quality as in MA announcement. Also in this area MA can work together with MET institutions as well.

- MA issues a regulations or suggestion for the organization in the Maritime industry to conform to IMO standard which is IMO's guidance. The Maritime industries are ship owner, shipyard, ship engineer, ship management, shipping company, and crew manning company etc.

- MA might readjust the Minimum Safe Manning Certificate, maybe adjust the number of seafarer appropriate with the ship and its condition referring from the Resolution A.1047 (27) PRINCIPLES OF MINIMUM SAFE MANNING in associated with MSC/Circ.1014 GUIDANCE ON FATIGUE MITIGATION AND MANAGEMENT for improving the safe manning and decreasing the chance of Fatigue.

International perspective

- As for international process, MA can be a representative person to submit the proposal to IMO through the Maritime Safety Committee (MSC). The main idea is to conscientiously build recognition of Fatigue. Anyhow, the Contract State might compile the documents and related study to persuade other countries about the problem of Fatigue and convince them to agree with the submitted proposal.

5.3.2 Step to be taken by MET Institution

One of the main function of MET is to make the standard and efficiently set the course outline completely covered content that IMO recommended and also remain the standard of teaching at the same time.

1. **Course design**

Even if MA sets criteria and standard in the Fatigue awareness course, MET Institute still has to work together with MA to design an assessment for evaluating the course instruction. The conclusion of evaluating will be a guide for an institution to design the course according to MA objective. In that, the institution has to, likewise, create a

course syllabus, course outline and timetable covering the learner qualification and evaluation.

2. **MET quality standard**

Maintain the quality of education is also important; however, MET needs to maintain it as MA assigned. The quality of instructor, learning hour, facilities, teaching AIDS concluding the number of the instructor to the learner is what needed to consider as well.

3. **Selection of trainees**

Although Fatigue awareness course can access by seafarer in any ranking but the lack of institutions and the difference of level of learner can be the problem. So, MET has to make the process of selecting learning to the appropriated level by setting the essential standard, for example, the second-year student in University or experienced seafarer, to help people profoundly understand the content since they already have been associated in the field before.

5.3.3 Step to be taken by Shipping Company

A shipping company is one of the most important communities in which demonstrating the significance of Fatigue prevention. Shipping Company, whereas, might carry out it in any channel by followings.

1. Course and Design

Even though the cost and design have been discussing above that it is the direct responsibility of both MA and MET. Anyway, as the shipping company, they can provide MET guidance and information which is useful for designing the course. The company might ask for the necessary facility, for example, a simulator or a workshop related to fatigue onboard.

2. Onboard training

Seafarer did gain experiences of Fatigue from the Academic institution; however, the different type of ship is different from the characteristic of fatigue. So that training onboard is necessary in order that the new signing crew will attain and take care of oneself correctly. For the training, it can be learnt from video or from the senior officer in that ship as well.

3. Manning

Manning is the most important part of participation in Fatigue awareness. In fact, more than 30% of the ship expenses apply for the ship manning. It is the fact that cutting off the number of crew affects the workload onboard so the appropriate way of expression by the shipping company is to wisely examine characteristics of the ship and its need. The consideration of crew number, then, not only considered by the ship characteristic but also the load of work. In case of using an automatic system instead of a human, it needs to be confirmed for the reliability of those equipment as well.

4. Management organization

One of the factors that interfere with Fatigue awareness is the organization structure. As in project MARTHA study and the questionnaire in chapter 4 showed that most of the seafarer has an opinion on workload including paperwork that affected Fatigue on board as well. *"The increasing of the amount of paperwork has not only added stress on seafarers but has also made them less focused on their core duties."* (Raunek, 2017) Thereby, the improvement of organization and the human resource management in both ashore and onboard might efficiently influence the mitigation on Fatigue.

5. Facilities and Requisition support

Supporting of the shipping company is one of the problems that seafarer has to confront with. Since the requisition by the ship might not fulfill the need of seafarer. To be more clear, the company's main reason is to reduce the cost or there is not enough equipment to provide, these things can lead to Fatigue in which seafarer cannot find the tool precise at the job. According to that, the company should reconsider supporting facilities and requisitions as the crew request properly.

5.3.4 Step to be taken by Seafarer

1. Training and Education; seafarer has to be prepared before training. Even so, nowadays, the seafarer is required to certify in many training courses which might require more money to sign in; however, every training gives the benefit to seafarer themselves, ship, and shipping company. So, seafarer should recognize it as a good chance for improvement.
2. A right of seafarer; thus seafarers already understand of Fatigue and its condition but the major problem is they are not protecting their right. Most seafarers yield to work overtime even they are reaching the minimum of resting hour, they still working without notifying the involving sector or

Maritime Administration. That may lead the ship and themselves to an unavoidable accident. To conclude, maintaining the right is good for solving the problem of Fatigue in one's lifetime.

CHAPTER 6 Conclusion and recommendation

After studying through setting hypotheses, and finding the answers in perception and awareness of danger from fatigue condition, survey research, and SPSS analysis result all go in the same direction. That is the seafarers has low education and understanding on dangers happened to themselves, the colleagues, the ship, and environment, that caused by working under fatigue condition.

Moreover, from the hypotheses set earlier, the survey also shows more information that in the real situation, there is intentionally ignorance of adequate rest hours which resulted from not having enough rest hours and has the impact on work, and apparently, could cause the accident. There also appeared the information that has not been studied before, that is, the adequate rest hours for fatigue recovery, which comes after the study in Project MARTHA. The information could benefit in further study to find the ways to effectively prevent fatigue condition from happening.

Not only IMO or other international organizations that should take a part in preventing fatigue, but also other maritime communities that involved with the seafarers; MA, MET, and shipping companies, all should take a role in pushing forward fatigue issue so as to prevent and decrease the associated risks.

Lastly, the best way to prevent fatigue is not waiting for IMO to issue new convention, or waiting for the companies to assign seafarers adequate rest hours. It all has to start from the seafarers themselves, that has to see the importance of the condition and danger associated by learning and understanding on effect of fatigue condition on work to prevent the determinant of fatigue condition that leads to accident.

Therefore, educating and training the seafarers to have better understanding on fatigue and its effect is very effective on fixing the problem, starting from the seafarer themselves, to having better understanding and awareness on dangers that could follow. To set teaching curriculum, it should start since MET institution, and make it mandatory course. The curriculum should be set based on mutual opinion

gathering and principles, not just from MET only, but also from MA and other shipping companies.

Understanding and correct coping methods are not only preventing and reducing the harmful accidents from happening, it also encourages their health and the ability to work at their full capacity result in benefit for maritime industry henceforward.

References

Allen, P., Wadsworth, E. and Smith, A. (2006). The relationship between recorded hours of work and fatigue in seafarers. In P.D. Bust (Eds), *Contemporary Ergonomics 2006* (pp. 546-548). London: Taylor and Francis.

Allen, P.H., Wadsworth, E.J. and Smith, A.P. (2008). Seafarers' fatigue: a review of the recent literature. *International Maritime Health, 59, 81-92.*

Australian National Transport Fatigue Expert Group. (2001). *Options for a regulatory approach to fatigue in drivers of heavy vehicles in Australia and NewZealand*. Retrieved 3 May, 2012 from: http://www.ntc.gov.au/filemedia/Reports/FatigueExpertGroupRepFeb2001.pdf

Bureau of Labor Statistic. (2017). National census of fatal occupational Injuries in 2017. Retrieved 14 April,2018 from: https://www.bls.gov/news.release/pdf/cfoi.pdf

Carotenuto, A., Fasanaro A.M., Molino, I., Amenta, F. (2017). Psychological stress in seafarers: a review. Retrieved April 18, 2018 from: https://www.researchgate.net/publication/260528006_Psychological_stress_in_seafarers_a_review

Fatigue: IMO guidance, mitigation and management. 2006, March. *Seaways, 7-9.*

Health and safety Executive. (2017). Fatal injuries arising from accidents at work in Great Britain 2017. Retrieved 14 April,2018 from: www.hse.gov.uk/statistics/pdf/fatalinjuries.pdf

Inter manager. (2016). IMO SUB-COMMITTEE ON HUMAN ELEMENT, TRAINING AND WATCHKEEPING, 3rd SESSION 2 – 5 FEBRUARY 2016. Retrieved April 18, 2018 from: https://www.intermanager.org/2016/02/imo-sub-committee-on-human-element-training-and-watchkeeping-3rd-session-2-5-february-2016/

International Chamber of Shipping (ICS) and International Shipping Federation (ISF). (2012). Recommendations relating to the application of requirements governing seafarers' hours of work and rest. Retrieved 20 April,2018 from: https://www.ocimf.org/media/55169/Recommendations-Relating-to-the-Application-of-Requirements-Governing-Seafarers-Hours-of- Work-and-Rest-Nov-2012.pdf

International Convention for the Safety of Life at Sea. IMO. (2009).

International Labour Organization [ILO]. (2001). The impact on seafarer's living and working conditions of changes in the structure of the shipping industry. Geneva: Author.

International Maritime Organization. (2001, June 12). *Guidance on Fatigue Mitigation and Management* (MSC/Circ.1014). London: Author.

International Maritime Organization. (2011). *Maritime Safety*. Retrieved July 5, 2012 from International Maritime Organization website: http://www.imo.org/OurWork/Safety/Pages/Default.aspx

International Maritime Organization. (2011, December 20). *Principles of minimum safe manning Resolution A.1047(27).* London: Author.

International Maritime Organization. (2016). Proposal for a new module to address "other stakeholders" in the revised Guidelines on Fatigue. Retrieved June 1,2018 from International Maritime Organization website: http://www.imo.org/OurWork/Safety/Pages/Default.aspx

International Maritime Organization. (2016, November 24). *Revision of the guidelines on fatigue Report on the seafarer's workload assessment* (HTW 4/INF.5). London: Author.

International Maritime Organization. (2016, November 21). *Role of the human element* (HTW 4/7). London: Author.

International Maritime Organization. (1999, June 6). *The role of the human element* (MSC/Circ. 813/MEPC/Circ.330). London: Author.

Isle of Man Ship Registry. (2013). Hours of work and hours of rest. Retrieved 14 April,2018 from: https://www.iomshipregistry.com/forms-reports/mlcilo-reports/

Lützhöft, M., Thorslund, B., K*irch*er, A. & Gillberg, M. (2007). *Fatigue at sea-A field study in Swedish shipping.* Linköping: the Swedish National Road and Transport Research Institute.

Marine Accident Investigation Branch. (2003). Report on the investigation of the grounding and loss of the Cypriot-registered general cargo ship Jambo off Summer Islands West Coast of Scotland 29 June 2003. Southampton, United Kingdom.

Maritime Labor Convention 2006, ILO, (2006).

Smith, A.P. (2007). Adequate crewing and Seafarers' fatigue: The International Perspective. Retrieved June 1, 2018 from: https://orca-mwe.cf.ac.uk/.../ITF%20FATIGUE%20REPORT%20final.pdf

Smith, A.P. (2007). Seafarer fatigue where next?. Retrieved June 1, 2018 from: www.nautinst.org/filemanager/.../fatigue.../itf_-_fatigue_where_next.pdf

Strauch, B. (2015). Investigating fatigue in marine accident investigations. Retrieved 14 April,2018 from: https://www.sciencedirect.com/science/article/pii/S2351978915008604

The International Convention on Standards of Training, Certification and Watchkeeping for Seafarers (STCW), and the STCW Code (the 2016 edition), IMO, (2016).

Takala, J. (1999). Global Estimates of Occupational Accidents. Retrieved 14 April,2018 from: www.who.int/quantifying_ehimpacts/methods/en/takala.pdf

Warsash Maritime Academy. (2009). Horizon Research Project. Retrieved 2 February, 2018 from: https://www.warsashacademy.co.uk/about/resources/final- horizon-report-final-as-printed.pdf?t=1529848062455

West of England. (2011). STCW - Manila Amendments to the STCW Convention and Code. Retrieved April 18, 2018 from: https://www.westpandi.com/Publications/News/Archive/STCW---Manila-Amendments-to-the-STCW-Convention-and-Code/

Working Time Directive 2003, European Commission, (2003).

Appendix

Appendix A; Questionnaire for research survey

Section 1; General question.

1.1 What is your current occupation on maritime industry ?

□ Deck officer

□ Engine officer

□ Operator in relevant field to maritime industry (Pilot, Tug master,..)

□ Student in maritime university

2. What is your latest ranking onboard ?

□ Rating (AB, Oiler, Bosun, Wiper, OS, Deck boy)

□ Operational level (Jr./Off, 3/Off, 2/Off, 4/Eng, 3/Eng)

□ Management level (Master, Ch/Off, 2/Eng, Ch/Eng)

□ Student / Cadet

3. What type of cargo ship you have been working in?

□ Container

□ Tanker (Oil, Gas, Chemical)

□ Bulk carrier

□ General cargo

□ Ro/Ro

4. How long have you been working onboard?

□ Less than a year

□ 1 - 2 years

□ 3 - 5 years

□ More than 5 years

5. Have you ever heard word "FATIGUE" before?

□Yes, I have

□ No, I have not

Section 2; Fatigue onboard

1. Have you ever learned or are taught on Fatigue before?

□ Yes, I have

□ No, I have not

2. According to MLC, how many hours of rest in minimum per week ?

□ 56 Hours

□ 70 Hours

□ 77 Hours

□ 84 Hours

□ I do not know

3. Practically, your rest-hours are strictly followed MLC regulation or not?

□ Greater than MLC standard

□ Little more than MLC standard

□ Equal to MLC standard

□ Little less than MLC standard

□ Much less than MLC standard

4. Which item is the most influence to fatigue - in crew specific area?

□ Sleep and Rest

□ Health

□ Stress

□ Ingested Chemicals

□ Age

□ Workload

5. Which item is the most influence to fatigue - in management Factors?

□ Organizational Factors Onboard-Ashore

□ Voyage and Scheduling Factors

6. Which item is the most influence to fatigue - in ship-specific Factors?

□ Ship design

□ Level of Automation

□ Equipment reliability

□ Age of vessel

7. Which item is the most influence to fatigue - in environmental Factors?

□ Temperature

□ Humidity

□ Excessive noise levels

□ Sea condition

8. From question number 2.4 - 2.7, which factor is influence to Fatigue the most?

□ Crew-specific factor

□ Management factor onboard and ashore

□ Ship-specific factor

□ Environmental factor

9. Quality and quantity of sleep are influence to fatigue level?

□ Least

□ Less

□ Moderate

□ Much

□ Greater

10. Do you feel sleepy during a day watch?

□ Least

□ Less

□ Moderate

□ Much

□ Greater

11. Do you feel sleepy during a night watch?

□ Least

□ Less

□ Moderate

□ Much

□ Greater

12. Do your motivation level will decrease depend on time spend onboard?

□ Yes

□ No

□ Not so sure

13. How long working time spends onboard with significantly reduce your motivation?

□ 1 – 3 Months

□ 4 – 6 Months

□ 7 – 9 Months

□ 10 – 12 Months

14. How long for recover fatigue after end of voyage?

□ Less than 6 hours

□ 6 – 12 Hours

□ 13 – 18 Hours

□ More than 24 Hours

Section 3; Fatigue during ship operation

1. Do you frequently sleepy during cargo operation?

□ Least

□ Less

□ Moderate

□ Much

□ Greater

2. Is working in 6/6 system make you feel fatigue more than 4/8 system?

□ Yes

□ No

□ Not so sure

3. Have you ever fatigue during working on 6/6 system?

□ Least

□ Less

□ Moderate

□ Much

□ Greater

4. Which ship operation period influencing fatigue the most?

□ During ship on sea passage

□ During berthing

□ During cargo operation

□ Pre-departure

□ Anchoring

5. What is the accuracy of work - rest period report recording onboard?

□ Least

□ Less

□ Moderate

□ Much

□ Greater

6. Do you think that fatigue effect to working performance?

□ Least

□ Less

□ Moderate

□ Much

□ Greater

7. Have you ever requesting to do job while you are in rest period?

□ Least

□ Less

□ Moderate

□ Much

□ Greater

8. Have you ever have an accident or near miss situation cause by fatigue?

□ Least

□ Less

□ Moderate

□ Much

□ Greater

Section 4; Need of fatigue course

1. Should seafarer learned about fatigue and dangerous from fatigue

□ Yes

□ No

2. What is the proper time to teach fatigue course?

□ Half a day, 3 Hours

□ A whole day

□ Depend on contents

3. Should Fatigue course be in a mandatory course or additional course?

□ Mandatory course

□ Additional course

4. Which contents are you want to be in a course?

□ What is fatigue

□ Factors influence fatigue

□ Studies about fatigue

□ Case study

□ Accident related to fatigue

□ Law and conventions

□ Mitigation of fatigue