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CONTENTS

APPLICATION OF *POWERINT IP EXPERT* SOFTWARE IN SHIP LED LIGHTING SYSTEMS DESIGN

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The LED technology is applicable for the ships' navigation and signalling lights, including sidelights, stern light, anchor light, manoeuvring lights and warning signals, ensuring high-reliability, low-maintenance and reduced electrical-load-power requirements, resulting in low through-life costs. The lights meet the Colregs (International Regulations for Preventing Collisions at Sea), which means they are suitable for night operations.
Our paper analyzes the application of *Powerint IP Expert* software in the design of ship lighting systems with LEDs.

Keywords: LED, ship lights, *Powerint IP Expert* software

1. INTRODUCTION

The application of LED light sources in the ships is significantly limited due the established traditions, especially in the systems for general lighting. The rapid penetration of these sources in the 90th years in the control and signalization systems was followed by long periods of stagnation. When we consider the development of these sources and their growing use in different applications in coastal conditions we can conclude that there is wide scope for their deployment on ships.

Marine lighting consumes a large part of the electricity of the ship and is regulated by the International Convention for the Safety of Life at Sea (SOLAS) [1] and the requirements of the marine classification_societies. According to these requirements, the lighting of the ship is divided into normal, emergency, temporary, signalling and navigation lights, floodlights for search and rescue and others. The normal lighting should provide a sufficient number of lightings for providing good level of illumination for all parts of the ship.

According to Bulgarian Register of Shipping a sufficient number of lighting fixtures shall be provided to achieve a good level of illumination [2]. It is powered by the main sources of electricity and illuminate all areas accessible to passengers and crew.

The main sources of energy are with enough power, allowing installation of all types of lighting. This lighting for the most part is supplied with a voltage of 220 V. As light sources are mainly used fluorescent lamps with an efficiency of 60 Lm/W (lumens per watt), which replace traditional incandescent bulbs in almost newly built ships.

For areas where there are bare rotating parts is required to implement measures to prevent stroboscopic effect such as the combination of fluorescent lamps with incandescent bulbs or LEDs. For some tankers and ships built in the U.S. and Japan the grid in residential areas and the main lighting is with a voltage of 110 V.

The lighting of open decks, holds and other spacious premises the use of floodlights with discharge lamps. The discharge lighting lamps are powered also with 220 V although starting them may need a higher voltage. All transformers and actuators on the requirement of classification societies must remain sealed in the lamp shell. These light sources have a large light efficiency - 100-180 Lm/W, but distort color light.

To illuminate the wet areas like bathrooms, the Bulgarian Register of Shipping [2] has special requirements, such as the most dangerous part of the area requires the safe low voltage up to 12 V (Safety Extralow Voltage - SELV) – Figure 1.

The application of LED light sources may be of greater efficiency in emergency lighting, and especially in emergency lighting powered by rechargeable batteries.

The emergency source of electrical power should provide power for emergency lighting for 36 hours on passenger ships and 18 hours on merchant ships (rules 42 and 43 of SOLAS). If this source is a generator powered by internal combustion engines, it should run automatically and takes 45 seconds to load. When his starting is with a longer duration it is necessary to have transitional source - rechargeable battery that provides power for emergency lighting for half an hour.

Rule 42-1 of SOLAS requires additional emergency lighting for Ro-Ro passenger ships such as all passenger public spaces and corridors must be secured with additional electric lighting, which can run at least three hours when all other sources of energy are damaged and in heel. The insured lighting must be such that access to evacuation routes should be clearly visible.
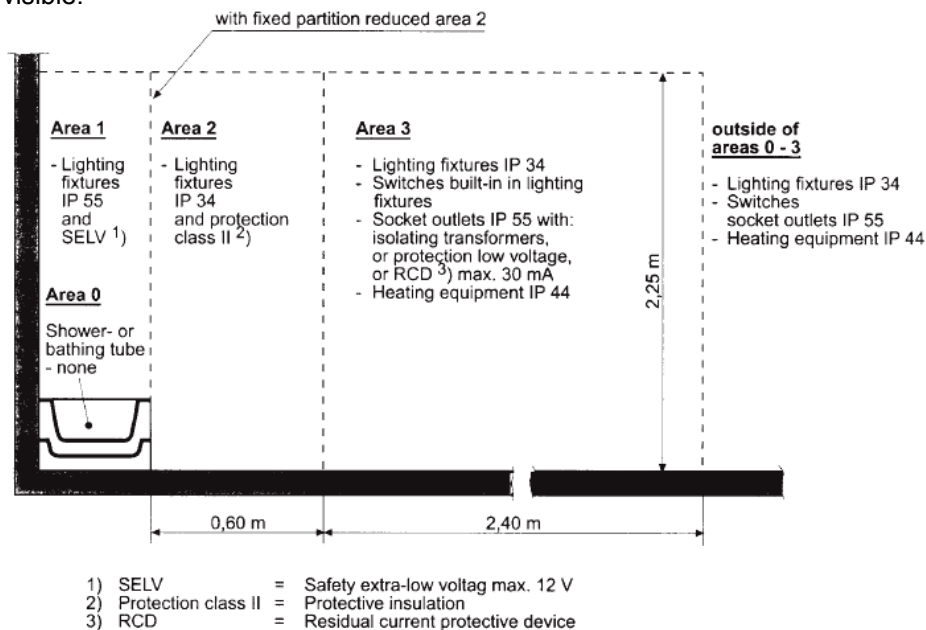
Fig. 1 Ilustration of the special requirements of the Bulgarian Register of Shipping

The power sources for additional lighting should include rechargeable batteries located in the lighting shells that should be constantly charged, as far as possible from the emergency switchboard. Additional electric lighting should be such that any failure of a lamp to be immediately detected.

According to the Lloyd's Register of Shipping the electrical power available is to be sufficient to supply all those services that are essential for safety in an emergency, due regard being paid to such services as may have to be operated simultaneously. The emergency source of electrical power may be either a generator or an accumulator battery [3].

The need of high power supply for emergency purposes requires the use of batteries in parallel. Damage to a single battery, thus the connection shows a major fault, that all parallel to it began to be diluted.

Another disadvantage of the supply from batteries is the reduce of the supplied voltage as SOLAS and the registry organizations provide this reduction to be up to12%. LED sources are supplied with low voltage and are much less dependent on its variation. This in emergency lighting is their main advantage over fluorescent lamps.

At present there are emergency lights with fluorescent lamps which have rectifier, battery and inverter (transverter) in case of dropout voltage, but the use of LED would increase their effectiveness. The incandescent lamps are about 6 times less efficient than LED, which requires the use of larger batteries. They are strongly influenced by voltage change and reduce it by 12% will lead to a 40% reduction in radiation flux. LED sources are used for illumination of escape routes, the so called Low Location Lighting (LLL).

Under regulations II-2/28 and II-2/41-2 of the 1974 SOLAS Convention, the means of escape, including stairways and exits, must be marked by a low location lighting system at all points along the escape route. Additionally, Regulation II-2/20.2 requires all ships to be provided with fire control plans and these should be permanently stowed in a prominently marked weather tight enclosure and use symbols in accordance with Regulation A.654.

In recent years a very effective photoluminescence materials were developed allowing to fully meet the requirements of the classification societies, which constitute the main competitor of the LED [4]. Another use for LED may be the spotlights for search and rescue mounted on the bridge, on the lifeboat deck and on the lifeboats – Figure 2.

According to the recent reports of U.S. Defense Advanced Research Projects Agency (DARPA) under the HEDLight (High Efficiency Distributed Lighting) program, U.S. Navy ships could save 87 percent of the electricity used on existing lighting systems by converting to LED and HID lighting systems [5]. The savings would add up over the long-term. When an aircraft carrier goes out on deployment, on average, every single one of its 18,000-some light bulbs will need to be replaced.

According to DARPA, HEDLight remote source lighting relies on centralized light generation, optically transporting the light where it's needed. The system allows the lighting system electrical circuitry and wiring to be concentrated, protected, and removed to the interior of the warship. The highly efficient metal halide high intensity discharge (HID) and light emitting diode (LED) lights are coupled to large core plastic optical fiber.
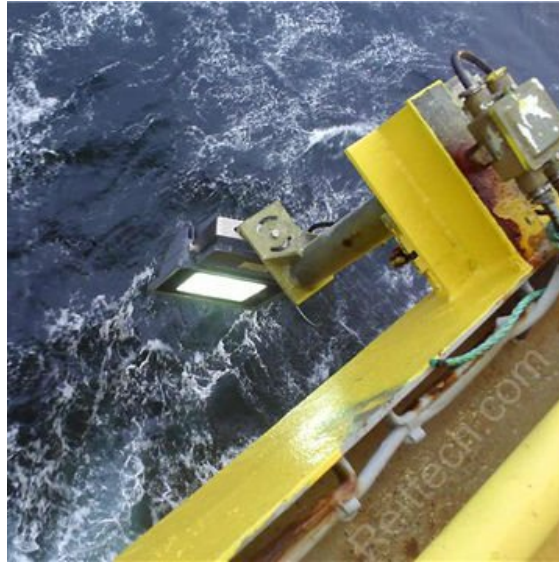
Fig. 2 ReitTech LED floodlight on ship

2. HELD EXPERIMENTS

The paper analyzes the application of software *IP Expert* [6] in the design of marine lighting systems with LEDs. The products of the same manufacturer (*Powerint*) are oriented to power sources and our aim was to examine their application in the shipping problems.

The experimental studies were carried out by the reconstruction of the lighting system of the ship, consisting in replacing incandescent lamps with LED matrix.

Several circuit solutions have been implemented through each of the technologies offered by *Powerint* - DPA, LinkSwitch, PeakSwitch, TinySwitch and TOPSwitch [6], using the generated by *IP Expert* topography of the scheme:

- **Figure 3.** AC-DC converter implemented with a series DPA426PN.÷ DPA422PN. The scheme is designed to operate with input voltages in the range 85÷265V, which should ensure a wide margin of variation of voltage. Experimental studies have been made using LED matrix arrays for illumination of passageways, stairways, traps, etc.
- **Figure 4.** AC-DC converter implemented with a series LNK364PN.÷ LNK362PN. The source consists of multiple output power supply LED matrix arrays for illumination and signaling.
- **Figure 5.** DC-DC converter implemented with a series TOP261YN.÷ TOP254YN. Experiments were conducted in powering LED lights from rechargeable batteries.
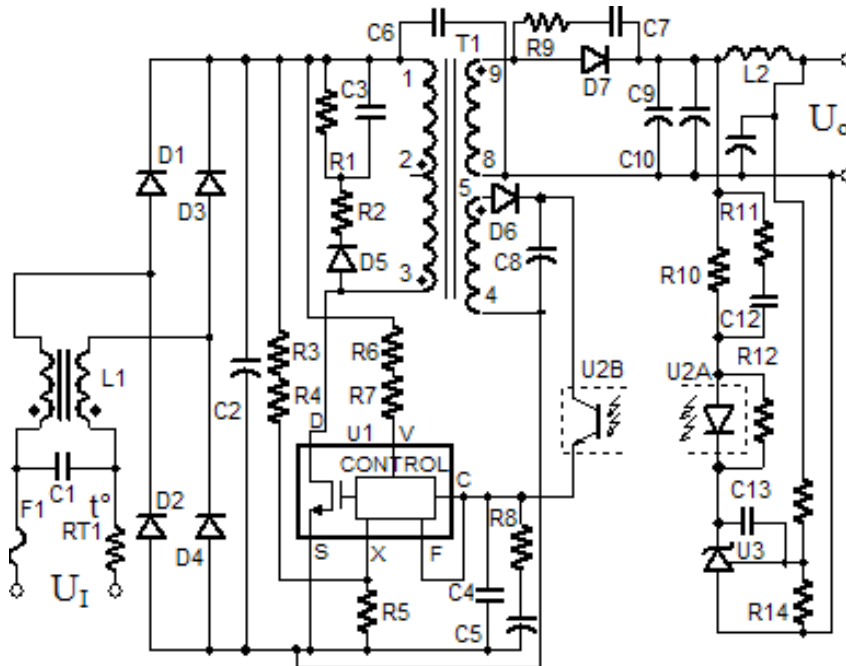
Fig. 3 AC-DC converter, realized with TOP254YN
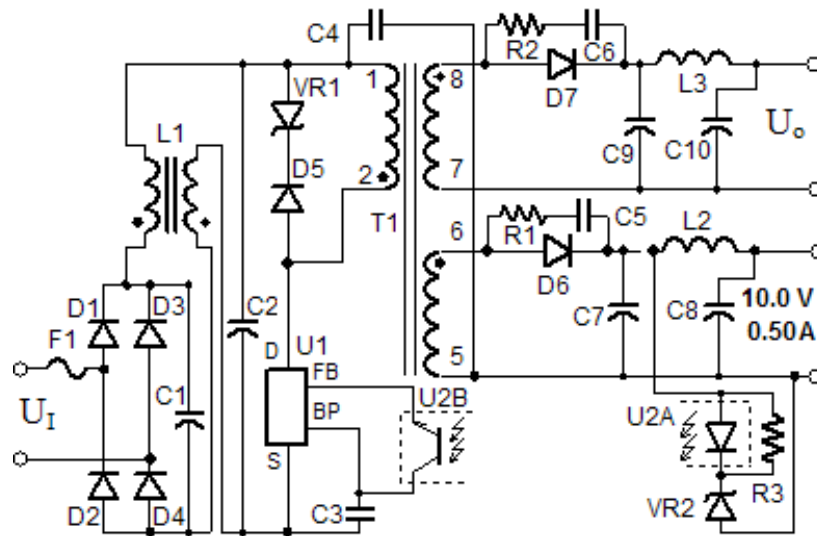
Fig. 4 AC-DC converter with two outputs, realized with LNK364PN
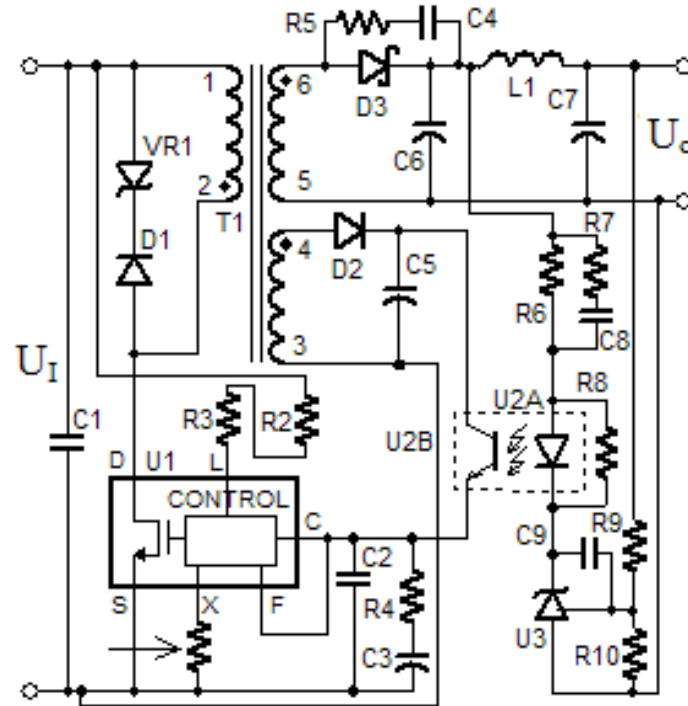
Fig. 5 DC-DC converter, realized with DPA424PN

The results of experimental studies can be summarized as follows

- **Figure 6.** Efficiency ratio η and output current Io [A] at different input voltages Ui [V] AC: 1–Ui=85V; 2–Ui=220V; 3–Ui=250V. In this case the nominal current of the scheme is 1A. The study shows that the efficiency is stable in the range 50÷100% load.
- **Figure 7.** Correlation between output power Po [W] and the input voltage Ui [V] AC, at different input power: Pi[W]: 1–Pi[W]=4W; 2–Pi[W]=3W; 3–Pi[W]=2W. The graphs show that the schemes of *Powerint* have stable work under a wide range of supply voltages.
- **Figure 8.** Temperature as a function of input voltage: 1 - TOP243P; 2 - transformer, 3 - output capacitor, 4 - ambient temperature. Temperature tests are averaged for the testing of several schemes solutions. They were made at maximum temperatures of 40°C and display the extreme limit values.
- **Figure 9.** Pattern of the output current depending on input voltage: 1-matrix with 110 LED; 2 - matrix of 130 LED. The experiment was made with an output current up to 3.5 A, powering LED matrix arrays with 110 and 130 LEDs and rated current of 20 mA.

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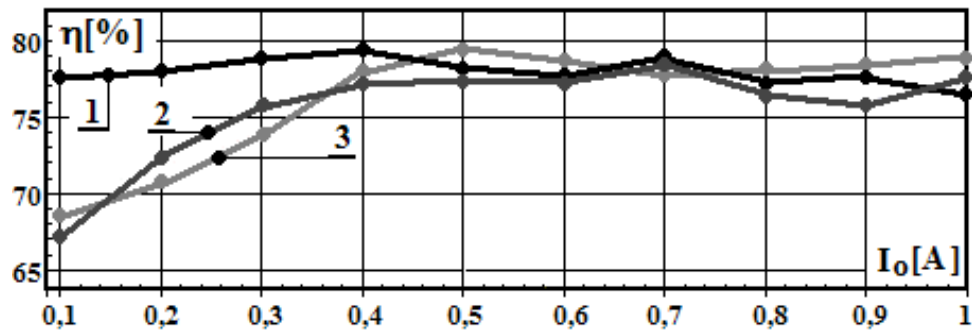
**Fig. 6 Efficiency ratio η and output current Io [A] at different input voltages Ui [V]
AC:1–Ui=85V; 2–Ui=220V; 3–Ui=250V**
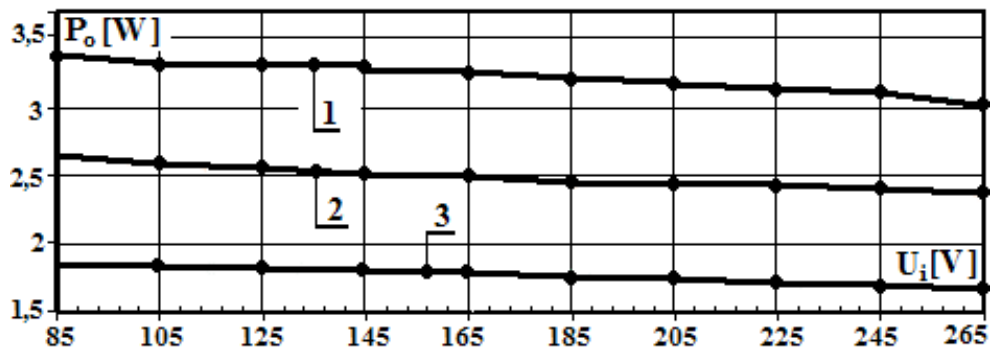
**Fig. 7 Correlation between output power Po [W] and the input voltage Ui [V] AC, at
different input power: Pi[W]: 1–Pi[W]=4W; 2–Pi[W]=3W; 3–Pi[W]=2W**
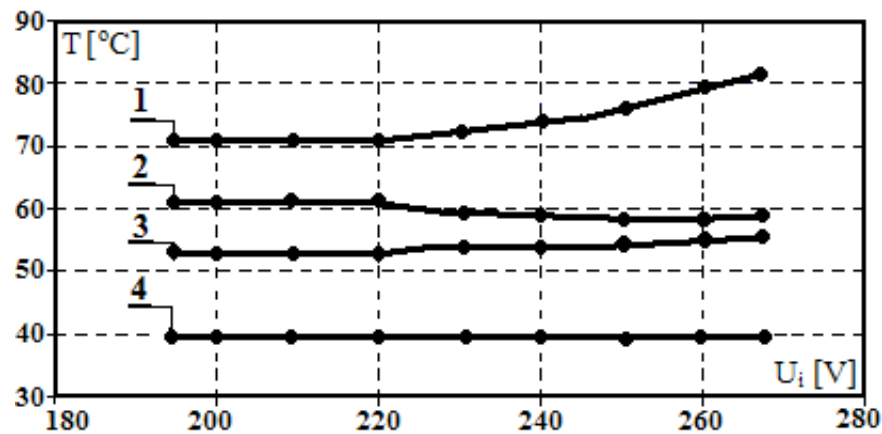
**Fig. 8 Temperature as a function of input voltage: 1 - TOP243P; 2 - transformer,
3 - output capacitor, 4 - ambient temperature**
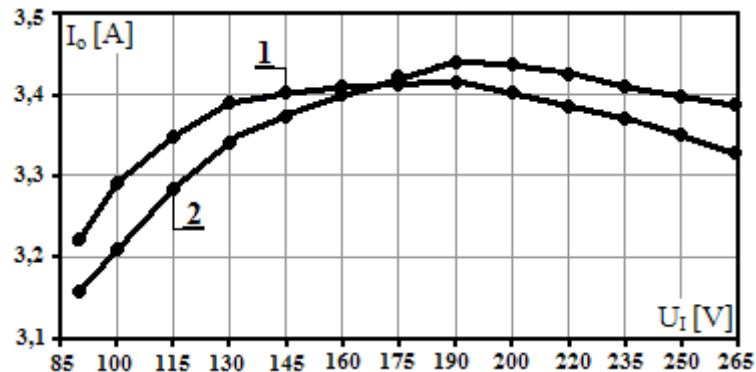
Fig. 9 Pattern of the output current depending on input voltage: 1-matrix with 110 LEDs; 2 - matrix of 130 LEDs

3. CONCLUSIONS

From the research can be deduced the following important conclusions:

- *Powerint* surveyed controllers are applicable to developing circuit solutions for ship lighting.
- The schemes provide an opportunity to supply a wide range of input voltages and stability of baseline characteristics. This is achieved by the introduced optical feedback.
- *IP Expert* software provides topography of the scheme directly applicable to the research problems and does not require any modification.

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IMPROVEMENT OF THE CONTACT RIVETS DURABILITY OF SHIPS' ELECTRICAL APPARATUS BY USE OF MULTILAYER TITANIUM NITRIDE COATINGS

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Requirements to the materials for electrical contacts are increased due to high loads and high operating temperatures. Often conventional single-layer coatings of electrical contacts can not meet these requirements. Using multilayer coatings allows the requirements to the contacts to be complied and also to control structure (internal stresses and elastic behavior of the material), and therefore to control the properties of coatings. Particularly hard, wearing and corrosion resistant are coatings of titanium nitride TiN type.

By simultaneous and coherent operation of two types of plasmatrons – Electric Arc Plasmatron (ARC) and magnetron (MS - Magnetron Sputtering) we have experimented the following three types of coatings on electrical contacts of contactor K6E: Monolayer coating of titanium Ti; Double layer coating of titanium - titanium nitride, Ti/TiN; Triple layer coating of titanium-titanium nitride-titanium Ti/TiN/Ti.

Coating is done in combination of the following factors: thickness of the coating and composition of the gas environment in the vacuum chamber, in which they are implemented and tested 10 different modes of coating.

It has been observed that modification of the interface by the formation of the surface layer can lead to increase of the electrical contact durability

Keywords: multilayer coatings, contact rivets of electrical apparatus

1. INTRODUCTION

Electrical contacts are used in a large number of industrial applications, this includes all sorts of modern transportation including ships. Mechanical assemblies are subjected to vibrations and micro-displacements between mating surfaces are observed leading to fretting wear. Mechanical degradation can additionally be accelerated by a corrosive factor caused by variable humidity, temperature and corrosive gas attack. Fretting-corrosion leads to an increase of contact resistance or intermittent contact resistance faults as corrosion products change the nature of the interface primary through a range of film formation processes.

Electrical contact terminals used in the electrical apparatus must be good electrical conductors, highly reliable under repeated use, and at the same time be resistant to corrosion or oxidation. Traditionally the contact bodies of the electrical contacts are made from pure metals, metal alloys and ceramics [1]. Often the contact bodies are silver plated. Silver has high electrical and thermal conductivity, but lower hardness and wear resistance. A disadvantage of known contact bodies of electrical contacts is their low electrical and mechanical ruggedness.

On the other hand in recent years endurance coatings of the type (Ti,Me)N and (Ti,Me)C pass from single layer to multilayer. Moreover, their characteristics, such as hardness and corrosion resistance are increasing [2],[3],[4]. Interesting are nano-structured coatings with thickness 2-10 nm and the so-called superlattices.

Multilayer nanostructured coating with thickness of the individual layer in the range of lattice sizes - from 2 to 5 nm is considered to be completely new material called superlattice [5]. These are nanocrystalline materials with grain size about 10 nm and completely new properties. Coatings of carbide and nitride superlattices are superhard materials with radical changes in both electrical and thermal and mechanical properties. By varying the thickness of the layers of the superlattices, their number and the materials used we can consciously modify the properties of the obtained materials.

Nanostructured coatings consist of at least two phases, most often a crystal and an amorphous. Physical and performance properties of the working surfaces can be secured by deposition of coatings for improving hardness, wear resistance, electrical conductivity, etc.[6],[7],[8],[9],[10],[11].

To obtain a coating with desired properties major role have the method and the parameters of the deposition of the coating. They define the structure and the properties, and the relation coating - pad. For application of nitride and carbide coatings on titanium and chrome base the most promising appear to be electric arc and magnetron source of vapor.

The purpose of this paper is to adopt the technology and the application of single layer and multilayer coatings of titanium nitride with electric arc evaporator and magnetron source of vapor on contact bodies of electrical contacts, thereby creating a contact rivet body with increased rigidity and durability in high electrical and thermal conductivity.

2. HELD EXPERIMENTS

Experiments were held in a vacuum system facility at the University of Rousse "A. Kanchev". The facility provides vacuum to approximately 2.10^{-3} Pa. General view of the magnetron and arc evaporation engine, which were performed the experiments is shown in Fig. 1.

Fig. 1 General view of the engine, used for the deposition of Ti/TiN nanostructured coatings on rivets of electrical contacts

Scheme of the working chamber is shown in Figure 2. The engine for coating is composed of magnetron source of vapor 1 arc evaporator 2 stand 4 which have different configurations depending on the experiment. Samples 3 are hung on the stand.
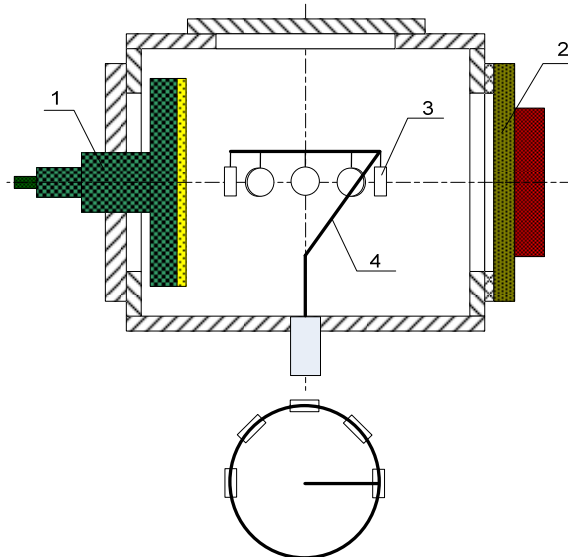
Fig. 2 Scheme of the working chamber of the engine for coating.
1 - magnetron source of vapor, 2 - arc evaporator, 3 – experimental samples, 4 - stand

The contact body made of pure metal in a vacuum chamber is coated with nanostructured multilayer coating by arc evaporation and magnetron sputtering in a combination of both methods. The aim is to achieve a high microhardness of the surface of the contact body, due to the specific physical properties of the nanostructured layers. Practical aggravation of electrical and thermal conductivity can be ignored due to the negligible thickness of the coating.

The following three types of coatings were deposited on electrical rivets of contactor K6E:
• Monolayer coating of titanium Ti;
• Double layer coating of titanium nitride, titanium Ti/TiN;
• Triple-layer coating of titanium-titanium nitride-titanium Ti/TiN/Ti.
Coating is done by combining the following factors:
• Total thickness of the coating, with two levels: 100 nanometers and 200 nanometers;
• Composition of the gas environment in the chamber, with three levels: pure argon Ar, pure nitrogen N_2 and mixture of 50% nitrogen N_2 and 50% argon Ar.
Ten different regimes of deposition were experimented - Table 1.

Fig. 3 presents a partial section of the contact body of the contactor K6E. According to the figure on the conductive plate 1 of the contact is attached the contact body 2 of solid material - an alloy of silver. In a vacuum chamber by arc evaporation on the contact body 2 was deposited a triple layer of nanostructured coating 3 of Ti/TiN/Ti. The deposition of layers of Ti was carried out in inert gas Ar and the deposition of TiN layer in an environment of N_2. The thickness of each layer is up to 100 nanometers and selected in accordance with the desired microhardness on the surface of the contact body.

Fig. 4 presents a general view of electrical contact with deposited nanostructured multilayer coating on the contact body.

Table 1: **Basic parameters of the implemented regimes of deposition of Ti/TiN nanostructured coatings on contact rivets**

Regimes	Types of coatings	Composition of the gas environment in the chamber	Total thickness of the coating, nm
Regime 1	Ti	Ti-100% Ar	123
Regime 2	Ti	Ti-100% Ar	252
Regime 3	Ti/TiN	Ti-100% Ar, TiN-50% Ar +50% N_2	110
Regime 4	Ti/TiN	Ti-100% Ar, TiN-50% Ar +50% N_2	202
Regime 5	Ti/TiN	Ti-100% Ar, TiN-100% N_2	118
Regime 6	Ti/TiN	Ti-100% Ar, TiN-100% N_2	212
Regime 7	Ti/TiN/Ti	Ti-100% Ar, TiN-50% Ar +50% N_2, Ti-100% Ar	124
Regime 8	Ti/TiN/Ti	Ti-100% Ar, TiN-50% Ar +50% N_2, Ti-100% Ar	222
Regime 9	Ti/TiN/Ti	Ti-100% Ar, TiN-100% N_2, Ti-100% Ar	122
Regime 10	Ti/TiN/Ti	Ti-100% Ar, TiN-100% N_2, Ti-100% Ar	210

The durability tests are conducted in the laboratory facilities at the Technical University of Varna. Laboratory setting and methodology for experimental investigation of the durability of the contact bodies of electrical apparatus are developed. The methodology is in accordance with the standarts BS EN 60947-4 and IEC 60947-4-1:2009.
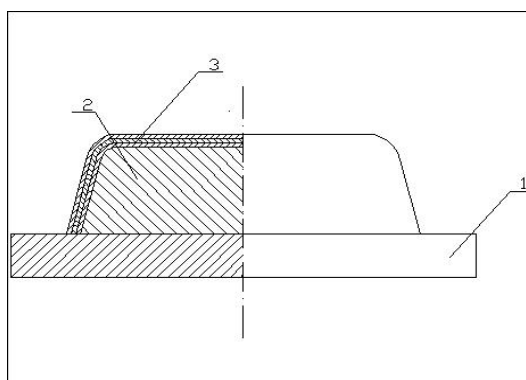
Fig. 3 Partial section of the contact body of the contactor K6E. 1 - conductive plate, 2 - contact body of solid material - an alloy of silver, 3 - triple layer of nanostructured coating of Ti/TiN/Ti

Fig. 4 General view of electrical contact with nanostructured multilayer coating on the contact body. 1 - conductive plate, 2,3 - contact body with the nanostructured coating

To perform the required number of switching cycles the scheme shown in Fig. 5 is used, and the contactor's rated values of current and voltage are applied.
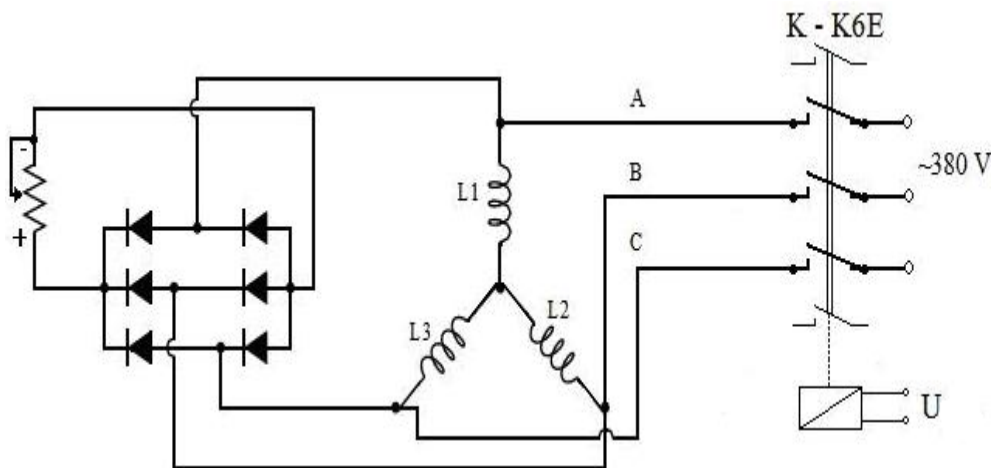
Fig. 5 Durability testing scheme and wiring diagram.

The control of the contactor's testing regime is made using computer software and special control device through computer LPT port.

To measure the weight of the contacts before and after the set number of commutations highly accurate analytical balance with accuracy of 0.0001 grams is used.

The test results are shown in Table 2 and graphically in Figs. 6, 7 and 8.
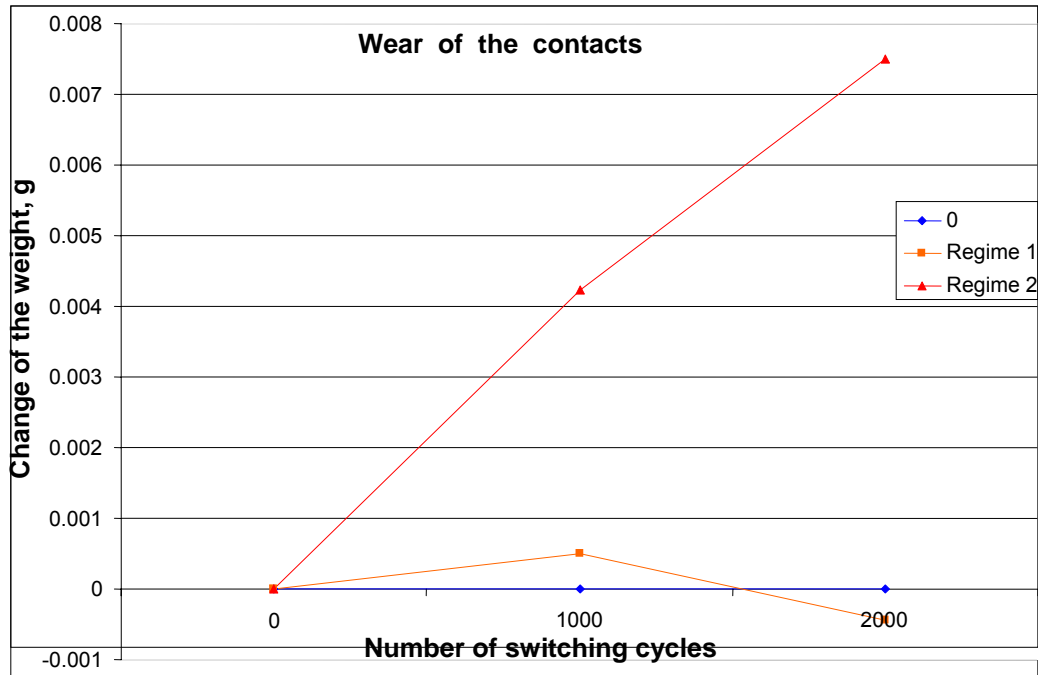
Fig. 6 Wear of contact bodies with deposited Ti coatings, normalized to the wear of non-coated contact bodies
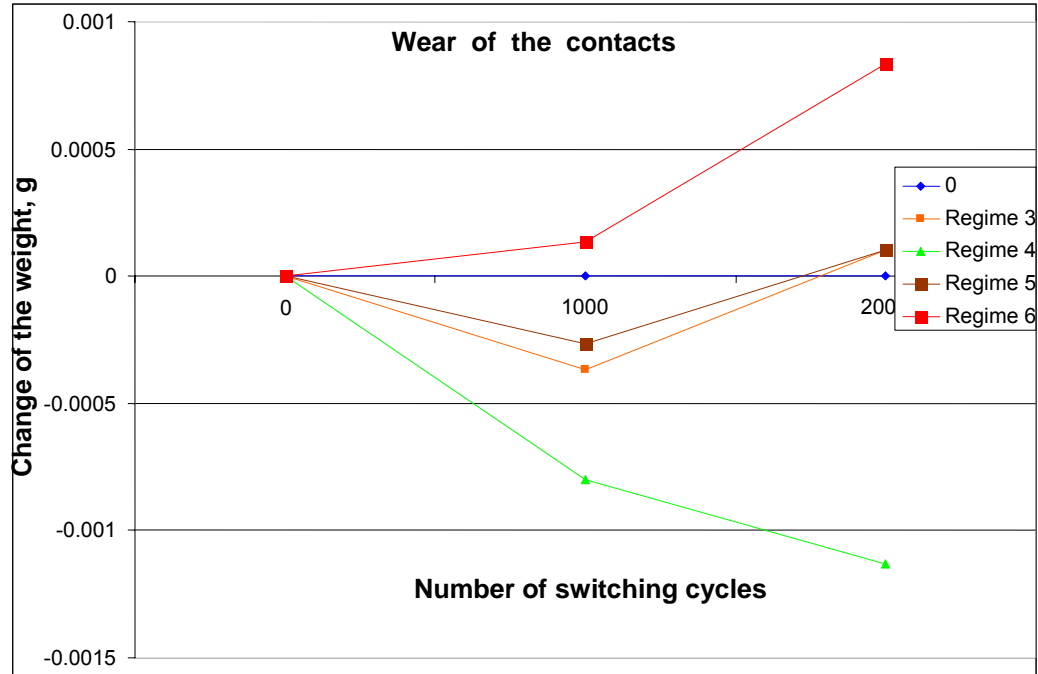
Fig. 7 Wear of contact bodies with deposited Ti/TiN coatings, normalized to the wear of non-coated contact bodies

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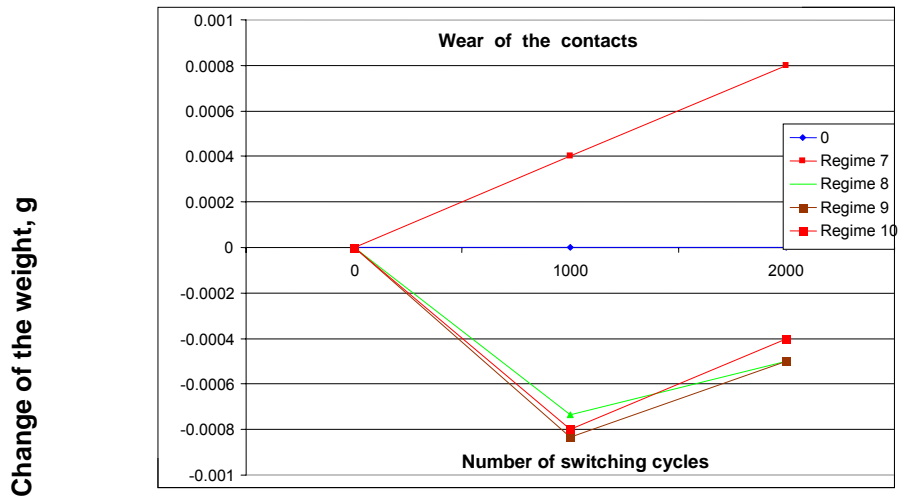
Fig. 8 Wear of contact bodies with deposited Ti/TiN/Ti coatings, normalized to the wear of non-coated contact bodies

The designations in Figs. 6, 7 and 8 correspond to the regimes of deposition of coatings listed in Table 2.

The "0" means the wear of non-coated contact bodies.

***Table 2:* Durability testing results**

Regimes	Change of the weight of the contacts after the following number of switching cycles in grams		
	0	**1000**	**2000**
0	0	0.001067	0.001733
Regime 1	0	0.000500	-0.000433
Regime 2	0	0.004233	0.007500
Regime 3	0	-0.000367	0.000100
Regime 4	0	-0.000800	-0.001133
Regime 5	0	-0.000267	0.000100
Regime 6	0	0.000133	0.000833
Regime 7	0	0.000400	0.000800
Regime 8	0	-0.000733	-0.000500
Regime 9	0	-0.000833	-0.000500
Regime 10	0	-0.000800	-0.000400

The results in Table 2 are normalized to the wear of non-coated contact bodies.

The wear of each regime is normalized as resulting from the wear of the corresponding regime the wear of the non-coated contact is subtracted.

Minus sign means that the wear is less than that of the non-coated contact body.

In experiments to obtain more reliable data specially developed procedure involving the reporting of the environmental parameters, such as temperature and humidity is applied, and

reference standartized weight (in the range of the contact body weight) before each weighing is used.

3. CONCLUSIONS

1. New technology is adopted for deposition of monolayer and multilayer coatings of titanium nitride with electric evaporator and magnetron source of vapor on contact bodies of electrical apparatus.

2. The resulting contact bodies can be applied as a direct substitute for conventional contact bodies of electrical contacts in electrical apparatus.

3. Special methodology is developed and a laboratory stand testing the electrical and the mechanical endurance of the received contacts of electrical apparatus is established and the test results will be presented in a separate article by the authors.

4. Special methodology is developed and a laboratory stand recording with digital oscilloscope the burning of the electric arc in switching contacts of electric apparatus is established and the test results will be presented in a separate article by the authors.

5. The resulting contact rivets of electrical apparatus are claimed as a patent for utility model at the Patent Office of Bulgaria- Patent reg. № 1879/4.11.2010 - BG.

From the durability tests can be conducted the following conclusions:

1. The pure Ti coating deteriorates the wear resistance of the contact bodies for any given thickness of the coating and the ambient gas in the chamber for coating. It is therefore not appropriate to use.

2. Superlattices of double layer and three-layer nanostructured coatings of Ti/TiN and Ti/TiN/Ti significantly improve the durability of the contact bodies of electrical contacts. Best results are achieved in atmosphere in the chamber for coating Ti-100% Ar, TiN-50% Ar +50% N2.

3. Experiments with nanostructured coatings with a greater number of layers in the superlattice are sheduled.

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GENERATION OF PSEUDORANDOM NUMBERS WITH VERY LONG PERIOD BASED ON FAREY SEQUENCES

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A theoretical and experimental investigation of a generator of pseudorandome sequences is described in this paper. The generator consists of shift registers with linear feedback. A number of statistical tests have been used to invastigate the features of this new generator structure.

1. INTRODUCTION

The intensive use of pseudo-random sequences occurs in modern radar [1, 7], navigational aids [6], cryptography [3] and telecommunications [4], but also in sonar systems, geophysics, ect. Hardware for implementation of pseudo-random generators (PN, RNG, PNRG) produces most often sequences with uniform law of distribution. The basic element used in such devices utilises a module, which generates random noise, for example radiotube. This type of devices has a serious problem–how to maintain stable operation.

An alternative solution is to use software PN, in particular those, consisted of shift registers with feedbacks (Linear Feedback Shift Register, LFSR). Because of their simplicity they have wider applications [3, 7], but they also have their shortcomings [3]. The aim of this paper is to investigate the possibility of improving the quality of PN by combining the LFSR with external sources of sequences, thereby seeking to suppress the utmost shortcomings of LFSR. Achieving the goal would make possible a practical realization of generator, which could be experimented in radar systems with continuous transmission, telecommunications, sonars and cryptographic applications.

To achieve this goal the idea of Klapper and Goresky [3] will be modified where an external sequence will be used instead of the memory cell. Using this approach and having in mind the statistical independence of the external bit sequense and the register sequence we seek greater accident of the output bit stream. One of the most appropriate sequences that can be used in this case is Farey fractions (numbers).

2. CHARACTERISTICS OF FAREY NUMBERS

Sequence of Farey F_n of order n is a set of irreducible corrected rational fractions a / b, belonging to the interval [0, 1], and order of growth [9, 10].

Table 1 shows Faray sequences of order 1 to 8.

Table 1

$F_1 = \{{}^0\!/_1,\ {}^1\!/_1\}$
$F_2 = \{{}^0\!/_1,\ {}^1\!/_2,\ {}^1\!/_1\}$
$F_3 = \{{}^0\!/_1,\ {}^1\!/_3,\ {}^1\!/_2,\ {}^2\!/_3,\ {}^1\!/_1\}$
$F_4 = \{{}^0\!/_1,\ {}^1\!/_4,\ {}^1\!/_3,\ {}^1\!/_2,\ {}^2\!/_3,\ {}^3\!/_4,\ {}^1\!/_1\}$
$F_5 = \{{}^0\!/_1,\ {}^1\!/_5,\ {}^1\!/_4,\ {}^1\!/_3,\ {}^2\!/_5,\ {}^1\!/_2,\ {}^3\!/_5,\ {}^2\!/_3,\ {}^3\!/_4,\ {}^4\!/_5,\ {}^1\!/_1\}$
$F_6 = \{{}^0\!/_1,\ {}^1\!/_6,\ {}^1\!/_5,\ {}^1\!/_4,\ {}^1\!/_3,\ {}^2\!/_5,\ {}^1\!/_2,\ {}^3\!/_5,\ {}^2\!/_3,\ {}^3\!/_4,\ {}^4\!/_5,\ {}^5\!/_6,\ {}^1\!/_1\}$
$F_7 = \{{}^0\!/_1,\ {}^1\!/_7,\ {}^1\!/_6,\ {}^1\!/_5,\ {}^1\!/_4,\ {}^2\!/_7,\ {}^1\!/_3,\ {}^2\!/_5,\ {}^3\!/_7,\ {}^1\!/_2,\ {}^4\!/_7,\ {}^3\!/_5,\ {}^2\!/_3,\ {}^5\!/_7,\ {}^3\!/_4,\ {}^4\!/_5,\ {}^5\!/_6,\ {}^6\!/_7,\ {}^1\!/_1\}$
$F_8 = \{{}^0\!/_1,\ {}^1\!/_8,\ {}^1\!/_7,\ {}^1\!/_6,\ {}^1\!/_5,\ {}^1\!/_4,\ {}^2\!/_7,\ {}^1\!/_3,\ {}^3\!/_8,\ {}^2\!/_5,\ {}^3\!/_7,\ {}^1\!/_2,\ {}^4\!/_7,\ {}^3\!/_5,\ {}^5\!/_8,\ {}^2\!/_3,\ {}^5\!/_7,\ {}^3\!/_4,\ {}^4\!/_5,\ {}^5\!/_6,\ {}^6\!/_7,\ {}^7\!/_8,\ {}^1\!/_1\}$

Length of Faray sequences of order n tends asymptotically to [9, 10] :

$$|F_n| \approx \frac{3.n^2}{\pi^2}$$

It is obviouse that $|F_n| \to \infty$, when $n \to \infty$. Here we will not dwell on generating of Farey sequences of order n. Some mathematical software tools like Wolfram MATHEMATICA can generate Farey numbers of desirable order, and we will use such software.

Over rational fraction sequences it is necessary to do a transformation to obtain a stream, suitable to be embeded into FPGA or a microcontroller. This transformation gives an extra ability to extend the length on output sequence. Transformation will be shown in the following example.

Consider the sequence F_n, n=4, i.e. $F_4 = \{{}^0\!/_1,\ {}^1\!/_4,\ {}^1\!/_3,\ {}^1\!/_2,\ {}^2\!/_3,\ {}^3\!/_4,\ {}^1\!/_1\}$

1. Arrange the numbers in terms of numerator and denominator, starting from the first fraction: 0, 1, 1, 4, 1, 3, 1, 2, 2, 3, 3, 4, 1, 1.
2. Remove the first number - it is always 0
   1, 1, 4, 1, 3, 1, 2, 2, 3, 3, 4, 1, 1.
3. Replace each numerator with corresponding number of 1 and denominator with corresponding number of 0:

$$\frac{0}{1},\frac{1}{1},\frac{0000}{4},\frac{1}{1},\frac{000}{3},\frac{1}{1},\frac{00}{2},\frac{11}{2},\frac{000}{3},\frac{111}{3},\frac{0000}{4},\frac{1}{1},\frac{0}{1}$$

4. Hence the final binary sequence will be
   01000010001001110000010

This operation increases the length of bit sequence, the span depends on the order of Faray fraction and is difficult to determine.This approach gives a possibility to obtain sequences with very long period.

3. GENERATOR'S BLOCK DIAGRAM

In this study a structure combining the original LFSR and a Faray sequence is proposed. The pseudorandom genarator's block diagram is shown on Figure 1
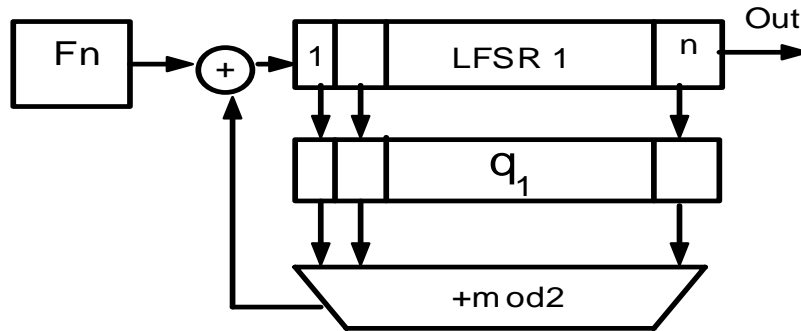
Fig. 1. General block diagram

The diagram consists of a linear feedback shift register LFSR1 with equation on feedback

$$q : x^5 + x^3 + 1$$

and a Faray sequence F_n. Here the memory cell in original diagram on Klapper and Goresky [3] is replaced by the Module F_n.

4. STATISTICAL TESTS OF PROPOSED GENERATOR AND EXPERIMENTAL RESULTS

The generator for pseudo-random sequences proposed above (Figure 1) has been evaluated with various statistical tests. From many different tests the following have been selected:

1. Standard test to check the law of distribution of random variable in MatLAB[5]

The test is conducted by the MatLAB built-in function *runstest (x)*, whose argument *x* is a sequence generated by LFSR [b]. Command for the test is *[h, p] = runstest (x)*. As a result the function *runstest* returns:
- For variable h zero (h = 0) if zero hypothesis H_0 is accepted and for value h = 1, if H_0 is rejected. A random law of distribution is accepted for the zero hypothesis H_0.
- For variable *p* - probability adopting H_0 at the level of significance of 5%.
The test results are as follows:
- input sequences reject H_0 – test results: $H_0 = 1$, P = 3.52740e-010
- output bit stream accept H_0 – test results: $H_0 = 0$, P = 0.1782228

2. Frequency test [2]

This test determines the ratio of zeros and ones generated in order to have approximately equal numbers. The test is conducted by the MatLAB built-in function erfc (x)

[2, 8], where the argument $x = S_{obs}$ is the value of so-called test statistics, expressed by the formula $S_{obs} = |S_n| / \sqrt{2.n}$. The calculation of the value of the test statistics requires preparation of the input data, which consists of the following - all n elements of the sequence is converted using the rule: each generated 1 is replaced with +1 and each 0 with -1. Then the sum of the elements S_n is calculated. Command for the test is *P = erfc (x)*. Calculated test scores are as follows:

- input sequences – P = 5.465e-006
- output sequences – P = 0.02782

To pass the test, P must be great then 0.01 [2]. The results have been interpreted as an assessment of quality of output random sequence.

3. Coherence function

This function is used to assess the maximum similarity of input Faray bit stream and the output sequenses produced by the LFSR. The value of the function depends on the initial state of the register. Experimental resaults are shown in Table 2. Table consists of the values of coherence function for all 31 initial conditions of LFSR. Column P presents *p* value of *[h, p] = runstest (x)* for each initial condition.

The range of values of initial condition depends on the order on feedback equation of LFST. The maximum possible value Q for a register of order N is:

$$Q = 2^N - 1$$

Table 2

Stage	Initial condition	Coherence max	P	Stage	Initial condition	Coherence max	P
1	1	0,939	0,1782	17	17	0,886	0,2202
2	2	0,9477	0,075	18	18	0,9187	0,713
3	3	0,8157	0,189	19	19	0,872	0,7017
4	4	0,8248	0,146	20	20	0,9056	0,8058
5	5	0,9434	1	21	21	0,8527	0,5956
6	6	0,9176	0,0241	22	22	0,9074	0,6768
7	7	0,9127	0,0526	23	23	0,8478	0,7549
8	8	0,9633	0,8451	24	24	0,9656	0,2411
9	9	0,9435	0,2695	25	25	0,8859	0,2728
10	10	0,8842	0,9779	26	26	0,8257	0,339
11	11	0,8901	0,1892	27	27	0,8319	0,0475
12	12	0,8529	0,7315	28	28	0,8504	0,419
13	13	0,9121	0,6114	29	29	0,8934	1
14	14	0,8763	0,1223	30	30	0,8902	0,977
15	15	0,9159	0,4504	31	31	0,8991	0,0567
16	16	0,8658	0,4913				

4. Autocorrelation function

Figure 2 present autocorrelation function of output sequences.
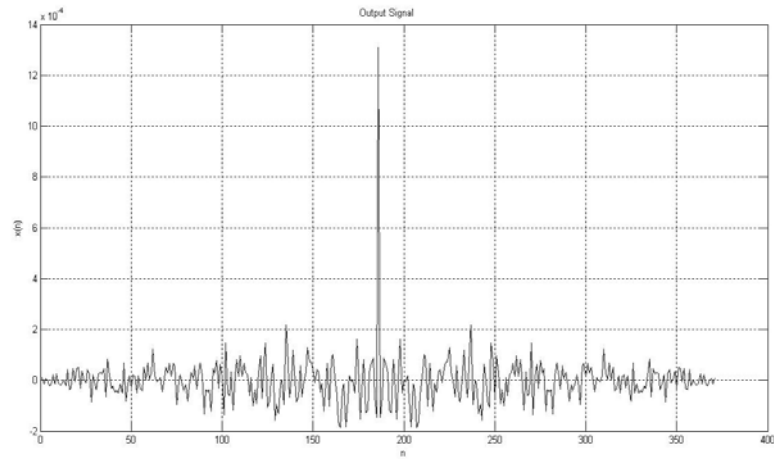
Fig. 2 Autocorrelation function

The shape of this symmetrical function is appropriate for radar systems for example, when two targets are very close each other and must be separated.

5. Practical experiment

Figure 4.5.1 presents a part of pseudo-random signal. Output from LFSR is used for frequency modulationof a carrier signal. Two different frequencies are used for representation of 1 and 0 of a pseudo random sequence. Hardware realization is build by Microchip dsPIC PIC30F4013 using R2R 8-bit DAC. Output signal is buffered. The generator has two outputs, one for modulated signal and another for refference binary modulation signal.
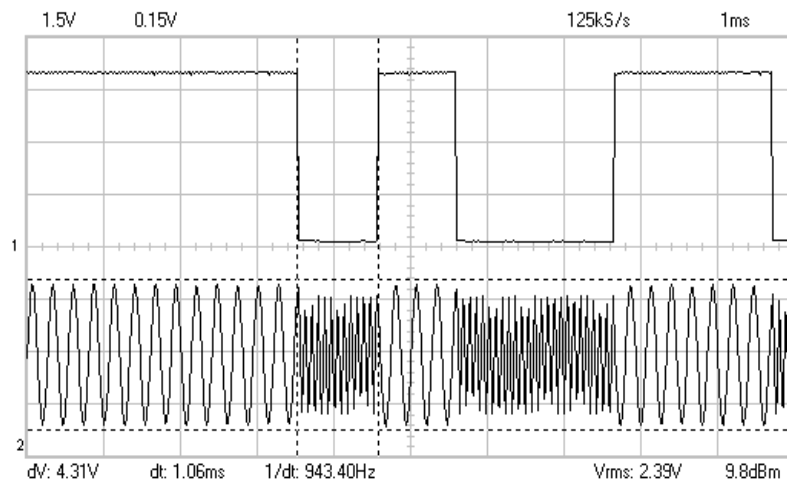
Fig. 3 Experimental results from hardware realization

5. CONCLUSIONS

The experimental results described above give grounds to claim that the synthesized generator does not reject the proposed test criteria for using of these procedures. The approach can be used for testing of the generator by increasing the length of the output sequence (period) and to increase the length of Faray sequences as well.

The approach adopted for this study has a significant dissadvantage - a requirement of computing resources. On the practical side the proposed idea could be carried out by means of programmable logic arrays (FPGA). Using different prime polynomials in the feedback of LFSR the length of random sequences could be extended much more than the register itself can produce. This approach gives potential to obtain sequences with very long period.

Future researches will be directed to implement this idea in FPGA and also to a theoretical survey of the generator using abstract mathematics approaches.

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AN ANALYSIS ON CAREER PATH OF TURKISH OFFICERS

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Nowadays, the volume of maritime trades and number of ships are increasing in the world. Therefore, the demand for qualified seafarers has increased in parallel with this volume. This study aims at forming a career path map on Ocean Going Officers who graduated from Dokuz Eylül University (DEU), Maritime Faculty (MF) Marine Transportation Engineering Department (MTED) between 1999-2008. Furthermore, it analyzes the reasons for choosing the sea initially, the factors which affect the sea career, the reason and the means they use for coming ashore. The results cover the descriptive analysis of career path of ocean going officers, the reasons for choosing the sea and negative factors which affect the sea career.

Keywords: Ocean Going Officers, Career, Career Path, Seafarer Shortage

1. INTRODUCTION

The world merchant fleet was 722.6 million dwt in 1999. This figure reached 1,113 billion dwt in 2009 (DTO, 2009). Yet, the targeted growth rate of qualified seafarers of worldwide fleet has not been achieved. According to the BIMCO/ISF Manpower 2005 Update Report, the estimate worldwide shortfall of seafarers in 2015 will be 5.9% of the total workforce (BIMCO/ISF, Manpower 2005 Update Summary). The OECD countries remain an important source of officers although Eastern Europe has become increasingly significant with a large increase in the number of officers. However, over 25.0% of these are over 50 years old, and well over 50.0% are over 40 (OECD, 2005).

As a result of the fact that seafarer shortages in the coming years will increase, IMO launched ''Return to Sea'' Campaign in November 2008. Moreover, this campaign is to ensure that the world have the resources of trained seafarers which the industry needs, not just now, but in the long term. According to the results, the first item is staying away from family and loved ones with 67.6% (www.imo.org).

The most comprehensive study of career paths in the maritime sector was conducted by the European Union (EU) with the support of 10 countries which were EU members in 2005 (The Mapping of Career Paths in the Maritime Industries). Arising from the results of this study can be summarized as follows (ECSA-ETF Final Report, 2005; 12-21);

Reasons for going to sea: The location of home or place of upbringing, family influence, good career prospects, a long-term interest in the sea, travel and satisfying wages.

Reasons for staying at sea: A long held ambition to become a Master or Chief Engineer, appreciation for the job and the seafaring lifestyle and rapid promotion.

Reasons for coming ashore: Expensive education, limited career, reduced number of personnel on board and increased workload, heavy weather and sea conditions, piracy, cultural differences, license exams, new certificate programs and training, being away from family and social life, health problems (fatigue and excessive stress), the duration of stay in port being short, increased employment opportunities on shore, family and environmental pressure, limited social rights on board, the duration of the contracts, and limited communication facilities.

2. AIM OF THE STUDY

The aim of the study is; to form a career path map for Ocean Going Officers who graduated from Dokuz Eylül University, Maritime Faculty Marine Transportation Engineering Department. Furthermore, the study analyzes the reasons for choosing the sea initially, the factors which affect the sea career, the reason and the means for coming ashore.

3. DATA COLLECTION METHOD

In this study, quantitative research methods were used to collect data. The data were collected with the help of a questionnaire prepared. The questionnaire variables were developed to obtain demographic information and career status of the respondents. Some of the variables which were used in the survey of "The Mapping of Career Paths in the Maritime Industries" (ECSA-ETF Final Report, 2005; 12-21) were utilized for the development of the questionnaire. Pilot study was carried out to test reliability of the questionnaire. The results of the pilot study were satisfying. The questionnaire was applied to 10-year graduates from August 2009 to January 2010.

4. POPULATION AND SAMPLE SIZE

The population study consists of alumni who graduated from DEU MF MTED between 1999-2008. The first alumni graduated from Marine Transportation Engineering Department in 1999 with bachelor degree. During this study, researchers tried to reach all members of the population. A great proportion of alumni were working on ships all over the world, which made it difficult to reach all the population. The questionnaires used to collect data were delivered to the respondents via e-mail, facebook and alumni forums on the web. As a result, 67% of the population has been reached.

5. DATA ANALYSES METHOD

SPSS 15 (Statistical Package for the Social Science) was used for data analysis. SPSS data analysis techniques were used in the analysis of frequency distribution and percentages.

6. FINDINGS OF THE STUDY

During the study, out of a total number of 314 graduates, 213 respondents were reached. 212 questionnaires were evaluated in the study. Table 1 shows the profile information of alumni

In general, 67% of the targeted number of 10-year graduates took part in the study.

Table 1. Alumni's Profiles

	Graduation Year	General n	Achieved n	Percent %
Participation percentages of alumni responding the questionnaire	1999	17	16	94,12
	2000	13	6	46,15
	2001	18	15	83,33
	2002	30	22	73,33
	2003	29	17	58,62
	2004	40	21	52,50
	2005	36	15	41,66
	2006	45	31	68,88
	2007	41	31	75,60
	2008	45	37	82,22
	General	314	212	67,51
Age	Average : 28,06 Age range: 23 - 34			
		n	%	
Marital status	Engaged	15	7,1	
	Married	64	30,2	
	Widowed	1	0,4	
	Single	132	62,3	

Alumni career status can be seen in Table 2. Even though approximately 20.3% of the alumni participating the questionnaire have Oceangoing Master License, 14.3% serve as captains. The reason for the discrepancy between these figures is that the alumni want to get the Unlimited Master License before starting a career on shore. 78.2% of the alumni prefer to work with Turkish flag. One of the main reasons for this can be expressed as social security.

Table 2. Alumni's Career Status

		n	%
Valid licence	Captain	43	20,3
	Chf. Off.	84	39,6
	Deck Off.	85	40,1
Sea service	Average : 38,6 month Sea Service Range: 0-120 month.		
		n	%
Preferred type of vessel flag	Turkish	165	78,2
	Foreign	46	21,8
		n	%
Last proficiency on board	Cadet	2	1,0
	Deck Off.	102	48,1
	Chf.Off.	77	36,3
	Captain	31	14,6
Age of stopping sea service	Average: 27,25 Stopping sea service range: 22-33		

Table 3 shows the analysis of ship types that alumni prefer to work at sea. 35.37% of the alumni preferred to work on bulk cargo ships and then came chemical tankers, dry cargo

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vessels and bulk cargo vessels and container ships. The reasons for choosing Bulk cargo ships can be listed as fewer rules and audits than on the tankers, longer voyages compared to tankers and containers, longer stays at ports than tankers and container ships. Chemical tankers are the second most preferred type of the ship by alumni. The main reason for choosing chemical tankers rather than the others approximately 2 times more financial income can be picked up.

Table 3. Alumni's Ship Type Preferences

	Ship type	n (%)
1	Bulk Cargo	75 (35,37)
2	Chemical Tanker	58 (27,35)
3	Dry Bulk	55 (25,94)
4	Container	54 (25,47)
5	Oil Tanker	45 (21,22)
6	Ro-Ro	14 (06,60)
7	Passenger	12 (05,66)
8	Others (Yatch, Mega Yatch)	05 (02,35)

The alumni's reasons for choosing the sea can be examined in Table 4. Alumni chose to be seafarers due to its being a lucrative and guaranteed career. Those who choose a planned and conscious way received third place at the table. As can be seen from the results, alumni have chosen higher income and guaranteed job instead of their favorite occupation. This factor leads to early discontinuation of the sea.

Table 4. Reasons for Being a Seafarer

	Reasons for being a seafarer	n	Mean *	Standard Deviation
1	Satisfying Income	210	3,8333	1,11357
2	Employment Guarantee	211	3,7251	1,28370
3	Prior Plan	211	3,6635	1,29304
4	Travelling Interest	210	3,2143	1,30761
5	Sea Interest	210	3,1810	1,32174
6	Respectable Occupation	210	3,1619	1,21493
7	Freedom	210	2,8714	1,42689
8	Family Advice	210	2,4857	1,47135
9	Friends Guidance	211	2,3318	1,44877
10	Coincidence	210	2,0714	1,27532
11	Insistent Family Guidance	210	1,7857	1,18878
12	Miscellaneous Problems on shore	210	1,7714	1,14714

*5- Likert Scale – 1: Strongly Disagree, 5: Totally Agree

In Table 5, the factors adversely affecting the working times of the graduates in the sea, in other words, the first 10 factors causing to leave sea can be seen. These include increasing daily stress of work, constantly renewed and increasing rules, increasing inspections and tightening, the advancement of technology as a result of rapidly declining number of personnel working on board, which results in increased workload. Then staying away from the family and inability to perform tasks and communication difficulties follow.

Table 5. Reasons to Leave Sea

	The respondents' reasons to leave sea	n	Mean *	Standard Deviation
1	Increasing stress on the work done	212	4,1934	,94661
2	Inadequacy for loved ones	212	4,1840	1,01605
3	Communication problems with the family	212	4,1509	1,02843
4	Fewer social rights than on shore	212	4,0330	1,13281
5	Excess workload	212	3,9387	1,18882
6	Short stays in ports	212	3,8679	1,17296
7	Decreased quality of seafarers on ships	212	3,8443	1,12672
8	Wage differences between shore and sea	212	3,7925	1,20989
9	Wearing processes in the controls at ports	212	3,7877	1,25711
10	Increased level of responsibility for captains	212	3,7453	1,22812

*5- Likert Scale – 1: Strongly Disagree, 5: Totally Agree

23.4% of alumni stated that as a result of illness or disease of a family member, they decided to leave the sea. 3.3% of them decided to leave sea while they were students at school, 18.3% of alumni decided to leave sea within a year of sea service, 10% of them decided to leave sea during their sea going training and 10% of alumni decided to leave sea within 2 years of sea service. The main reason for this is accumulating savings for the on shore careers. Alumni's first career goals on shore have been found to be related with maritime industry with %78. Well concerning the alumni's transition to careers on shore the list includes, prior plans (% 39), coincidence (% 39), help of friends on shore (% 11). Alumni with careers on land have been identified as 72% of those who have permanent jobs.

Figure 1 shows the map of alumni's career path. 62.8% of alumni continue their careers in private sector on shore, 37.2% of them continue in public sector. 33.3% of alumni who transfer to the private sector are working at maritime sector in posts such as "personnel manager", "super intended", "fleet manager" and "operation manager".
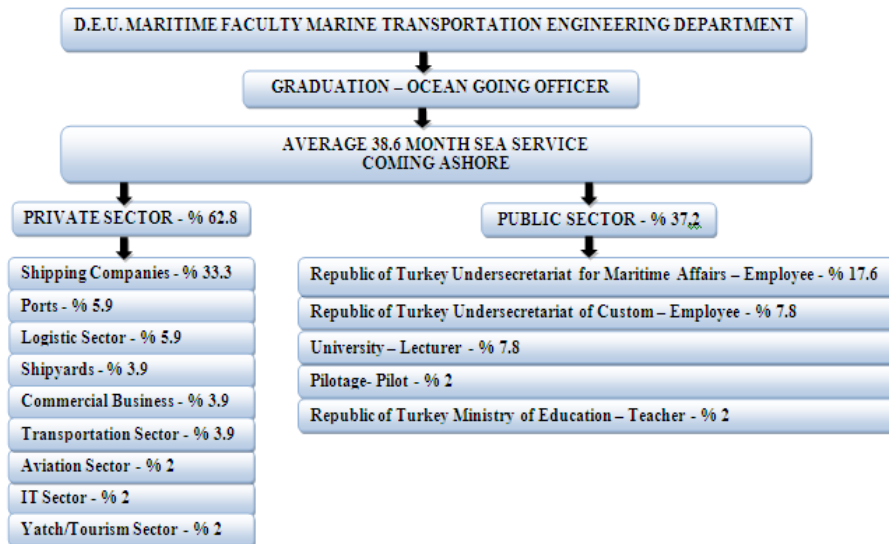
Fig. 1 Alumni's Career Path Map

Some of the alumni who never worked at sea after graduating from school started to work for the aviation sector (travel coordinator), IT and logistic sectors.

71% of alumni who continue their careers on shore receive less income than they did at sea. In addition, 25% of them returned to work at sea and 75% of them continue their careers on shore. The factors causing the alumni to return back to the sea from shore can be listed as "unemployment" (41%) or "financial hardship on shore" (35%). Only 4.1% of alumni state that they will return to the sea if there is some improvement in working conditions at sea. In addition, 18% of alumni have stated that they are thinking of returning to the sea.

7. CONCLUSIONS AND RECOMMENDATIONS

As a result of the study based on data obtained from the shipping industry needs, qualified officers can continue their careers at sea for the recommendations listed below.

Majority of alumni decided to end their careers at sea while at school, at the sea going training and within 1 year of sea service. In this situation prior to the university entrance examination students planning to study at this section should adequately recognize the challenges of the maritime profession; and should gather proper knowledge about this profession. Especially before exams, both at schools and university counseling centers, by explaining the overall structure of the maritime profession can help students make conscious choices.

Based on the reasons for the alumni leaving early their sea careers early; the physical conditions on the ships the workloads of seafarers, responsibilities, and stress levels should be investigated and necessary arrangements should be made to increase job satisfaction.

To support entrepreneurship education, the curricula should more thoroughly focus on properties; business, maritime management, ship chartering, and insurance For example, the hours of theoretical lessons and practice can be increased. The sea-based academics at educational institutions can be role models. For easier adaptation to the marine environment ,there could be maritime boarding schools with hierarchical structures.

As for promotions in the sea, the required sea service time was shortened as a result of the requirements of the maritime industry.This caused an early desire to achieve career goals and discontinue the sea among the alumni. As a solution, promotion related regulations specified in terms of a higher qualification should be reviewed and the conditions need to be updated today.

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MARINE ENGINEERING TERMS: LINGUISTIC ANALYSIS FOR EDUCATIONAL PURPOSES

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The paper is intended to show the importance of linguistic analysis in the process of creating teaching/learning materials for students who begin their academic career at Maritime University. The strategy of Maritime English teaching in the countries where English is not the native language is of upper priority for ESP (English for Specific Purposes) departments. Marine Engineering terminological system causes certain difficulties for students in the process of acquiring professional skills through abundant reading and writing. Therefore, the contents, structure, amount of Marine Engineering word stock should be properly studied, described, arranged and presented in a dictionary pursuing practical goals. The format of the dictionary is the main concern for a researcher. The textual study based on such linguistic parameters as origin of terms, their frequency, derivation, combinability, structural peculiarities, etc, helps to develop authentic teaching/learning materials which facilitate the process of acquisition and application of special terms in real-life communication.

Keywords: marine engineering, system of terms, linguistic analysis, a dictionary

1. INTRODUCTION

The teaching/learning materials developed in Kyiv State Maritime Academy include the Introductory Maritime English Course and Maritime English-Russian Dictionary with illustrations and explanations. These materials are designed for the first- and second-year students - non-native English learners who begin their studies at Maritime Academy aiming the Bachelor Degree in Marine Engineering and Navigation.

Three influences behind the development of the course book and the dictionary and as such its contents and the format are taken into consideration. These are: a) the lack (or absence) of professional Maritime experience of the students, b) the lack (or absence) of Maritime English language proficiency, c) the lack of General English language competency. Thus, the strategic purpose of teahing/learning materials creation was to provide efficient tools of language training to the students and their teachers from the very beginning when it's necessary to increase the students' motivation, to improve their General English profeciency and, finally, to encourage them in special terms learning.

According to IMO requirements the following topics (both for future deck officers and marine engineers) are included into curriculum: 1) Introducing Oneself. Filling up personal documents. Types of documents. Interviews. 2) Letters, numbers, colours. Maritime code words. Times at sea and at shore. Languages, nationalities, flags. 3) Maritime jobs and professions. Functions and duties. 4) Places and locations. Countries, water bodies. Other geographical names. Maps and charts. Longitude, latitude. 5) A ship: dimensions, particulars, parts, structure, functional zones. 6) Types of vessels. 7) Motion and directions:

navigation, propulsion. 8) Engineering: types of a vessel's equipment. Engines 9) Running the vessel. The bridge. The engine room. 10) Watches and watch keeping. 11) SMCP: on-board, external. Orders and commands. VHF radio. 12 Daily routines of the crew members. 13) Weather and climate, weather forecast; natural disasters. 14) Emergency situations. 15) Safety equipment and its location. 16) Steering, mooring, anchoring. Piloting. 17) Ports and port infrastructure. Administration, customs, sanitary inspection, etc. 18) Navigational aids: buoys and lighthouses. 19) Cargoes: types; loading/discharging operations. Deck equipment. 20) Bunkering operations. 21) Shipping documents (basics). 22) Checking supplies. 23) Incidents and accidents. Injuries. First aid.

The vast subject coverage of the course book requires efficient supplementary materials in the format of a dictionary, in particular. Its type, the scope of entries, the way of a term's presentation were of great importance in order to obtain the final results. Here are some ideas and examples to demonstrate the basic approaches to the terminographic description of Marine Engineering vocabulary.

2. METHODS AND RESEARCH MATERIAL

1. Terms and terminography. One of the most important aspects of Maritime English training is the arrangement and systematisation of maritime–related word stock. Traditionally, the methodology of practical work with special terms in a language classroom has been focused on translation as the immediate means of a term's semantisation (i. e. the way of explaining its meaning and liaisoning to the notion the term corresponds to). Nowadays lexicographic (termonographic) teaching /learning materials basically purpose the development of skills and abilities of communicative nature. Being different from lexicography which is mostly descriptive, terminography is primarily prescriptive. *A term* is a word or expression that has a precise meaning in some uses or is peculiar to a science, profession, or subject (Merriam Webster's Dictionary, 2008). Since the subject teachers always are the source of scientific information about the concept of an engineering term, it should be taken for granted to coordinate the work of language teachers with them. *Terminography* is qualified as a synchronic research, uses only experts as informants and is entirely based on systematic classification in one subject field. (Bergenholtz, Kaufmann, 1997). There exist three types of dictionaries: a language dictionary, an encyclopaedia and an encyclopaedic dictionary. An *encyclopaedic dictionary* has been chosen as the best way of arranging and representing the terms for beginners in Marine Engineering. The reasons are the following: a) it gives maximum explanations of a particular term; b) it suggests illustrations (pictures, sketches, diagrams, etc) to increase the efficiency of a term's comprehension as well as to enhance the students' motivation in learning both profession and Maritime English which accompanies this process; c) it comprises insertions entitled "Consolidation" in order to systematize important linguistic and extra linguistic facts specific for Maritime English.

As it comes from the title, this is a bilingual dictionary which is rather convenient to deliver references in spelling and meaning for non-native English speakers. The Maritime English-Russian Dictionary for beginners comprises 10.000 terms and terminological expressions. The sources of research material are multiple: Mass Media samples, IMO documents (Conventions and Regulations), the Internet information on the subjects involved, spesialists lecture notes, text books, etc. reflecting the synchronous state and major characteristics of Maritime English in use. Part 2 of the Dictionary provides the information on abbreviations mostly often used in professional texts including maritime issues, technical symbols and acronyms, etc. Appendix suggests General English basics: rules of spelling, main grammar rules, list of affixes common for ME terms, list of Latin and Greek words being the source of contemporary maritime and technical terminology.

2. Linguistic notions. Assuming the fact that ME is *an operational language* (Ziarati et al., 2008) with its linguistic peculiarities and *a lingua franca* for those who use it in multilingual envirinment, we should emphasize on its communicative characteristics mostly observed in Standard Marine Communication Phrases (IMO SMCP) and in the way the orders and commands are given. In this respect, Maritime English is of the same nature as the English language used in the army, navy, aviation and space, other branches of transport. This factor has been foreseen in the present terminological and terminographic research work, and the corresponding samples of SMCP are included into the Dictionary.

As a whole, Maritime English word stock is not homogenious, represented, on the one hand, by the General English language patterns of word formation and derivation; on the other hand, it's obvious that under the influence of specific conditions of work of international crew members at sea (fatigue, pressure, hazardous situations, emergency and risk – which is traditionally called "human factor") there must be standardized ME patterns (SMCP) which ensure fast response or immediate action in order to avoid or to correct a human error.

From the point of view of structural linguistics, the Maritime English (incorporating the Marine Engineering corpus of terms) possesses all traits of *a sublanguage* which depicts the current language use in the field of shipping. In its turn, *the sublanguage of Marine Engineering (Marine Technology)* is characterised by the use of classical engineering terminology mostly of Latin and Greek origin being connected with names of various equipment applied onboard ship and onshore. The introductory notions about *the sublanguage of navigation* were first presented at TransNav 2011 (Demydenko, 2011).

3. Sublanguage of Marine Engineering and its specific features. The sublanguage concept states that the word stock describing a particular sphere of life is arranged according to the "field" structure. Any word field (lexical or semantic) has its core (key word/words) and perifery (periferic elements). The core is characterised by invariable conceptual value and high frequency in use; the perifery is somewhat instable and changeable thus demonstrating its evolution: new tendencies in the development of the whole sublanguage area. In Marine Engineering several words express conceptual meaning: *marine, maritime, motion, engine* and others. They are of ancient origin: Lat. "mare, mar-" - Eng. "sea, marine, maritime"; Lat. "moveō"- Eng. "move, motion, motor"; Greek "μηχανή, μηχαν-" -Eng. "machine, mechanics". The adjective *marine* (with the meaning "relating to or characteristic of or occurring on or in the sea") forms one of the biggest groups of terminological expressions: *marine* auxiliaries, *marine* boiler, *marine* engine, *marine* engineering*, marine* environment, *marine* industry, *marine* installation, *marine* motor, *marine* pollution, *marine* propulsion, *marine* rig, etc. Similarly, the "core" term *propulsion* when used with different nouns denoting various vessel's equipment (for example, *propulsion device, propulsion engine, propulsion generator, propulsion installation, propulsion machinery, propulsion plant, propulsion reactor, propulsion reduction gear, propulsion system)* immediately re-addresses these terminological expressions to the area of Marine Engineering. The core elements play the role of markers for the whole word group, or field. In the sphere of Marine Engineering there are the following semantic groups presented in the Dictionary : Marine propulsion. Marine equipment. Main engine. Auxiliary equipment. Deck equipment. Marine fuels. Cooling. Bunkering operations. Pipelines. Ventilation. Maintenance and repair. Safety equipment. Firefighting equipment. Firefighting drills. Marpol IMO Convention. Orders and commands: orders to the engine room. SMCP for marine engineers.

3. SAMPLES OF MARINE ENGINEERING TERMS DESCRIPTION

As it was mentioned above, the Dictionary has been designed for practical needs: a) a term's description is supposed to help the 1st and 2nd year students to accumulate knowledge in Marine Engineering; b) it gives the ready-made teaching materials to ME teachers who

conduct the language classroom; c) it is a source of reference about the spelling and meaning of a term; d) it involves all the participants of the ME training process in communication (comparing definitions, discussing information, using terms in different situations, clarifying details, making additional glossary, commenting pictures or graphs, exchanging opinions, etc.). The samples suggested below will help to get an idea of how the Maritime Engineering terms descriptions are arranged.

1. Presenting a "core" term: propulsion, n; -marine propulsion (Marine propulsion is the mechanism or system used to move a ship or boat across water (human, paddles, sails, a propeller, an impeller). Marine engineering is the discipline concerned with the design of marine propulsion systems); -direct drive propulsion system (Direct propulsion system is an invariable choice for low speed diesel engines and has a very basic arrangement. It consists of a propeller, which is connected to the main engine with the help of the shaft); -geared drive propulsion system (Gearing has more than one function; it reduces the number of revolutions from the engine output in such a way that the system can derive maximum propeller efficiency. Gearing can also be used to connect one shaft to two prime movers or can be used to share power between two shafts or to connect a shaft alternator to the shaft connected to the propeller); -electrical propulsion system.

2. Presenting a term, its word group and materials for revision in the format of "Consolidation" insertion: bunker, v; bunker, n (-bunker capacity, -bunker clause, -bunker fuel, -bunker oil, -bunker oil tank, -bun*ker tank); bunkering, n* **(**The act or process of supplying a ship with fuel): **-***bunkering tanker, -bunkering operation* CONSOLIDATION: - *Bunkering operations*: -products, fuel, gasoline, fuel oil**,** lub oil**,** fuel consumption**,** a flow, fluid**,** a tank, ship tanks, day tanks**,** a petrol bunk**,** a bunker, a bunker tank, a bunker barge, a bunker manifold, a bunker station, bunkering, bunkering operations, bunkering procedure, a pump, transfer pumps, pumping rate, a fluid nozzle, a hose, connections, manifold connections, valves, couplings, flexible, a pipe-pipes, pipeline(s), a pipeline network; quality, quantity, volume, lab analysis, fuel samples, sounding (of a tank); -to supply, to store, to fuel, to fill with fuel, to run out of fuel, to pump, to consume, to refuel, to deliver, to receive, to start, to commence, to stop, to connect, to design, to locate, to check, to order (a product), to secure a vessel, to agree (signals), to calculate, to be available, to distribute, to open, to close, to show;-pollution, oil pollution, adjacent waters, emergency, emergency shut down procedure, SOPEP plan, a foam fire extinguisher, Bravo flag, red light, Alfa Laval, warning signs, stop/start signals, specification sheet, check up list, pre-bunkering procedure, required standards.

3. Presenting the origin of terms in comparison of current use: *engine, n.* [Middle English engin, *skill, machine,* from Old French, *innate ability,* from Latin ingenium; see gen- in Indo-European roots; 1300, "mechanical device," also "skill, craft," from O.Fr. engin "skill, cleverness," also "trick, deceit, stratagem; war machine" (12c.), from L. ingenium "inborn qualities, talent" (see ingenious). At first meaning a trick or device, or any machine (especially military); sense of "device that converts energy to mechanical power" is 18c., especially of steam engines]. Current use: 1. a. A machine that converts energy into mechanical force or motion. b. Such a machine distinguished from an electric, spring-driven, or hydraulic motor by its use of a fuel**.** 2. a. A mechanical appliance, instrument, or tool. b. An agent, instrument, or means of accomplishment. 3. A locomotive. 4. A fire engine. 5. *Computer Science* A search engine; *tr.v. engined, engining, engines* -To equip with an engine or engines; *engine, n* (A machine that turns energy into mechanical force or motion, especially one that gets its energy from a source of heat, such as the burning of a fuel. The efficiency of an engine is the ratio between the kinetic energy produced by the machine and the energy needed to produce it); *engineer, n.* [Middle English enginour, from Old French engigneor, from Medieval Latin ingeniator, *contriver,* from ingeniāre, *to contrive,* from Latin ingenium, *ability.* engineer (n.) early 14c., "constructor of military engines," from O.Fr.

enggigneor, from L.L. ingeniare (see <u>engine</u>); general sense of "inventor, designer" is recorded from early 15c.; civil sense, in ref. to public works, is recorded from c.1600. Meaning "locomotive driver" is first attested 1832, Amer. Eng. The verb is attested from 1843] - Current use: 1. One who is trained or professionally engaged in a branch of engineering. 2. One who operates an engine. 3. One who skillfully or shrewdly manages an enterprise. *tr.v. engineered, engineering, engineers* - 1. To plan, construct, or manage as an engineer.2. To plan, manage, and put through by skillful acts or contrivance; maneuver.

4. Presenting derivation of terms: -corrode (v) - corrosion (n) – corrosive (adj) – corroding (adj) – noncorroding (adj) – noncorrosive (adj) – noncorrodible (adlj); -oil (n)– oil (v) – oiler (n) – oily (adj) – oiling (n); -mechanic (n/adj) – mechanical (adj) – mechanism (n) - mechanization (n); -lubricate (v) – lubrication (n) – lubricant (n) – lub (adj) + noun– lubricating (adj); -heat (v) – heat (n) – heater (n) – heating (n/adj) – heated (adj); -overheat (v) – overheat (n) –overheating (n) – overheated (adj).

5. Presenting synonyms: engine (n) - machine, motor, mechanism, generator, dynamo; *obligation (n)* **-** duty, responsibility, job; *equipment (n)* – tools, devices; *examine (v)* **-** to test, to explore, to inspect. to inquire, to search; *personnel (n)* - workers**,** staff, employees, human resources, people, recruits, laborers; *oil (n)* – petroleum, petroleum derivative, a machine oil or lubricant; *machine (n)* - apparatus, appliance, automaton, computer, engine, gadget, implement, instrument, mechanism, motor, robot, tool, vehicle, widget; *repair (v)* **-** to restore, to set right, to renew, to revitalize, to make up; *ground (v)* – to earth.

6. Presenting antonyms: local – foreign; entrance – exit; top – bottom; heavy – light; full – empty; ancient – modern, update; beginning – end; upper – lower; minimum – maximum; rigid – flexible; slow – fast; simple – complex; advantage – disadvantage; major – minor.

7. Presenting definitions: insulate, v **(**To prevent the passage of heat, electricity, or sound into or out of, especially by surrounding with a nonconducting material); *installation, n* **(**A system of machinery or other apparatus set up for use. A building or place that provides a particular service or is used for a particular industry. The state of being installed; also called *installment*); *light, n/adj* **(**1**.** Electromagnetic radiation that has a wavelength in the range from about 4,000 (violet) to about 7,700 (red) angstroms and may be perceived by the normal unaided human eye. 2. Having a greater rather than lesser degree of lightness. 3. Of relatively little weight; not heavy); *electromagnet, n -(*An electromagnet is made from a coil of wire that acts as a magnet when an electric current passes through it but stops being a magnet when the current stops.); *magnetism, n* (Attraction for iron; associated with electric currents as well as magnets; characterized by fields of force); *overhaul, n* (1. An act of overhauling. 2. A repair job.); *robotics, n* **(**The branch of technology that deals with the design, construction, operation, structural disposition, manufacture and application of robots. Robotics is related to the sciences of electronics, engineering, mechanics, and software. The word "robot" was introduced to the public by Czech writer Karel Čapek in his play R.U.R. (Rossum's Universal Robots).

8. Presenting structural elements: Ways of expressing opposite meanings: Un- to load – to unload; loading –unloading, done – undone. De- announce – denounce; freeze – defreeze. Dis- to charge – to discharge; charging – discharging; to mount –to dismount. Out-onboard– outboard; inlet – outlet. Mis- to lead – to mislead. Ab- normal – abnormal. In-complete – incomplete; convenience – inconvenience; combustable – incombustible. Im-possible – impossible; flammable – imflammable; pure – impure. Non- working – non-working; operating –non-operating; freezing – nonfreezing. Mal- adjustment – maladjustment; function – malfunction. Off- grounded – offgrounded. Counter- measure – countermeasure; weight – counterweight. Contra- rotation – contrarotation; propeller – contrapropeller. -less powerful – powerless; wire – wireless

9. Presenting lexical and grammatical means for a particular function. *Comparison:* -to compare, a comparison, comparable, incomparable; -to differ from, to be different to,

difference; to resemble, resembling; -similar, to be similar to, similarity; -to distinguish, distinguished, distinguishing; -to contrast, a contrast, contrasting; -the same: almost the same, absolutely the same; -between (when two objects are compared); -among (when several objects are compared); -general, common, special, specific, particular, peculiar; -equal, single, minor, major, minority, majority; -bot and, as…as, like (who? what?).

10. Presenting a historical fact: *Diesel, Rudolf* (1858 - 1913). *Rudolf Christian Karl Diesel* was a German inventor and mechanical engineer, famous for the invention of the diesel engine.

11. Presenting a glossary: *Diesel engine glossary:* *Bore* – refers to diameter of engine cylinder. *Stroke* – refers to distance piston travel from TDC to BDC. *TDC* (Top dead center). *BDC* (Bottom dead center). *Engine displacement* –refers to the total volume displaced by the pistons during one stroke. *Degree of crankshaft rotation* – because the piston is connected to the crankshaft, any location of the piston corresponds directly to a specific number of degrees of crankshaft rotation. *Firing order* – refers to in order in which each of the cylinder in a multi-cylinder engine fires. *Clearance volume* – volume remaining in the cylinder when piston is at TDC. *Compression ratio* - Total volume / clearance volume. *Horse power* – power is amount of work done per unit time or the rate of doing work. For diesel engine power is rated in units of HP. *Brake horse power* refers to the amount of usable power delivered by the engine to the crankshaft. *Mechanical efficiency* - the ratio of engine BHP and its indicated HP*. IHP* (Indicated Horsepower) is the power transmitted to the piston by the gas in the cylinder and is mathematically calculated.

4. CONCLUSIONS

The Encyclopaedic English-Russian dictionary of Maritime Terms has been developed for the 1st and 2nd year students of the Maritime Academy. Being attached to the "Introductory Maritime English Course" it serves as a terminographic material designed for students' practical needs: a) as a reference for meaning and spelling, b) as a reference for word combinations of a particular term, c) as a source of additional information about terms (and respectively - people, objects, phenomena, etc they denote) in order to stimulate their use in the professional environment. The linguistic analysis, preceding the terms arrangement and description in the Dictionary, included the study of authentic texts, frequency of their appearance in current use, their structural peculiarities, combinability, derivation and origin. Thus, the main advantage of the Dictionary is stimulation of students to develop their communicative skills right at the beginning of the ME learning process. In this respect, the combination of a concise encyclopaedia with bilingual dictionary designed for beginners create efficient foundation both for language classroom activities and individual work of Marine Engineering students, in particular.

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THE ROLE OF HUMAN FACTORS IN MANAGEMENT OF MARITIME TRANSPORT OPERATIONS

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Although certain functions have been automated, a maritime transport is still largely a human-controlled system. It is explained the tendency for objective assessment and management of interactions between work-place and environment and their affects on final results of maritime transport operations.

1. INTRODUCTION

Human factor has an ambiguous influence in the maritime transport. Vessels are mostly human-operated systems regardless of automation of some functions. Two main conceptions (ergonomic and psycho-physiological) for the influence of the human factor in maritime transport are considered as "two sides of the same coin". In fact, precise distinction between two conceptions should be done, independently their focusing upon controlled interactions between humans and physical work environment and machines:

- *Ergonomic conception* is the reflection of the influence of workplace of maritime transport for adaptation of human needs.
- *Psycho-physiological conception* considers the reflection of the influence of workplace of maritime transport upon functioning of a human component.

The human factor is considered as the main reported parameter in the activity of maritime transport. In the course of the last 50 years the research of the influence of human factor in maritime transport created solid scientific discipline on the basis of theory and empirical data. Practical-applied purpose of this tendency gave expression in working out a number of handbooks and guides for functioning of the human factor in maritime transport (Salvendy, 1987; Wilson and Corlett, 1990, McCormick and Sanders, 1983; VanCott and Kincade, 1972).

1. CONDITIONS FOR THE CREATION OF ACCIDENTS IN MARITIME TRANSPORT

The popular explanation of the main part of accidents in maritime transport are human errors. There are many sources, which show that approximately 75 – 90% of all accidents in maritime transport are due to human errors. The purpose of the perception of indefiniteness of present conceptions is influenced by the professional experience of their creators:

- *Legal*: concentrated on possible negligence or criminal conduct
- *Technical*: the operator misused the system

- ***Psychological***: the operator is inhibited by trauma
- ***Social-technical***: non-adequate operator's behaviour
- ***Ergonomic***: lack of the whole received information

Therefore the explanation of a stranding by "navigation error" may have different interpretations as:

- Negligence due to low morale
- The control system did not give any feedback
- Wrong assessment of the situation due to lack of necessary skills
- Inadequate performance due to lack of procedure for actions in such situations
- Electronic disturbance
- Perception error due to low arousal

Therefore, human error conception demands deeper consideration.

Very seldom there is only one explanation about the accident. In many cases a accident has many interpretations. This disturbing situation was pointed out more than 30 years ago (Stewart, 1973). During the studying of the classical stranding scenario (Figure 1), Stewart demonstrated the interaction between various factors. The factors that led to the stranding were:

1. Vessel was approaching a dangerous headland.
2. Strong outside wind.
3. Attempt was made to adjust for setting the course change against wind direction.
4. No allowance was made for leeway.
5. Despite a later position fix, heading was not corrected.
6. Echo sounder was not in use.
7. Decreasing visibility near land.
8. Light picked up to starboard.
9. Assumed to be the headland light.
10. Stranded at full speed.
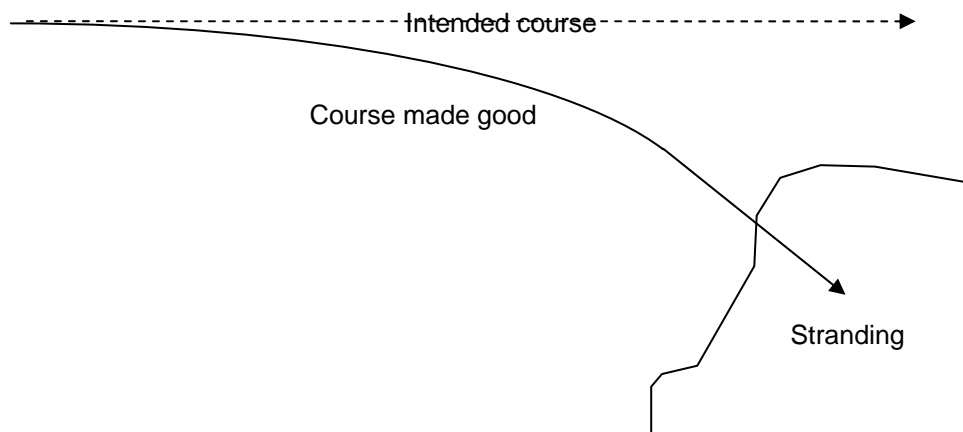
Fig. 1. A stranding scenario. (Adapted from Stewart, 1973)

One of the first studies of human error in ship operation (NAS, 1976) the following factors are shown:

• Inattention	• Excessive alcohol use
• Ambiguous pilot – master relationship	• Excessive personnel turnover
• Inefficient bridge design	• High level of calculated risk
• Poor operational procedures	• Inadequate lights and markers
• Poor physical fitness	• Misuse of radar
• Poor eyesight	• Uncertain use of sound signals
• Excessive fatigue	• Inadequate rules of the road

The most of these problems are just as relevant today. Investigations of accidents had a broader view which took workplace factors, procedures, fatigue, health and management into consideration.

Fukushima (1976) took a wide scope of the initiative purposes for an accident. He saw accidents as combinations of the following complex conditions:

- Natural phenomena: sharp changes in hydro-meteorological conditions.
- Navigation rout: fairway conditions, navigational obstacles and visibility.
- Vessel: stability, manoeuvrability and technical standard.
- Traffic congestion.
- Navigator: knowledge, skills and health.

It can be concluded that there is an understanding of why accidents happen that involves the operator, technology, work conditions and organization. Therefore, there is more limited point of view for design and planning of operations. This point of view reflects upon bridge design shortcomings, lack of safety training and ignorance in management. Employees in maritime transport are expecting the entire professional, multi-factors research and analysis of accidents (Caridis et al., 1999).

During the proceedings concerning the increase safety and in particular to minimize the negative effects of human errors the following lessons about accidents happened are recognized:

1. Routine:
- Implementation of activities in normal operational situations.
- Negligence of the possibility of realization of abnormal events or conditions.
2. Gradual escalation:
- Reaching sufficient parametrical values above needed conditions for realization the dangerous events resulted.
- Incapacity to cancel events, before they transform into tha accident process (lack of safety control).
3. Multiple causes:
- An accident is a result from more than a single event.
- Causal factors are reflection of multitude of their sources (technological, humans and organizational).
4. Human error
- An operator is a part of the accident events chain.
- The human behavior should be viewed in broader scope.
5. Presence of situation factors
- Oncoming changes in physical environment.
- Oncoming changes in workplace conditions.
- Unsteady pressure by the tasks performed.
- Mental and special motivational state.

The important meaning is attached to the establishing of the objective perspective of the time scale for the events related to an accident (as illustrated in Table 1). Decisions leading

to hazardous conditions can be taken in the order of year in advance. The critical events may develop within a day or an hour and the dramatic release of energy in the order of seconds. The consequences in terms of breakdown of vessel, human suffering and environmental damage have long-range effects. This perspective is reported by the solution of the human factors problem.

Table 1. Characteristic time scale of a vessel accident

Time scale	Typical event
1 year	Management decisions connected with the vessel operations
1 day	Breakdown of safety function
1 hour	Initiating failure or operator error
1 min	Attempt to avoid threatened accident
1 sec	Non-regulated energy release
1 min	Collapse of hull and breakdown of systems
1 hour	Flooding and fire, loss of vessel and evacuation of people
1 day	Rescue of people and vessel
1 week	Pollution of the environment, hospitalization of people
1 year	Environmental damage, post-tramatic effects on people

In the US study (RSS, 1988) referred to the service of the nuclear reactor distribution of human errors admitted in routine and non-routine activities are pointed out. One of conclusions obtained is that the non-routine operations such as testing/calibration and repair/modification were especially prone to omission error (Table 2). The analysis of behavioural mechanism showed that functionally isolated acts often lead to the bad errors (Table 3). This behavioural mechanism is typical for non-routine activities.

Table 2. Omissions in nuclear power plant operations by activity category

Activity	Omissions (%)
Monitoring and inspection	0
Supervisory control	2.3
Manual operation and control	5.9
Inventory control	9.4
Test and calibration	32.9
Repair and modification	41.2
Administrative task	1.2
Management, personnel planning	1.2
Other or not specified activities	5.9
All tasks	100

Source: RSS (1975).

Rasmussen (1982) reveals an important distinction between the following main performance levels: skill- rule- and knowledge-based behavior (see Figure 2). Skill-based behavior relies on the subsisted personal experience and almost unconscious actions. Rule-based behavior applies for certain well-known situations. The complex situations require some kind of problem solving called knowledge-based behavior. Skill-based behavior is most frequent in daily operations and also less subject to error and accidents. The knowledge-based behavior is used for the implementation of unfamiliar and difficult tasks. This behavior may also have the largest consequences in case of error.

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Table 3. Errors in nuclear power plant operations by behavioural mechanism

Behavioural mechanism	Errors (%)
Absent-mindedness	1.5
Familiar association	3.0
Alertness low	5.0
Omission of functionally isolated act	34.0
Other omissions	8.5
Mistake among alternatives	5.5
Strong expectation	5.0
Side effect not considered	7.5
Latent condition not considered	10.0
Manual variability, lack of precision	5.0
Weak spatial orientation	5.0
Other not specified	10.0
All behaviours	100

Source: RSS (1975).

SKILL-BASED
Almost automatic or unconscious
Habitual   Based on training and recurrent execution
routines   Low level control: Initiating cause – necessity of action

Procedures   **RULE-BASED**
Familiar tasks handled with higher mental presence
Stored response patterns: Situation – necessity of action
Know-how

KNOWLEDGE-BASED
High-level mental activity and problem solving.
Analyse, Prioritize, choose and decide
Improvisation
Problem solving

Frequency (log) (vertical axis)

Potential loss (log)

Fig. 2. Alternative operator performance levels (Adapted from Rasmussen, 1982)

2. MODEL OF HUMAN RELIABILITY ASSESSMENT (HRA) EVENT TREE

Vessel activity deeply depends on human-machine control. Figure 3 presents a conceptual model of vessel control, which emphasizes the meaning of human factors. In the core of the control loop is the interaction between the operator function and the vessel.

The operator uses data from visual environment and the information displays onboard. This data is processed and results in control actions and communication with other crew members. The control of the vessel may be disturbed by the physical environment. The performance of the operator is governed by individual characteristics and the interaction with supervisors and other crew members.
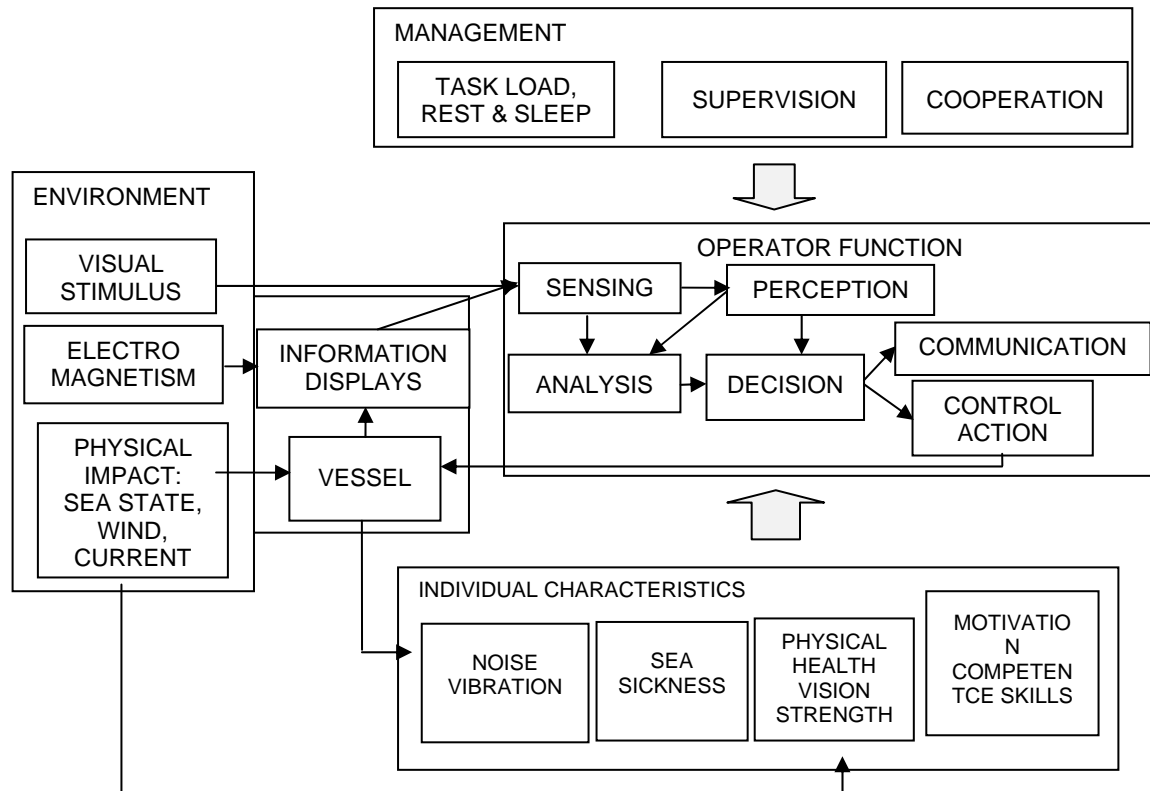
Fig. 3. Human-machine control of a vessel

Risk analysis includes making quantitative estimation of the risk associated with designs and operations. Typical is estimation of the probability of having specified accident events by means of fault tree analysis (FTA) or event tree analysis (ETA). In order to make realistic estimates, human-error-related events must be incorporated. This is not a trivial problem given limited understanding of this phenomenon and lack of systematic data. Various approaches have been developed and to some degree have also been supplemented with quantitative data. The objective of human reliability assessment (HRA) has been stated as follows by Kirwan (1992a, 1992b):

1. Human error identification: what can go wrong?
2. Human error quantification: how often will it occur and what are the possible consequences?
3. Human error reduction: how can it be prevented or the impact reduced?
   The key methodological steps are outlined in Figure 4.

Considerable experience has been accumulated with so-called first-generation HRA methods, primarily from applications in the process and nuclear industries. These methods come under increasing attack from cognitive scientists who point to the fundamental lack of ability to model human behavior in a realistic manner (Hollnagel, 1998).

The Technique for Human Error Rate Prediction (THERP) is probably the best-known and most widely used technique of human reliability analysis. The main objective of THERP is to provide human reliability data for probabilistic risk and safety assessment studies. The methods and underlying principles of THERP were developed by Swain and Guttmann (1983) and are often referred to as the THERP Handbook.
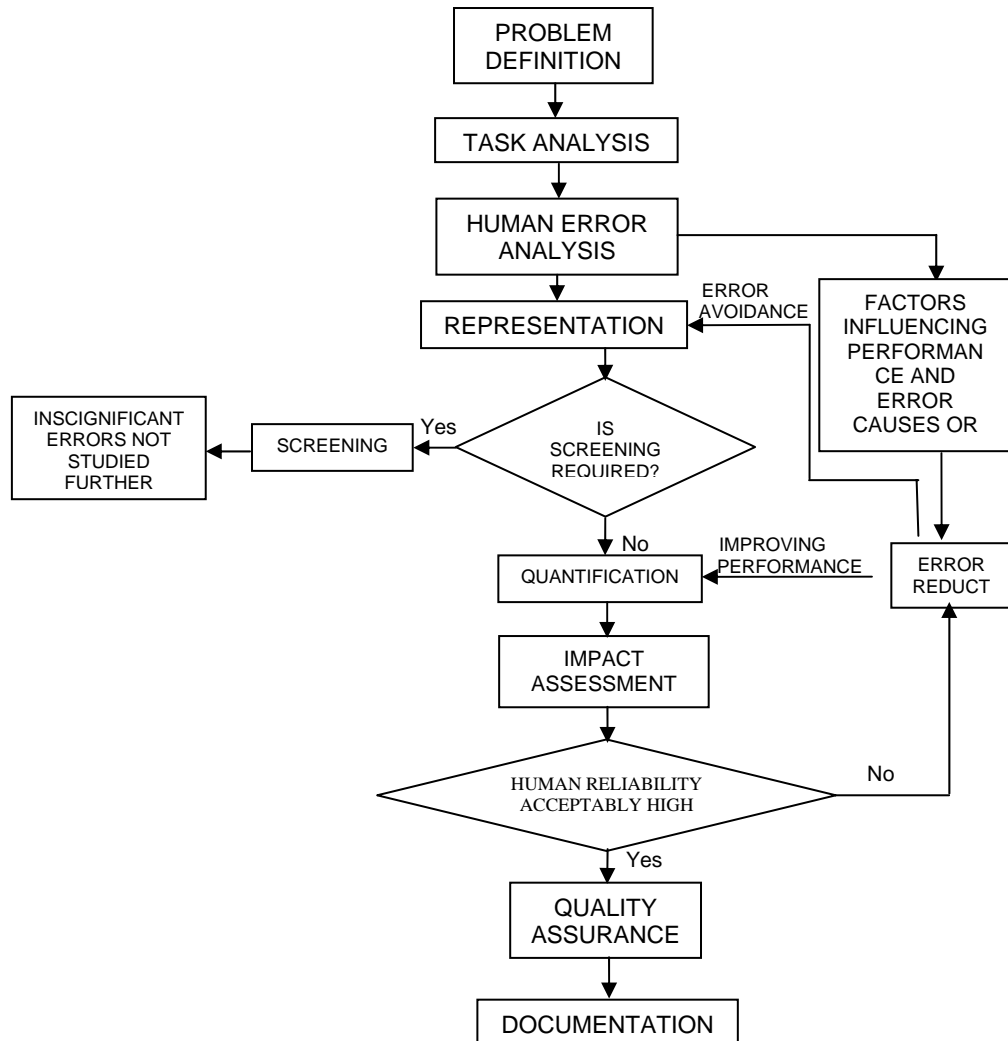
Fig. 4. Human reliability assessment steps (Kirwan, 1992a, 1992b)

The methodological steps are:

1. *Determination of system failures of interest*: This stage includes identifying the system functions, which can be influenced by human errors, and for which error probabilities are to be estimated.
2. *Analysis of connected human operations*: This stage includes performing a detailed task analysis and identifying all significant interactions involving crew members. The main aim of this stage is to create a model that is appropriate for the quantification in stage 3.

Table 3. Performance Shaping Factors (PSFs) in Technique for Human Error Rate Prediction (THERP)

Situational characteristics	Architectural features	Availability of special equipment
	Temperature	Adequacy of special equipment

	Humidity Air quality Lighting Noise and vibration Degree of general cleanliness Work hours and work breaks	Shift rotation Organizational structure Adequacy of communication Distribution of responsibility Actions made by co-workers Rewards, recognition and benefits
Job and task instructions	Procedures required (written or not) Cautions and warning Written or oral communication	Work methods Plant policies
Task and equipment characteristics	Perceptual requirements Motor requirements (speed, strength, etc.) Control-display relationship Anticipatory relationships Interpretation Decision-making Complexity (information load) Narrowness of task	Frequency of repetitiveness Task criticality Long- and short-term memory Calculation requirements Feedback (knowledge of results) Dynamics vs. step-by-step activities Team structure and communication Man-machine interface
Psychological stressors	Suddenness of onset Duration of stress Task speed High jeopardy risk Threats (of failure, of losing job, etc.) Monotonous and/or meaningless work	Long, uneventful vigilance periods Conflicts about job performance Reinforcement absent or negative Sensory deprivation Distractions (noise, flicker, glare, etc.) Inconsistent cueing
Physiological stressors	Duration of stress Fatigue Pain of discomfort Hunger or thirst Temperature extremes Radiation G-force extremes	Atmospheric pressure extremes Oxygen insufficiency Vibration Movement constriction Lack of physical exercise Disruption of circadian rhythm
Organism factors	Previous training/experience State of current practice or skill Personality and intelligence variables Motivation and attitudes Knowledge requred Stress (mental or bodily tension)	Emotional state Sex differences Physical condition Attitudes based on external influences Group identification

3. *Estimation of the human error probabilities*: In this stage the human error probabilities (HEPs) are estimated using a combination of expert judgements and available data.
4. *Determination of the effect on system failure events*: The main task of this stage is the estimation the effect of human errors on the system failure

events. This usually includes integration of the HRA with an overall risk/safety assessment (i.e. PRA/PSA).

5. *Recommend and evaluate changes*: In this stage changes to the system under consideration are recommended and the system failure probability recalculated. Possible solutions for various human factors problems include controls, and implementation of training and certification requirements.

The probability of a specific erroneous action is given by the following expression:

$$P_{EA} = \text{HEP}_{EA} \sum_{k=1}^{m} \text{PSF}_k \cdot W_k + C \tag{1}$$

where:

P_{EA}	=	Probability of an error for a specific action
HEP_{EA}	=	Basic (nominal) operator error probability of a specific action
PSF_k	=	Numerical value of k th performance shaping factor
W_k	=	Weight of PSF_k (numerical constant)
C	=	Numerical constant
m	=	Number of PSF_k

The probability is a function of the error probability for a generic task modified by relevant Performance Shaping Factors (PSFs). The basic Human Error Probabilities (HEPs) can be looked up in 27 comprehensive tables in the THERP Handbook (Swain and Guttmann, 1983). The Performance Shaping Factors (PSFs) are tabulated in the same fashion. The three sets of Performance Shaping Factors (PSFs) are shown in Table 3.

Human Reliability Assessment (HRA) Event Tree
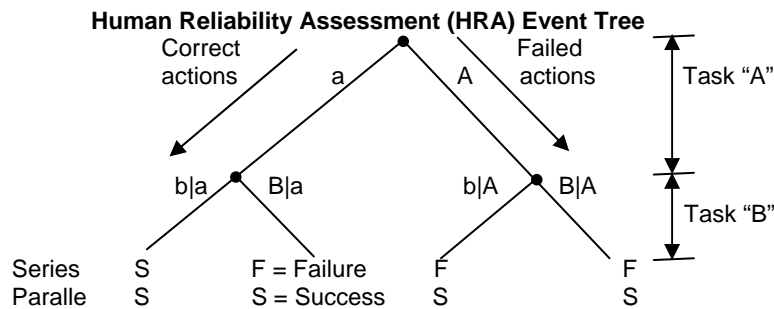
Task "A" = The first task
Task "B" = The second task
a   = Probability of successful performance of task "A"
A   = Probability of unsuccessful performance of task "A"
b|a = Probability of successful performance of task "B" given *a*
B|a = Probability of unsuccessful performance of task "B" given *a*
b|A = Probability of successful performance of task "B" given *A*
B|A = Probability of unsuccessful performance of task "B" given *A*

Fig. 5. Human Reliability Assessment (HRA) event tree for two successive subtasks

The modeling of relevant human actions in event trees is based heavily on the task analysis performed in stage 1. In the present stage a more detailed analysis is carried out on each of relevant human actions identified and a comprehensive description of the performance characteristic is made. Each human/operator action is divided into tasks and

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subtasks, and these are then presented graphically in a so-called Human Reliability Assessment (HRA) event tree (Figure 5).

Human Reliability Assessment (HRA) event trees model performance in a binary fashion, i.e. as being either a success or a failure. Branches in a Human Reliability Assessment (HRA) event tree show different human activities, and the value assigned to all

human activities (except those in the first branching) are conditional probabilities. Figure 6 illustrates a simple Human Reliability Assessment (HRA) event tree (Swain and Guttmann, 1983). As can be seen from this figure, it is common to present the correct actions on the left-hand side of the tree and failures on the right-hand side.

END
Activity as a whole
performed correctly

A = Probability of successful performance of task A
a = *Probability of unsuccessful performance of task A*
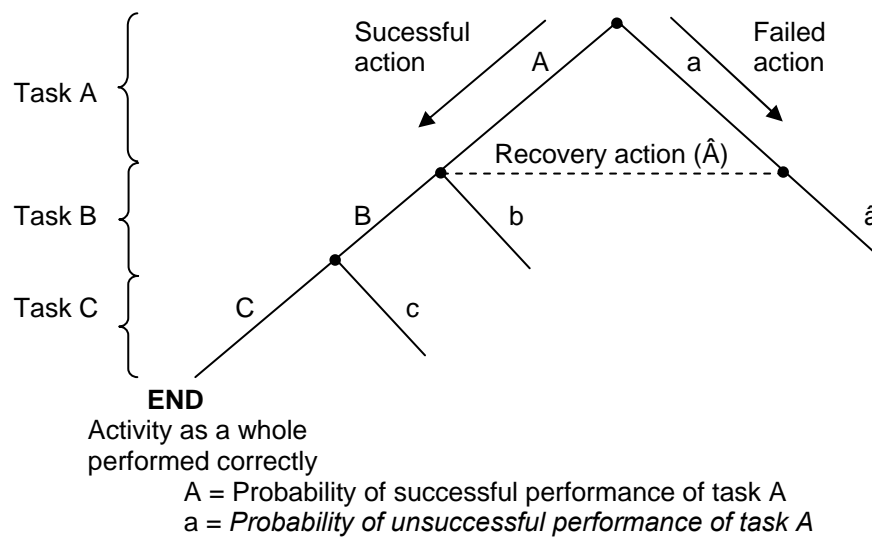
Fig. 6. Modelling principles in Technique for Human Error Rate Prediction (THERP)

The binary categorization of errors by the human activity used in Human Reliability Assessment (HRA) event trees may be too simple to make any claim on psychological realism (Hollnagel, 1998). First of all there is an important difference between failing to perform an action and failing to perform it correctly. The HRA event tree approach fails to recognize that an action may happen in many different ways and for different reasons.

4. CONCLUSIONS

It is proved that as a human behavior is a cognitive function or a mental act, rather than a manual action, the usage of the event tree description does not create the realistic image for the character of the activity carried out. This is because cognitive acts are not so easily separated into distinct and sequential subtasks, as is the case with manual actions. Human cognitive functions, such as diagnosis and decision-making, and particular the notion of a "cognitive error", play an increasingly important role in HRA. The standard approach used to model cognitive functions in HRA event trees has been to decompose these functions into their assumed components or subtasks, e.g. problem identification, decision-making, execution and recovery. This may at first time sensible, but there are a number of problems related to it:

- The number of subtasks that need to be modeled in the HRA event trees in order to incorporate the cognitive functions would easily become excessive, making the event tree complex and difficult to model.
- It is difficult to obtain appropriate and reliable Human error Probability (HEP) data on each of the (assumed) components of cognition.
- There are doubts as to whether such modeling is psychological realistic.

It is made a comprehensive list of the shortcomings of first-generation HRA approaches. These shortcomings should be kept in mind in the overall assessment of quantitative risk estimates.

- *Deficiency of information*: Within HRA there is a general lack of appropriate data can be used for quantitative predictions of human erroneous behavior. Much of the data used comes from simulator studies, and there is no basic agreement on how these data reflect the real world, or how they can be modified in order to achieve this.
- *Lack of order in revealing errors*: Fragola (2000) argues that this is one of the most glaring weaknesses of conventional HRA approaches. Well-intended actions with unintended and undesirable consequences largely remain an "unknown" area in HRA.
- *Inadequate proof of accuracy*: Demonstrations of the accuracy of HRAs for real-world predictions are almost non-existent. This goes particularly for non-routine tasks.
- *Inadequate psychological realism*: Many first-generation HRA approaches are based on highly questionable assumptions about human behavior.
- *Inadequate treatment of performance-shaping factors:* In most first-generation HRA approaches the influence of factors such as management attitudes, safety culture, cultural differences, etc. (e.g. organizational factors) are not treated sufficiently. There is also little knowledge on how these factors actually affect performance.
- *Inadequate treatment of dynamic situations*: Conventional HRA approaches are relatively static, meaning that they do not consider the dynamic situations under which tasks are performed.
- *A mechanical view of humans*: Conventional HRAs use a decomposition approach adapted from reliability analysis of mechanical system (i.e. hardware) on human actions. This decomposition is binary, i.e. either success or failure. In addition, this view results in a focus on the observable (or overt) aspects of human behavoiur, instead of the more "internal structure" of the problem space.
- *Quantitative rather than qualitative focus*: This is argued by the disadvantages of more conventional HRA approaches, due to the quantitative estimates produced are so uncertain.
- *High level of uncertainty*: Different HRA methods may produce widely different values for the Human Error Probabilities (HEPs) when used on the same tasks.
- *Inadequate determination and understanding of error cause*: This weakness is in accordance with the weakness of "inadequate psychological realism". Most of the first-generation HRA approaches run into problems when trying to explain why humans make error.
- *Lack of a systematic analysis of task structure*: Analysts who use HRA methods/ techniques make judgements based on the information obtained from task analysis. Therefore, a systematic task analysis is essential to enhance the validity and consistency of the HRA results. Most first generation HRA approaches lack such a systematic task analysis.

- *Inadequate provision of error reduction strategies*: Only several of HRA methods provide clearly defined strategies for how the estimated HEPs may be reduced in order to enhance safety.

In the last decade the constructive criticism directed at the techniques of conventional HRA have resu.ted in various efforts to resolve the stated problems. Therefore, the second-generation HRA approaches are oriented to the authorization the limitations of the first-generation HRAs.

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IMPACT OF LOGISTICS AND SHIPPING IN THE SUSTAINABLE DEVELOPMENT OF SOCIETIES

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Definitely, although not very obvious, shipping affects the daily lives of the majority of the world population. The socio-economic implications of logistics undoubtedly affect the social development of cities. With the implementation of sustainability in the supply chain, and not only think of a commercial profit but in an overall benefit in mind the impact it is having on the ecosystem. Solutions, research and discussion topics to open an academic contribution is interesting, that would open up discussions.

1. INTRODUCTION

The Maritime shipping guarantees the movement of about more than 90% of the goods being transported worldwide[1].

Having in mind this percentage, we understand the importance of this transport system, which over the years has become the cornerstone of supplies most of the world's communities, especially in the western hemisphere, which in most cases, it imports the majority of the goods than it consumes.

But shipping alone is not sufficient, as is known, it is necessary for interconnection with other modes of transport to carry the goods to the final customer or end consumer sites, hence the importance of strengthening the supply chain.

Initially, these transport systems were offered separately, ensuring shipping only "port to port." Over the time, the evolution of transport systems and the search for added value and qualitative improvement in ordinary operations, led to the trend "door to door", where, as is known; is necessary to connect with different kinds of transport, for complete the final stage of delivering the goods to the final customer, in some cases with a step by trains, and in other cases with the truck directly from the terminal.

The truck's companies, in most cases are formed by small and medium businesses and personal self, which is a sub-contracted service that thanks to intermodality provides the customer with a single cost and especially a common documentation, which generates the sought value to the land-sea section and aims to ensure customer's reliability in delivering his merchandise.

However, it should be noted that this increases costs, because if it is true that maritime shipping is the cheapest way of transport, it is also true that road transport is the most expensive, thus, the hability of the maritime lines, to negotiate prices based on the high volume of movement, generates to the client attractive offers highly competitive, which affects the final price of the contract of carriage.

In most carriers, these costs are separate, that is, one side pays the freight and expenses proper cargo terminal at port of origin, and secondly the delivery charges are paid at the port of destination, which allows the benefits of management are shared between the offices that actually make it, maintaining a common relation to the same company with different locations, providing a unique corporate image to customers.

Transport as is known, crosses the globe to bring these goods to those buyers who are waiting to turn sell them to third parties, depending on the distance between the port and place of delivery, it is necessary to interconnect different modes of transport, in what we call the supply chain.

2. THE SOCIAL IMPACT OF SUSTAINABLE LOGISTICS

Given the importance of freight, we can say that the development of a nation may depend largely on logistics.

The supply chain is a major source of income for the economies of countries and companies involved therein.

Today's businesses in the logistics sector to actively participate in Sustainable Development which "is a socio-ecological process characterized by a behavior for an ideal" [2] that is to generate a given development respecting the environment in which we live.

This ideal is infinitely approaching and it is precisely this approach that allows infinite process of sustainable development is maintained over time and space with the infinite ingenuity of man, which today is unattainable in the near future may become a target long term then become a short-term goal and finally a reality.

If part of the above principles, and sustainability should be a permanent reality in all companies that intend to stay in time, but it is common knowledge that in most cases, this has remained in theory and reality is unfortunately different.

The polluting effects of freight transport have grown over the years, and now, has not yet found a solution applicable to use alternative fuels for ships and trucks and trains in some cases, what has generated the Economic growth in the logistics have not been proportional to the desired sustainability by being very important and must be the reason for all international business: the Company.

In some cases, global logistics growth is back to society, and even approaching it from the standpoint of preserving the environment, society has every interest in preserving it, because the survival of the species depends mainly on the existence of the planet, yet to see major projects logistics group takes into account the income, technological improvements, technical advances, but no, at least to the extent that they should always do the fact that the development is "sustainable" and ensure that growth is not detrimental to the environment.

Social welfare should be the main reason for a country's economic growth because of these big business challenges, originating sources of employment, new economic activities that work with improving the social status of people living in that area, thanks the conversion of spaces for public use, or plan of land uses, where up new areas of logistics development which always has a social benefit.

The main suppliers in the world are the populations with the highest degree of poverty, and the idea of sustainability is often away precisely because many of the more powerful the aim to establish in large cities.

One of the best known is the export of timber from the Amazon deforestation criminal and other forests, worldwide logistics but this is unsustainable, which ends in many homes around the world in various forms, from furniture to the ground inside the containers, etc. and even indiscriminate logging in Africa, which also plays an important supply chain but not working with social development or economic growth in the region, this represents one of the most important challenges to overcome.

Fig. 1: The logistics of wood source.Source: www.delmas.com

3. POLLUTING EFFECTS OF TRANSPORT & RISK FACTORS

The effects of goods's transport aid the destruction of the ozone layer and global warming.By other hand, vehicles are also the main source of noise pollution in large cities.
 In Spain, for example; in 2005 was 27,657 thousand cars. It is considered that 74% of the Spanish population is subjected to high noise levels [3]

Pollution related to transport continues to increase each year, despite policies to reduce greenhouse gases. These account for 22.6% of CO_2 emissions and 37% for oxides of nitrogen [4]

Growing energy demand and energy sources are depleted. The 15% of the world population consumes 70% of energy and natural resources available on the planet.

According to the World Trade Organization, if all countries could reach the western way of life, it would take three Earths planet to supply us with the necessary energy and natural resources [5]

Moreover, as can be seen on the next graphic, the price of oil continues to rise and climate change is accelerating as a result of our current way of life.

4. POSSIBLE SOLUTIONS

Rethinking the theoretical foundation of logistics today, brings a change of consciousness that allows us to address sustainable, economic growth and social development. Some possible solutions studied by experts are:

• Reduce emissions from transport units used in logistics.The current logistics depends mainly on the road, for achieve que "door to door " transport; so, the truck for the moment is irreplaceable, one solution would be to encourage the use of non-polluting means-based "biofuels", which make more effective reduction of CO_2 emissions.

• As is well known, Biofuels are fuels derived from biological origin of organic remains of renewable materials. Most employees are biodiesel and bioethanol and the biodiesel is produced from vegetable oils and animal fats.

• By other hand; Bioethanol is an alcohol produced by fermentation of sugar products as sugar beet and sugar cane. It also comes from cereal grains such as wheat, barley and corn.

Among the advantages provided by biofuels, will point out just a few:

• Reduce emissions of CO_2 in the atmosphere, fighting against global warming.

• They are biodegradable.

• Reduce dependence on oil and gas.

• Revitalize the rural economy, foster new markets and create jobs. (Social benefits)
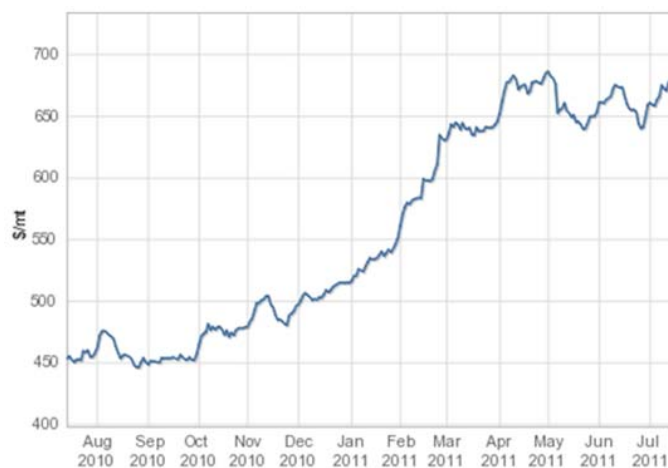
Graphics that demonstrate the evolution of the IFO 380 price during the year 2011 (www.bunkerworld.com)

Fig. 2: Graphic showing the growth of the price of IFO 380 during the year 2011, Source: www.bunkerworld.com

However, the transition from fossil fuels to biofuels is to be performed with great responsibility, and progressively, without affecting the food market. Recent experiences have shown that inefficient management of these resources, increased cereal prices, and therefore of both vegetable and meat foods, directly affecting the economy of the societies, which promote rather than worsened the quality of lives of people and favored speculation in such strategic sectors such as food.

An efficient, matter, among other things, encouraging new productions, establishing new points of cultivation in areas previously not engaged in agriculture, benefiting the economy of populations at risk of exclusion zones in economically reviving the past could have been economically inactive, and if farmers in the food sector also want to enter this market, should ensure a verifiable manner, which would not affect the production of foodstuffs, demonstrating its length and opening new areas just for this purpose.

Moreover, all this process must be constantly accompanied by a system of R+D+I that would ensure continuous improvement and seeking to optimize these processes.

Additionally, the sun, wind and water are good allies because they are inexhaustible sources that pollute so little, and the environmental impact they cause is minimal.

As can be seen, clean energy like solar, wind, biomass and biofuels are a solution and the logistics sector is not excluded in this topic.

5. CONCLUSIONS

Encourage the Short Sea Shipping, which certainly competes with road transport which the European Union, maintaining similar growth rates, measured in tons per kilometer of about 40% and where in the available data, between 1990 and 1997 grew by 23% in tons per kilometer of road transport being 26% in tonne-kilometers [6]. These emissions cause the inhabitants of the traffic areas, are subject to pollution levels well above those recommended by the WHO [7].

This type of transport must be sold to the owners of the transoceanic shipping as an opportunity for profitable and efficient business that is competitive and guaranteed ship calls on a regular, uninterrupted service, and performance bonds, as the be vessels of short routes, and rely on existing demands in the area, in many cases without sufficient volume to Maximize scale, canceled, causing delays in loading on port occupation costs, and problems in many cases end customers on site, waiting for their merchandise margins short time, receiving a service in many cases inefficient.

Keep in mind that it has been shown in several studies, the Short Sea Shipping, reduce pollution, as an example highlighting the values that are dramatically reduced, for example the Carbon Dioxide, Nitrous Oxide, Carbon Monoxide, non-methane volatile compounds, and others.

This is why we think that in places where this type of transport is applicable, must work through government policies and business initiatives that allow water to increase traffic.

Sustainability must go hand in hand with social benefits such as employment generation citizens of the areas in business development, education for local people working in the areas of logistics, but a complete shift in consciousness that can allow the entities involved in these countries begin now with the concept of preservation of the environment as normal way of life, and the fundamental basis of business developments in the logistics sector.

One of the most innovatory is the creation of Motorways of the Sea as a model of clean and efficient transport, which consist of short-sea routes between two points, less distance by land, which through intermodal transport costs significantly improving the logistics chain

It is also more convenient for shipping while reducing emissions from transport reduce congestion and noise pollution caused by road transport.

In short, the logistics sector must begin to work with the ideas you have as a central socio-ecological benefit of the companies, because if not, we will continue aimed at making the same mistakes.

But without a sustainable development is impossible to benefit society, and if it keeps growing back to the people, will be not eough to preserve a planet if most of its area is inhabited by humans eventually sentenced to death by starvation or suffer the stigma of forced displacement, which generates social inequality, marginalization and humiliation of

their dignity by a lack of knowledge and understanding of the causes of these social phenomena and transport and logistics chain can do much in favor of a better way of life

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A STUDY ON AN AMMONIA BASED REFRIGERATING SYSTEM USEFUL FOR A MORE EFFICIENT FISHING INDUSTRY

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Fishing is an important sector in most developing countries. The Turkish fleet consist of 1566 ships, fishing vessels representing 11% of the total.

In the framework of the international competition, Turkish autorities are facing the need to modernize the fishing vessels. In this study is analized a single stage vapor compression refrigerating cycle working with ammonia. Ammonia is environmentally benign in the atmosphere and has a proven safety record.

For several values of the compression ratio is analyzed the variation of some parameters of the refrigerating system, being revealed information useful for the plant operation. When it is aimed the plant improvement, it is used the exergy analysis. By estimating exergy destructions in each component of the plant, it is found the first element needed to be optimized.

1. INTRODUCTION

Fishing is a key economic sector in most developing countries. Fish, shellfish and other products from lakes, rivers, seas and oceans, are essential sources of proteins. Fishery products also provide significant employment and export earnings. In the developed countries, large size trawlers, factory ships, mother ships, special purpose tuna seiners, purse-seiners, cargo ships and reefers have been used for deep sea fishing and for fish transport involving trawl or transport duration of many weeks or even a few months.

During the journey from catch to consumer, the fishing industry is dependent on the cold chain to ensure the commercial viability of these products. The safety of the food, its shelf life, taste and appearance all are provided by reliable refrigeration which is able to retard spoilage.

In the favourable context of growing markets, the fishing industry is facing important challenges: environmental problems and technical and scientific progress. Nowadays, the potential of the fishing industry is very high. But this industry will be able to continue efficient and environmentally responsible operation only with major modifications.

To ensure good quality, the fish catch should be cleaned and chilled to 0 °C and frozen, as quickly as possible. Chilling and freezing operations do not improve the fish quality, but slow down the bacterial, enzymatic and chemical actions thus extending the shelf life of the fish. These operations continue even after freezing at temperatures above –30 °C and for some high fat seafood continue below –30 °C. The high fat seafood should be kept at –40 °C to –50 °C if stored for long periods. The bacteria multiply fast at temperatures above 0 °C

(melting ice). The shelf life of a fresh catch may be diminished by several days due to delays of only a few hours in handling.

Turkish Merchant Marine Fleet consists of approximately 1156 ships (Kilic et al, 2009). An overview on the Turkish fleet profile is given in Table 1. Seen the length of the Turkish coastline, fishing is an important contributor to the economy, statistics showing that in Turkey fish consumption per person is about 6 kg/year.

Table 1: Ship distribution in the Turkish fleet

Ship type	Number	Total Grt	Average Grt
Research vessel	5	1843	367
LPG	7	26681	3812
Fishing vessel	176	49379	281
Tug	220	93685	426
Passenger/ Ro- Ro	82	153373	1870
Passenger	212	164367	775
Chemical Tanker	99	378039	3819
Ro-Ro Cargo	27	431108	15967
Container	43	432525	10059
Oil Tanker	137	674016	4920
General cargo	454	1199155	2641
Bulk carrier	104	2280799	21931

Due to environmental challenges, there is a need to update technologies on board of fishing vessels. This situation became of concern in Turkey and it has made the relevant Turkish authorities aware of the importance of international competition in the field of fishing trade and its dominant effects in sea transportation. When speaking of new technologies on board of fishing vessels, a generally accepted option is the ammonia design, which is the environmentally friendly alternative for this industry.

2. SOME CONSIDERATIONS ON AMMONIA AS A REFRIGERANT

Particular applications of the refrigerated industry related to the fishing industry are: ice, refrigerated seawater, refrigerated compartments and cold stores. A common feature in all of these applications has been the traditional use of CFC-based refrigeration technology. Because of the negative impact of CFCs, HCFCs and other ozone depleting substances (ODS) on the earth's stratospheric ozone layer, the international community has agreed to reduce and eliminate the production and use of these chemicals. Under the Montreal Protocol on Substances that Deplete the Ozone Layer, developing countries agreed to a specific phase-out timetable, with a total phase-out by 2010. HCFCs, called transitional substances because they have been used as a replacement for CFCs in some applications, share the fate of CFCs. Developing countries have time until 2030 to complete the phase-out task. To meet the phase-out targets, the fishery industry must adopt new refrigeration technologies.

Ammonia has been intensely used in some refrigeration equipment on board the ships. Thus, ammonia is meet on reefer ships, as refrigerant for sorption ice machine, but also on fishing vessels as single refrigerant or in combination with CO_2, especially for low temperatures.

Ammonia is a natural medium-temperature refrigerant, having very good environmental and thermodynamic properties:

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1) Ammonia has an environmentally friendly behavior: its Ozone Depletion Potential (ODP) is zero and its Global Warming Potential (GWP) is also zero.

2) Ammonia has critical temperature and critical pressure of 132,3^{o}C and 11,33 MPa, higher than that of R 22 (92,6^{o}C and 4,99 MPa) or R 410 A (70,2^{o}C and 4,79 MPa). Ammonia has a low standard boiling temperature (-33,4^{o}C), a large volumetric refrigerating capacity, a high conductivity coefficient, a higher evaporative latent heat compare with the one of R 22 (6,4 times) or R 410A (5,5 times) at –15°C, a low throttling loss and a high refrigeration coefficient. Are found smaller size compressors and heat exchangers when using ammonia, compared with R 22, for the same temperature and refrigerating capacity.

3) The molecular weight of ammonia is 17 and his vapor density is lower than air; in case of leakage, ammonia rises and escapes easily; also it easily dissolves in water while a large leakage occurs.

4) Ammonia is cheaper than R 22, for the same volume.

5) Ammonia refrigerating systems have an excellent safety record, safety being partly explained by its specific odor which announces even the minor leaks.

Still, ammonia is far of being the irreproachable refrigerant. He shows also some disadvantages as:

1) A high adiabatic coefficient and high compressor discharge temperature at low evaporating temperature and high condensing temperature. It is imposed the cooling to assure the function of the lubricating oils.

2) Ammonia corrodes zinc, copper and copper alloys, being needed materials like steel or aluminium.

3) Ammonia causes health troubles to persons exposed to concentrations over the limit, and causes explosion with flame for a concentration in air of 16–25% at high temperature.

In the following, ammonia is working in a vapor compression refrigerating system which comprises a compressor, expansion devices, an evaporator and a condenser.

The refrigerant absorbs heat and evaporates at a low pressure, turning in a gaseous state. The obtained refrigerant vapor are then compressed to a higher pressure, in order to deliver the heat it has gained to ambient air or water in the condenser – where turns back into a liquid. The liquid refrigerant passes back to the evaporator, but before entering the evaporator, the pressure of the refrigerant must be reduced to the evaporator pressure to be possible the evaporation at low temperature. Thus, the throttling devices situated in the line between the condenser and the evaporator, close to the last one.

The vapor compression refrigerated cycle above described is presented in Figure 1.
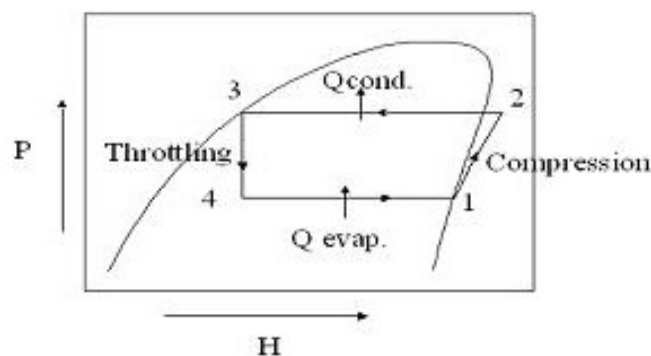
Fig. 1: Simple vapor compression refrigeration cycle in (p-h) diagram

3. PERFORMANCE EVALUATION OF THE ONE STAGE VAPOR COMPRESSION REFRIGERATION SYSTEM

The performance of refrigerators is expressed in terms of coefficient of performance (COP). COP is a standard criterion for performance analysis of a refrigeration cycle. The COP is the ratio of total removed heat from evaporator divided by required total input work in compression section.

The first law analysis method is widely used to assess thermodynamic systems but this method is focused only on energy conservation. That is why it cannot show how or where irreversibility occurs in a system or process. All real processes are irreversible because of effects like chemical reaction, heat transfer through a finite temperature difference, mixing of matter at different compositions or states, unrestrained expansion and friction. The maximum work obtainable from a system using the environmental parameters as reference state is called exergy and is given in terms of four components: physical exergy, kinetic exergy, potential exergy and chemical exergy. The kinetic and potential exergies are usually neglected.

To determine the irreversibility, the exergy analysis method is applicable.

Exergy analysis combines the first and second laws of thermodynamics, resulting a powerful tool for analyzing both the quantity and the quality of energy utilization. An exergy analysis is usually aimed at determining the maximum performance of the system and identifies the sites of exergy destruction.

The reversible work (W_{rev}) is the maximum amount of useful work output or the minimum work input for a system undergoing a process between the specific initial and final states in a totally reversible manner. Any difference between the reversible work (W_{rev}) and the actual work (W_u) is given by irreversibilities associated with the process; this difference is called irreversibility or exergy destroyed (Dincer and Kanoglu, 2010). In other words, exergy destruction indicates the loss of exergy inside the process boundaries due to irreversibilities:

$$Ex_{des} = W_{rev,out} - W_{out} \quad or \quad Ex_{des} = W_{in} - W_{rev,in} \tag{1}$$

Irreversibility is a positive quantity for all irreversibile processes; it can be seen as the wasted work potential or the last opportunity to do useful work. It is the energy that could have been converted to work, but was not. The smaller the irreversibility present in the process, the greater the work that is delivered. The performance of a system can be improved by minimizing irreversibility associated with it.

The exergy analysis of a single stage refrigeration cycle was developed in order to assess the magnitude of exergy destructions in each component of the analyzed refrigeration system.

4. RESULTS AND DISCUSSION

In the following it is analyzed the working of the refrigerating system by varying the compression ratio (the head pressure divided by the suction pressure). Are searched corresponding values for the refrigerant temperature at the compressor outlet, vaporization temperature, refrigerant volume rate at compressor inlet, specific refrigerating power and COP, where using ammonia as a refrigerant (see Tables 2–6). One by one, the compression ratio (β) will be equal with 3,5,7,9. High values of the compression rate have negative influence on the plant operation, this is why this parameter is limited to values between 8–10, when using ammonia.

Table 2: The influence of the compression ratio on the refrigerant temperature at the compressor outlet

β	3	5	7	9
t_2 (^{o}C)	80	130	170	200

With increasing of β, t_2 is also increasing. This temperature should not have high values, otherwise are worsen the conditions of lubrication of the compressor.

Table 3: The influence of the compression ratio on the vaporization temperature

β	3	5	7	9
t_0 (^{o}C)	5	−10	−17	−22

Normally, the vaporization temperature should be lower in order to be possible the heat absorption at a temperature lower then the ambient temperature.

Table 4: The influence of the compression ratio on the refrigerant volume rate at compressor inlet

β	3	5	7	9
v_1 (m^3/h)	93	87	83	79

The volume rate should have low values in order to get low weight and small dimensions of the compressor.

Table 5: The influence of the compression ratio on the specific refrigerating power

β	3	5	7	9
q_0 (kJ/kg)	210	208	205	203

The specific refrigerating power should have high values in order to ensure low mass rates.

Table 6: The influence of the compression ratio on COP

β	3	5	7	9
COP	6	3	2	1,3

Since COP is the ratio benefit/cost, the "efficiency of a refrigeration" should have, of course, high values.

In Table 7 are given exergy destruction rates in the components of the refrigerating system, for a compression ratio $\beta = 5$.

Table 7: Exergy destruction rates for $\beta = 5$

Component	Ex$_{des}$ [kJ/kg]
Condenser	107
Compressor	78
Throttling valve	27
Evaporator	27

The highest values for the exergy destruction rate is meet in the condenser. This is an important information in case of the plant optimization.

Hierarchically, the second component that should be improved is the compressor.

5. CONCLUSIONS

Fishing is an important part of the Turkish economy, being known that fishing industry relies on refrigeration. Modern equipped fishing vessels means also adequate refrigeration on board the ship.

In this study was analyzed the influence of the compression ratio on some parameters of the single stage refrigerating cycle, when using ammonia as a refrigerant.

When $\beta = 3,5,7,\text{or }9$, appropriate values for the refrigerant temperature at the compressor outlet are obtained for $\beta = 3\text{ or }5$ ($t_2 \leq 145^{\circ}C$), but adequate values for the vaporization temperature are seen for higher values of β.

Also, suitable values for the refrigerant volume rate at compressor inlet are meet for low values of β, just like the specific refrigerating power.

When using the natural refrigerant ammonia in the plant, the optimization hierarchy revealed by the exergy analyzes indicates that the condenser should be the first component to the improved.

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MARITIME TRANSPORT IN THE BLACK SEA – A KEY OF THE DOOR OF EUROPE

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The Black Sea constitutes a unique link between Asia and Europe and has a very important role in world trade as BSEC Countries generate 1/5 of the world trade. With a strategic importance to the West, and to Europe in particular, is bound to increase substantially in the years to come. Given the region's geostrategic position as a natural link between Europe and Asia, and between Central Asia and the Middle East, it constitutes a vital trade link as well as an important area of transit.

1. INTRODUCTION

The Black Sea basin is a strategically important region at the crossroads between Europe, the Middle East, and Asia. The region serves as a pivotal East-West and North-South corridor and a crossroad of geopolitics, commerce, energy, and culture where the interests of four major international actors overlap: the European Union, the United States , NATO, and Russia. It is a very dynamic area that presents various challenges and offers numerous opportunities. As a result, its development requires special consideration by policy makers.

Although the Black Sea region has succeeded to attract the focus of regional actors and major international players in the last few years, there are lingering misconceptions that need to be addressed. Countries and organizations often approach Black Sea issues from specific national interests or on a bilateral basis. What is missing is a strategic vision of the region as a whole and a more comprehensive strategy for its development.

As an important crossroad of commerce, the Black Sea region offers numerous opportunities for regional cooperation. However, its location also facilitates illicit trade in migrants, arms, and drugs. Such threats should not be underestimated as they fuel political and terrorist movements and disrupt regional economies. With Bulgaria and Romania becoming the external boundary of the EU, border security in the Black Sea area is becoming extremely significant for Europe as a whole.

European Union has carried out several projects having a direct effect and influence on the maritime transport in the Black Sea rim. Some of them are closely linked with the Pan-European Transport Corridors whereas the others are related to renovation of the ancient Silk Road.

Transport services exist to serve and foster the trade, be it domestic or international, and without the inclusion of the said services the trade cannot be implemented properly.

Shipping at this stage is the dominant means of transport for the World trade as the Earth is almost covered by the sea.

Shipping as the source of cheap transport has opened up wider markets to specialization and since the mid-1960s two main developments in shipping - unitization and bulking - have played a major role on increasing the productivity in sea transport.

Seaports as the ends of the shipping transport are purpose-built and commercial establishments where services for ships, cargoes or cargo groups, passengers and – in more general terms port users - are rendered.

They are geographical areas, acting as link in the transport chain and at the same time play important functions as distribution centers for national as well as regional economies by way of hinterland networks.

The demand for port services arises from the existence of shipping trade; services for ships, cargoes or cargo groups, passengers and – in more general terms – port users are rendered at such purpose-built commercial establishments.

Emergence of the global economy together with growing consumerism has led transport companies and ports to become more responsive than ever to the special needs of their trading partners. Customers on the other hand have tended to become more demanding for service quality, competitive pricing, timely and reliable delivery of goods - ultimately pushing ports and shipping companies to restructure themselves with larger, costlier and technologically more advanced investments.

2. THE TURKISH STRAITS SYSTEM

The Black Sea together with the Turkish straits system – TSS - and the north-eastern Mediterranean, starting from the Gulf of Iskenderun at the eastern end, are two major routes used to transport the oil produced in Russia, Azerbaijan and Central Asia to the west.

The catastrophic consequences of oil spills in many critical regions, such as Istanbul, have been admitted by various authorities, leading to comprehensive research in the region. The region is relatively well-known in terms of its hydrodynamic characteristics, and there are several ongoing efforts to develop an operational near-real-time prediction system for oil spills.

The Eastern Mediterranean Basin and the Black Sea constitute two largely isolated water bodies constrained by water exchanges through straits. Both regions are highly sensitive to anthropogenic and climate induced variations, as the surrounding land mass are highly developed in terms of industry and tourism and they are in close proximity to major atmospheric centers of action (the North Atlantic Ocean, the Sahara and the Indian Ocean). Their oceanographic features are briefly reviewed below from an oil spill perspective.

The Black Sea is one of the world's largest inland marine environments and represents the connection to the Mediterranean Sea is through two narrow straits: the Bosporus and the Dardanelles. The dissolved oxygen depletes at around 75–150m, depending on the region, and the rest of the water column up to 2,000m is anoxic; is known as the largest anoxic water body in the world. The freshwater input from rivers and the atmosphere exceeds the water lost through evaporation; therefore, the Black Sea has a positive water balance.

The difference is balanced out by the net outflow through the Bosporus. The fluxes through the straits, dramatic changes in topography, dynamic atmospheric forcing and freshwater input from rivers are the principal factors governing the circulation and thermohaline structure of the Black Sea.

The upper layers of water are characterized by a predominantly cyclonic, strongly time-dependent and spatially structured basin-wide circulation.

The Bosporus and Dardanelles Straits, together with the Marmara Sea (an area of 11,500km2) that lies between them, constitute the TSS. The system possesses a two-layer flow structure in which the lower-layer flow is driven by the density differences between the Black Sea and the Aegean Sea, and the upper-layer flow is driven by the higher sea-level elevation of the Black Sea with respect to the Aegean Sea.

The flow in both straits is hydraulically controlled. In the Bosporus Straits, three hydraulic controls exist due to contraction at the middle and the sills near either end, which lead to the development of so-called maximal exchange flow conditions.

The flow regime in the Dardanelles Straits differs from that of the Bosporus in that there is a single hydraulic control at the mid-strait constriction section, which implies a sub maximal exchange.

The Black Sea and the Caspian Sea area together with the Caucasus land bridge became one of the strategically most important regions for the transport of freight, passenger and energy. The demand on efficient and sustainable transport services is driven by the oil and gas production by the Caspian Sea littoral countries, their continuously and strong growing BIP with corresponding export/import cargo flows, West China's industrial development as well as the visibly more intensive incorporation of the Caucasus and Black Sea countries into the international globalization and trade process. Integration, acceleration of goods movements and transport cost reduction become only possible in case of a transport network functioning without major bottlenecks, administrative barriers or unbalanced development within the maritime transport links and between other regions.

Fig. 1: The Mediterranean basin(Source: www.seanews.info)

3. CONCLUSIONS

Black Sea area is very important from strategic point of view and deserves more weight than was given so far by the international community.

The entire Black Sea region, be it a Member State or a candidate country, is covered by various policies and instruments of the EU, which has multiple interests in the Black Sea.

Regarding energy, the EU wants to build alternative transit routes to supplement the existing ones from north to south. For this, the region must work more closely and did not

compete together. EU can better harness the potential of these markets in the Black Sea region, while helping those countries through technical assistance.

Romania's EU shares the concern regarding the frozen conflicts in the region, and we believe that we must work with our neighbors to meet citizens' needs and expectations to resolve threats. Frozen conflicts can explode at any time, affecting the EU. What happened in the Balkans in the '90s is an example; conflicts can be extended from the Caucasus and the Middle East. As regards Transnistria, in 2005, the EU and the United States were invited to participate as observers in discussions regarding that conflict mediation and the EU has appointed a representative to Moldova, while providing assistance to solve the Transnistrian problem.

An EU action in the Black Sea region is about changing the structure of the social and political weight, so that it becomes more open, more democratic and more predictable. So far as it did in other candidate countries, the EU can play a catalyst role in the modernization of society. Romania, through a sustained diplomatic activity in the region, strengthens cooperation and play an important role in several initiatives, including the Black Sea summit. Romania's commitment to move beyond declarations and to engage in practical activities, demonstrates the commitment to devote future actions to further contribute to the policymaking community and to strengthen existing mechanisms of regional cooperation.

The new policy of Romania in the Black Sea starts from two fundamental premises. It's about two parallel realities to a point, but to intersect at this stage to confuse the medium and long term. It is a new reality in the region and in Europe.

The EU is changing and will change further. Europe no longer can afford to treat the Black Sea area as a commuter. Instead, the Black Sea finds increasingly more prominent on the agenda of a central European, Euro-Atlantic agenda, and even on the agenda of the international community, considering the developments in the energy plan.

Euro-Atlantic community must be much closer to this region and requires a common effort and national initiatives to harmonize with the international. In formulating these strategies must take into account both our realities, and realistic assessment of the security environment in a comprehensive process for understanding the transformation of international relations is a precondition for a national strategy.

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INVESTIGATION OF POWER SAVING BY INCORPORATING KITE OR BALLOON TECHNOLOGY ON BOAT IN MALAYSIA WATERS

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Rising oil prices, increasing competition in the maritime industry, climate change and pollution are significantly more prevalent among the causes of the search of alternative energy other than the use of fuel. One of the forms of energy that is suitable to use by boats is the wind energy. Kite has been used by several types of ships in experimental stage to complement the main engine to move the ship. This study is describe a few subtopics on wind energy potential in Malaysia development of wind assisted ship devices and the major discussion on the feasibility of incorporating kite technology to move the boat in Malaysia (Terengganu) waters that have been selected to save the consumption of fuel. The amount of power saving was calculated using the formulae from the previous research. Then, economic assessment was carried out based on amount of power saving. Using kite propulsion technology, fuel consumption was reduced around 30% per year thus resulting in lower and operation costs on the particular routes. The results of the economic assessment indicate that, annual average cost for boat with kite sail is lesser than annual average cost for boat without kite sail. It is expected that the capital investment in the new device will be recovered within 9 years

1. INTRODUCTION

Nowadays, fuel is the major energy resource that has been used in transports including marine transportation. Increasing oil prices in 2008 have started a world-wide discussion among experts on how to reduce the fuel consumption in transportations especially in ships. According to (M.Azlan, 2009) many researches in Europe and Japan had started to develop alternatives energy to cover the use of fuel energy. In maritime industry, the alternatives energy is used for ship propulsion is expected to reduce the fuel consumptions. One of the alternative energy that widely used is wind energy. Wind energy is one of the useful energy for the ship propulsion when it is sailing. This is because the wind can be collected easily and very friendly to the environment. This paper studies on the kite technology with wind assisted propulsion for boat in Malaysia waters. The study investigates the suitability of using kite as a sailing device on boat around Malaysia waters in order to reduce oil usage and at the same time for safe our environment from pollutions.

2. REVIEW OF WIND ENERGY POTENTIAL

2.1 Potential of Wind Energy in Malaysia

Generally there are two types of monsoons in Malaysia, the South-West Monsoon, normally from May to September and North-East Monsoon from November to March. These monsoons given the different directions of wind has influence to the development of wind ship technology especially kite ship (M.Azlan,2009). According to data that was obtained from Malaysia Metrology Department (MMD) and a few of researchers (E.P. Chiang, Z.A. Zainal, P.A.Aswatha Narayana and K.N. Seetharamu, 2003; H.C. Ong, T.M.I. Mahlia, H.H. and Masjuki,2010; Tick Hui Oh, Shen Yee Pang and Shing Chyi Chya, 2009) the wind condition in Malaysia is changing according to times and places. The studies from Solar Energy Research Group from Universiti Kebangsaan Malaysia (UKM) in 1980-1991, found that the wind velocity in Kuala Terengganu and Mersing area is the highest compared with the other regions in Malaysia (Tick Hui Oh, Shen Yee Pang and Shing Chyi Chya, 2009). The use of risk approach for hybrid technoloogy promise reliability of novel technology for ship power (Sulaiman et al., 2010).

Figures 1 and 2 show the latest wind speed and direction data from January until December 2008, at latitude 1.0-8.0 North, longitude 100-105 East that was collected from Metrology Department (MMD). The data was obtained by using methods that were mentioned in reference (M.R. Islam , R. Saidur and N.A. Rahim, 2010). On the other hand, Table 1 shows the average data that has been used in this research.
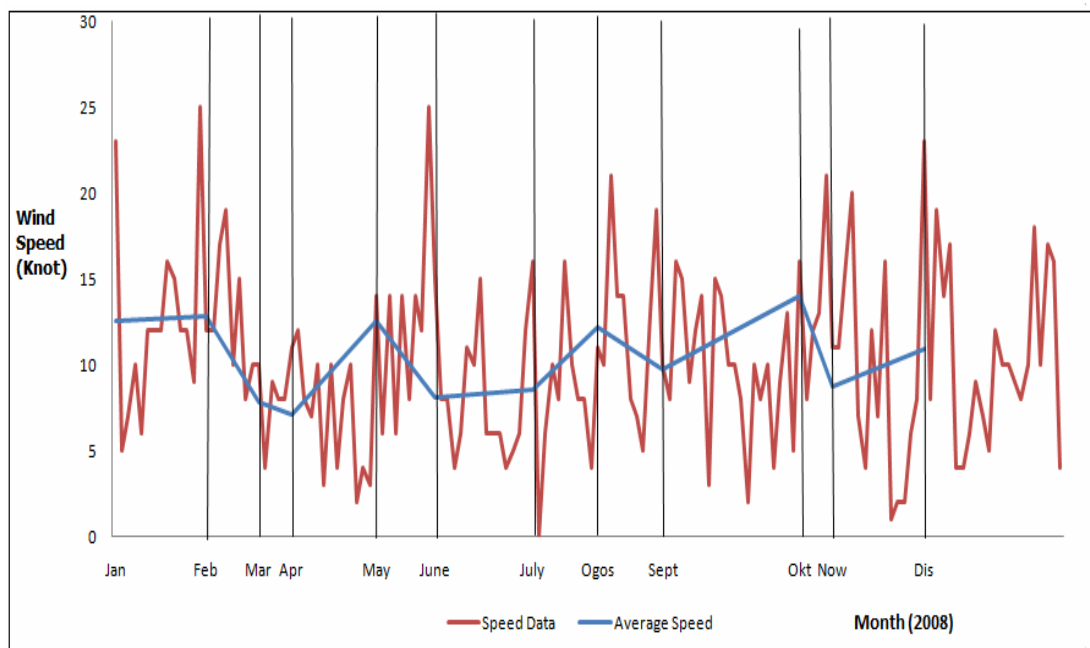
Fig.1: Wind Speed Data from January until December 2008 in Terengganu Waters
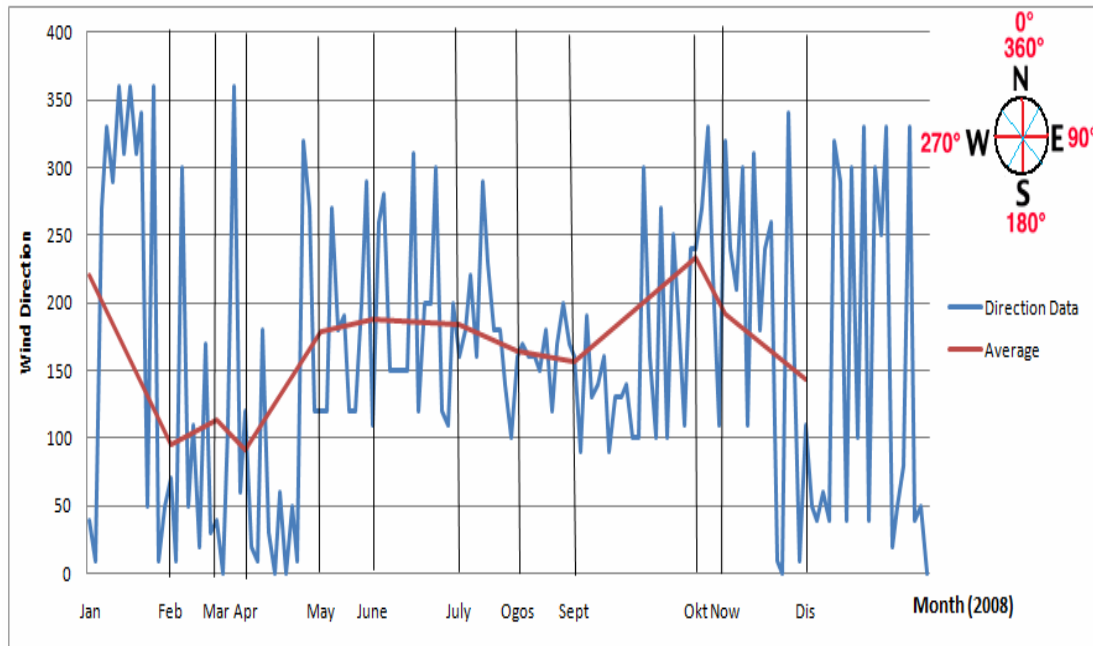
Fig. 2: Wind Direction Data from January until December 2008 in Terengganu Waters

Table 1: Average Wind Speed and Direction 2008

Month	Wind Direction [degree]	Wind Speed [knots]	Wave Height [meter]
January	220	12.57	0.5
February	95	12.87	1.5
March	114	7.80	0.5
April	92	7.08	0.5
May	179	12.56	0.5
June	187	8.13	0.5
July	184	8.60	1.0
August	164	12.20	0.5
September	156	9.76	0.5
October	234	14.00	1.5
November	191	8.79	1.0
December	144	10.91	1.0

The data shows wind energy in Malaysia especially Terengganu has great potential to be developed. According to studied from a few researcher and institution in Malaysia, they are suggesting to develop the wind device in Malaysia territory. For example in article (Tick Hui Oh, Shen Yee Pang and Shing Chyi Chya, 2009; M.R. Islam , R. Saidur, N.A. Rahim, 2010). From (M.R. Islam , R.Saidur and N.A. Rahim, 2010) article, said that the wind speeds in Malaysia Offshore are around 3.0knot until 8.0knot and it is suitable to build up the wind

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machine there. (E.P. Chiang, Z. A. Zainal, P.A. Aswatha Narayana and K.N. Seetharamu, 2003) in his article propose that Malaysia have to move to develop wind technology in eastern Malaysia offshore and Sabah and Sarawak, his stated that wind speed in that area are exceeding 10knot. Besides that, Table 2 shows the wind speed rate in Denmark, German and Spanish which are the largest wind technology users in the world with 23%, 8% and 4.3% respectively (Tick Hui Oh, Shen Yee Pang and Shing Chyi Chya, 2009). Base on this data, it shows that wind energy can be used as a one of alternative energy in Malaysia.

Table 2: Wind Speed Rate in Denmark, German and Spanish (www.windfinder.com)

Country	Using Wind Technology for Electricity	Average Wind Speed per Year (Knot)
Denmark	23%	13.2
Spain	8%	9.5
Germany	4.3%	13.5

2.2 Wind Assisted Ship

Wind energy has been used for long years ago on ships; in fact it is the first technology to drive the ship. In Malaysia, the wind assisted ship is widely used during Melaka pomp to carry out trades between countries. But the trend was change after 1900 era, where it was replaced by commercial engines which are using fuel on large scale. Nowadays, not many of Malaysia ships are use wind energy, according to (http://www.langkawiyachtclub.com) wind energy only used for tourism activities such as special sail boat and no more are used on large ships. However, the instability in the price of fuel made it essential for us to change back to obtain the utilization of the alternative energy. Countries like Japan, Australia and Germany has improved the technology by developing various new wind technologies that used in ship (M.Azlan, 2009). Figure 3 shows the several types of wind devices that has been developed by a few countries recent years.
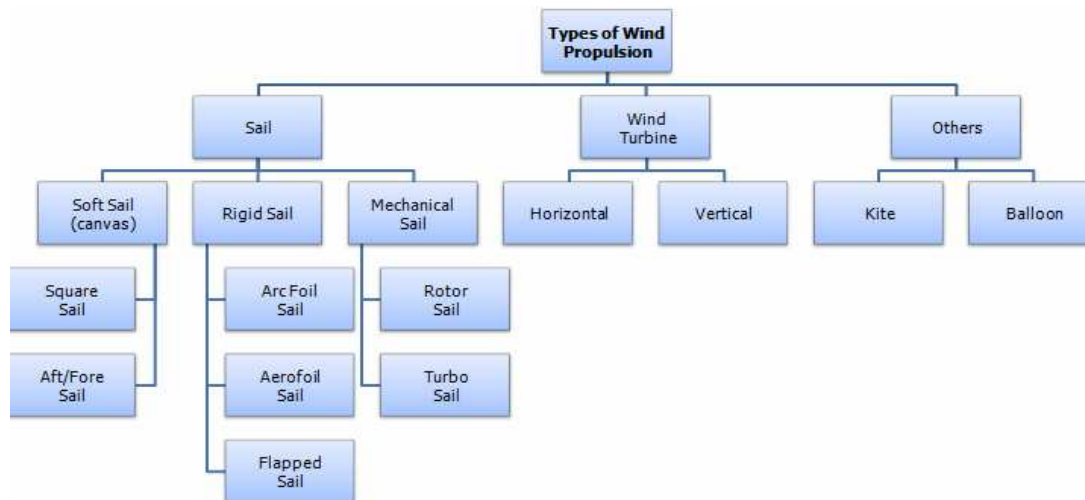
Fig.3: Types of wind propulsion

The examples of development of wind energy propulsion on ship such as in 1985, Japan have built a fisheries ship that combined with soft sail technology namely "Enoshima-Maru". This ship was declared to have ability to reduce oil consumption in her operation (Ishihara M, Watanabe T, Shimizu K, Yoshimi K and Namura H, 1980). In 1924, mechanical rotor that had been created by Fletener (Germany) have been utilized in 445GT cargo ship "Buchan" and "Barbara" (Ishihara M, Watanabe T, Shimizu K, Yoshimi K and Namura H, 1980). Wind turbine has been widely used since early 1980 until today to generate electric, however it still not much used on ship (M.Azlan, 2009). Recently in 2007, Solarsailor which is Australia company have successfully built a combination of solar and wind energy attached to the ship. Figures 4 to 9 show the examples of few designs.

Fig.4: Soft Sail, Japan Fisheries Boat, 1985

Fig.5: Wind Turbine boat, by Pat Patterson, United Kingdom, 2004

Fig.6: Rotor sail, Germany, 1924

Fig.7: Rigid sail Japan, Shin-Aitoku-Maru, 1970

Fig.8: Kite sail, Preliminary Design, SkySail, 2007

Fig.9: SolarSailor, Australia 2007

In Malaysia, the development of ship equipped with wind device is still left behind, however it is being developed especially for yacht boats. Report from Langkawi International Yacht, stated that they are targeting 360 registration of sail boat at the end of 2011.Others wise, some of Universities in Malaysia such as Univesiti Technology of Malaysia (UTM) and Universiti of Malaya (UM) have tried to develop a new wind technology to cut the fuel cost on boats. The examples of articles can be found on references (M.R. Islam , R. Saidur and N.A. Rahim, 2010; L.W.P, 2009).

2.3 Kite Ship Technology

Kite Technology is one of technology that was used as wind assisted ships. This technology is the latest technology which is being developed by several countries such as Australia, Netherland and UK (J.Ockels,1994). By using manoeuvrable kites, the high relative winds speeds can be trapped to give large tensile forces in the attachment. With this new technology, it is easily to generate five times more propulsion power per square meter sail area than conventional sail propulsions. This is because of the technical possibilities, which arise due to the spatial separation of the ship and the "sail" or towing kite. Usually, the tight flying of the previous systems which had applied to a very large vessel could operate at altitudes of 100 to 300m, where considerably stronger and more stable winds prevail. At an altitude of 100m the average wind speed is between 10 and 20% higher than at an altitude of 10m, due to the absence of resistance from the surfaces of earth and water. A higher wind speed is particularly relevant, for the calculation of the traction power of the towing kite and the wind speed is squared. Thus, an increase in wind speed of 15% represents an increase of the traction power system of over 30% (www.skysails.com).

According to studies from group Applied Sustainable Science Engineering and Technology (ASSET) base at Delft University Netherland; in 2003, they had discover that kite ship will reduce 50% of fuel usage on ship operation depending on wind speed and direction (J.Ockels,1994). On the other hand, in 2006, Germany Company had installed kite technology to MS Beluga S's ships, and has recorded the reduction of 10% to 30% of fuel (O'Rourke, 2006).Recently, in 2008, Sky Sail the company from Australia had recorded the reduction of fuel up to 30%(www.skysails.com). Besides, in term of controlling, the research found from (Air Commodore, in article of Outlook for wind assistance) that the kite technology is easy to handle compare with others wind energy devices.

However, there are some disadvantages on this technology, where, the kite propulsion system cannot be operated on courses against the wind, the system that will increase the resistance of the ship. However, due to the aerofoil profile of the kite, the towing kite can be used on courses up to 50 degrees close to the wind. In practice of the previous research, the kite can achive 70 degrees onwards high propulsion. The most efficient courses are those between 120 and 140 degrees (www.skysails.com).

3. METHODOLOGY

3.1 Ship Candidate

The UMT boat was selected to be ship candidate on this study. The boat is 16.5 m length, used for fishing research, discovery purpose and transportation. The boat is fitted by propeller by one single screw in engine board and equipped with all necessary facilities for 10 researchers/passengers and 3 crews. The speed of the boat during the first trial is 20 knots. The principal dimension of boat is shown in Table 3.

Table 3: UMT research boat principal dimensions

Properties	Dimensions
Length Overall	16.5 meter
Length Water Line	13.40 meter
Breadth	3.65 meter
Draft	0.6 meter
Speed	20 knots
Propulsion	1 x 360 HP Marine Engine
Block Coefficient	0.75
Fuel	1000 Liter
Water	500 Liter
Passenger and crew	13 Person

3.2 Kite Parameters

The basis ship is used to calculate the scale of the kite that will be attached to the candidate ship. The choosen ship is also compared from the previous research to make sure that the area scale of kite would be suitable for the candidate ship. The Table 4 has shown the principle dimension for the basis ship (L.W.P, 2009).

Table 4: Principle Dimension of Basis Ship
Name: 36 m, T.S. Landing Craft(Satchwell,1985)

Properties	Dimension
Length Overall	36.25 meter
Length Waterline	31.90 meter
Depth	2.44 meter
Design Draught	2.00 meter
Fuel Oil	150 / 200 MT
Fresh Water	150 MT
Crew / Passenger	20 men
Main Engine	3 x Yanmar Diesel Ghute 3 x 350 hp / 2300 rpm each
Speed	15 knots
Kort Nozzle	2 MT
Displacement	582.19 tonnes
Deadweight	355.71 tonnes
Block Coefficient	0.7198
Kite Area, A	200 m^2

By using scale ration equation the new parameters of kite can be determined as shown in Equation (1) (M.Azlan, 2009). Details of new area of UMT boat are shown in Table 5.

$$\left[\frac{s}{\Delta^{2/3}}\right]_{BK} = \left[\frac{s}{\Delta^{2/3}}\right]_{NK}, \qquad so, \;\; S_{NK} = \frac{S_{BK} \times \Delta^{2/3}{}_{NK}}{\Delta^{2/3}{}_{BK}} \tag{1}$$

Where, S_{NK} = Kite Area (New Kite), S_{BK} = Kite Area (Basis Kite), $\Delta_{NK} = \rho \; x \; L \; x \; B \; x \; T \; x \; CB$ (New Kite), $\Delta_{BK} = \rho \; x \; L \; x \; B \; x \; T \; x \; CB$ (Basis Kite).

Table 5: Sample of kite data

Kite Data	Value
Kite Area (A)	8.59 m^2
Aspect Ratio (AR)	0.043

3.3 Propulsion Force Analysis

A force may be thought of as a push or pull in a specific direction. Figure 10 shows an example of forces that act on the Wright 1900 aircraft when flown as a kite (S.A.Zakaria, 2009).
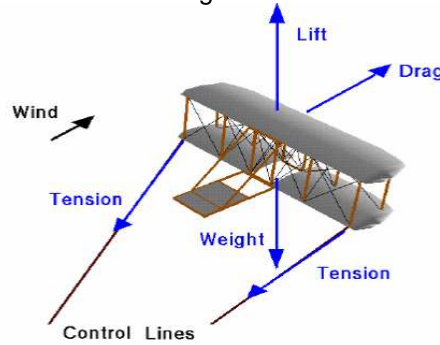
Fig.10: Kite Propulsion

First step on determining the propulsion force is to determine the values of true wind speed at require altitude using Equation (2) (S.A.Zakaria, 2009). From the calculation of the scale ratio, the required altitude is 15 meter above the sea level.

$$W_{(z)} = C_{log} \; ln\left(\frac{z}{z_o}\right), \qquad so, W_{(z)} = \left(\frac{U_{ref}}{ln(z_{ref} \; / \; z_o)}\right) ln\left(\frac{z}{z_o}\right) \tag{2}$$

Where, $W_{(z)}$ = wind speed at altitude z above sea surface, and Equation (2) become to;

$$C_{log} = \left(\frac{U_{ref}}{ln(z_{ref} \; / \; z_o)}\right)$$

Where; U_{ref} = known wind speed at reference level, z_{ref} = reference level (10 m), z_o = surface roughness(depending on wave height).

Several theories have been applied to determine the magnitude and direction of apparent wind (M.Azlan, 2009) (S.A.Zakaria, 2009). Equation (3) shows one of theory that was used on this project.

$$V_{(A)} = \sqrt{W^2 + V_S{}^2 - 2.W.V_S \; cos(\varphi)} \tag{3}$$

Where, $V_{(A)}$ = apparent wind , W = Wind Speed at some latitude, Vs = Ship speed, φ = Ship course angle (Ship heading – wind direction angle).

The stronger of apparent wind speedwill produce larger relative velocity, Equation (4-8) shows the formula to determine relative velocity (V_{rel}, V_{t-y}, V_{t-x}, V_t, V_{r-z}) and kite's own speed, ø.

$$\phi^2 \left(r^2 \sin^2(\theta)(1 + \tan^2 \gamma)\right) - \phi\left(Wr \sin^2(\theta)\tan(\gamma)\right) = -W^2 \sin^2(\theta) + \left(\frac{W\cos(\theta)}{\tan(\alpha)}\right)^2 \tag{4}$$

Where; α = Angle of attack, r = Tow line straight length, β = Tow line drift angle, γ = Kite flying direction , θ = Tow line inclination angle.

$$V_{t-y} = -r\theta + V_A \sin(\theta) \tag{5}$$

Tangential velocity at Y direction, V_{t-y} can be determined Tangential velocity at X direction, V_{t-x};

$$V_{t-x} = -r \sin\theta . \phi \tag{6}$$

Tangential velocity V_t

$$V_t = \sqrt{(V_{t-x})^2 + (V_{t-y})^2} \tag{7}$$

Total radial velocity at Z direction Vr-z

$$V_{r-z} = V_A \cos\theta \tag{8}$$

By using Foil Design Program, the NACA 4415-63 was designed to obtain the Lift coefficient, C_L and Drag coefficient, C_D at difference relative wind speed (S.Salim, 2006). Then, Lift and Drag forces were calculate by using following Equation (9) and (10).

$$F_L = C_L \times \frac{\rho_a}{2} \times V_{rel}^2 \times A \quad (1) \tag{9}$$

$$F_D = C_D \times \frac{\rho_a}{2} \times V_{rel}^2 \times A \tag{10}$$

Where, F_L = Lift force, F_D = Drag force, C_L = Lift coefficient, C_D= Drag coefficient, ρ_a = Density of the air , V_{rel} = Airflow relative velocity at the towing kite, A= Surface area of the towing kite.

Otherwise, the traction force, T and the vertical component of traction force in X axis in ship sailing direction, F_S was calculate by using Equation (11) and (12).

$$T = \sqrt{F_L^2 + F_D^2} \tag{11}$$

$$\left(F_S = T \cos\theta . \cos\beta \; 1 \right) \tag{12}$$

There are interrelationship between horsepower, boat resistance and speed; therefore, traction force in X axis, Fs can be connected to engine horsepower. This is because, resistance to boat is reaction force which opposite forward movement of boat, while traction force Fs is reaction force which helps forward movement of boat (M.Azlan, 2009; S.A.Zakaria, 2009). Equation (13) is relationship between traction force F_S and boat resistance R_T.

$$R_{T(new)} = R_T - F_S \tag{13}$$

where, R_T = Ship Resistance, F_S = Resultant Force and R_{Tnew} = New Ship Resistance.

Thus, we can compare the new/old break horse powerb by using general power prediction theory,

$$P_{HP(old/new)} = \frac{R_{T(old/new)}V_S}{\eta_T}$$ (14)

where, P_{Hp} = Brake Horsepower, R_T = Ship Resistance and V_S = Ship Speed, η_T = Total Efficiency.

3.4 Economical Analysis

Economy is the task of allocating a finite supply of investment funds in the face of infinite possibilities and it is an approach to determine whether the project will be not. This study used the annual average cost (AAC) and net present value (NPV) methods to compare the total cost between with kite and without kite. Equations (15) and (16) shows formula related to calculating NPV. Life time of the UMT boat was assumed as 20 years and interest rate (i) is 10%. Table 6 is shows the present costs of the system elements.

NPV (without kite) = ∑PV (maintenance cost) + PV (operation cost) - PV (salvage value) (15)

NPV (with kite) = ∑PV (maintenance cost) + PV (operation cost) + PV (investment cost in kite) - PV (salvage value) (16)

Operation cost; Fuel saving = operating time × [$P_{B(old)}$-$P_{B(new)}$] × specific fuel consumption. (17)

Table 6: Overall Cost Estimation

Cost	Properties	With Kite (RM)	Without Kite (RM)
Investment cost	Boat cost	-192,000	-192,000
	Total investment on kite	-55736.84	0
Maintenance cost (increase 2% each year)	Machinery & Hull	-19,200 per year	-19,200 per year
	Kite	-4,241 per year	0
Operation cost (assume constant each year)	Fuel oil	-5,716.28 per year	-20,376 per year
Salvage value (after 20 years, decrease 5% each year)		+88810.17	+68,829.30

4. RESULT AND DISCUSSIONS

4.1 Wind Speed

There are two different wind speeds that had been recognized. First is the true wind speed which is getting from Malaysian Meteorology Department. Second is the apparent wind speed that is calculated using the formula to get the wind speed at required altitude to force the kite for towing the UMT boat (Figure 11).
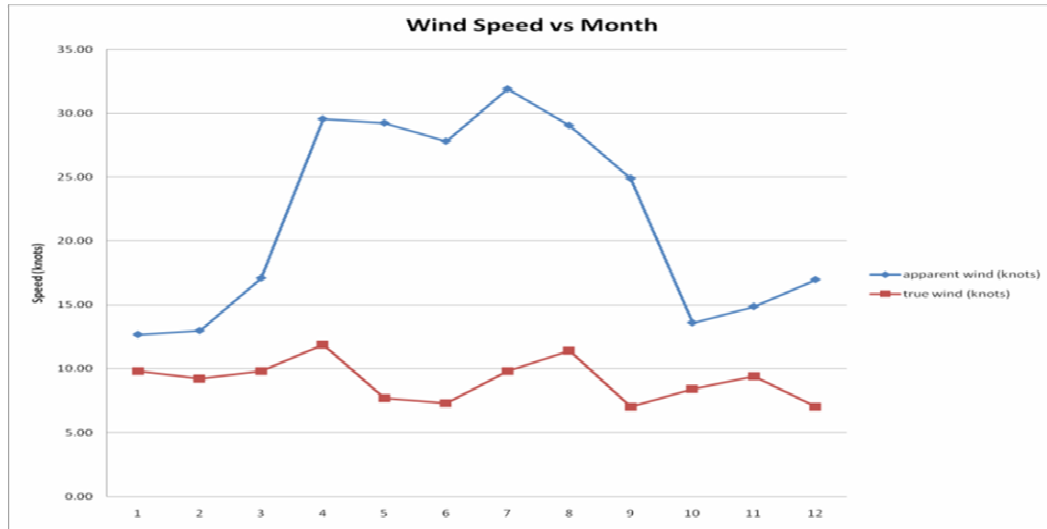
Fig.11: Result on Wind Speed versus Month at required altitude.

From the Figure 12, the different between wind speed at 10 meters and 15 meters above the sea level had been determined. The graph shows that, the higher the level above the sea, the higher the wind speed.

4.2 Result of Power Generate by Kite
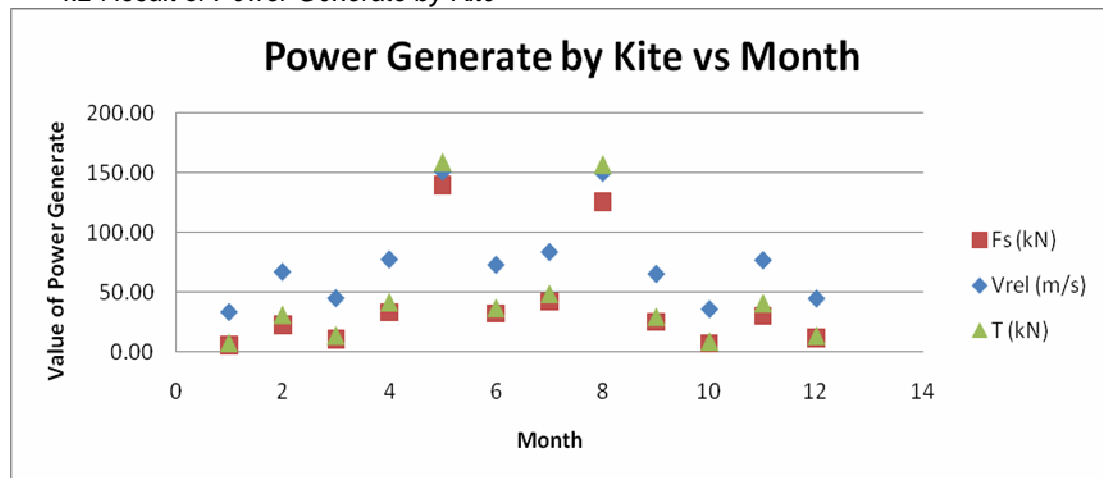
Fig.12: Result of Power Generate by Kite versus Month

The result of is generated by flying kite assuming that, the ship moving at constant forward speed and constant ship heading angle. From Figure 13, it is clearly indicated that, the Traction force depends on the apparent wind speed. Therefore, by increasing the apparent wind speed, the kite velocity relative also will increase and the traction force generate by flying kite will be higher.

4.3 Result of Power Saving
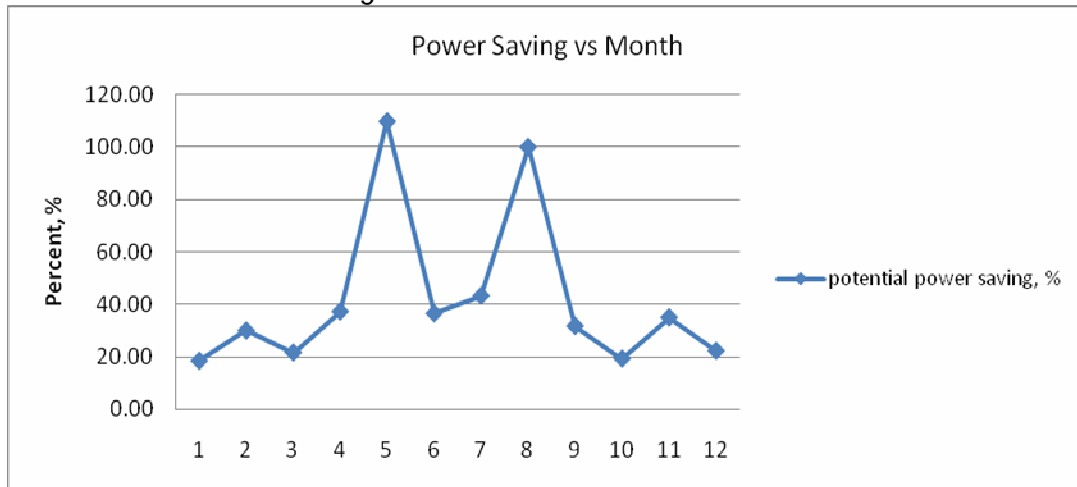
Fig.13: Result of Percentage of Power Saving for year 2008

Figure 4.3 shows the percentage of power saving throughout the whole year of the research. The route is from mouth of Sungai Terengganu to Bidong Island. From the figure, it shows that, the highest saving can be had on May, and August. The month of January, March, October and December, present the lowest percentage potential power savings.

4.4 Cash Flow Diagram

Cash flow diagram shows the flow of costs for one project. The positive direction shows the profit (debit) and negative direction shows the expenditure (credit). The involving cost of economic analysis can be shown by Figure 44 -Figure 16
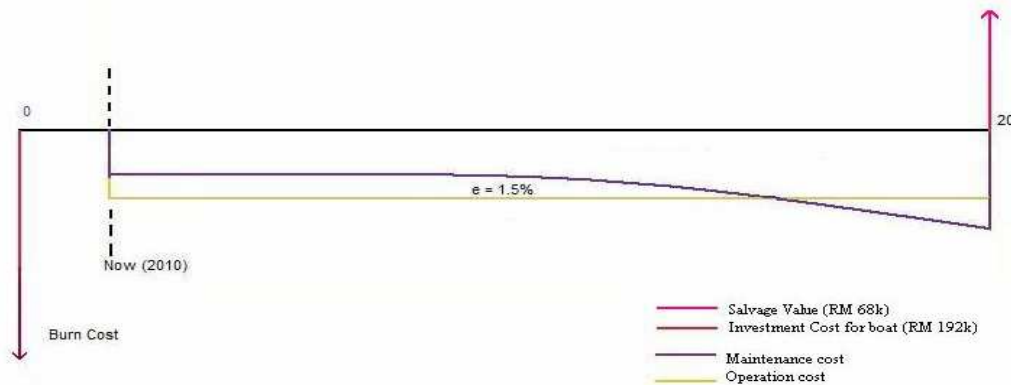
Fig.14: The costs for without kite sail (including burn cost)

The involving cost in Figure 4.5 shows the different way of the Figure 4.4 the simplified form. The inertia cost for UMT boat is removed. While in Figure 4.6, shows the involving costs for boat with kite technology sail.
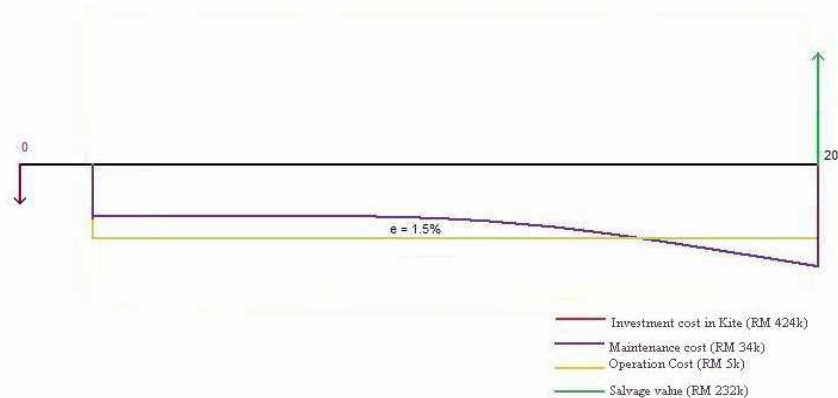
Fig. 15: Cash Flow Diagram (without kite sail)
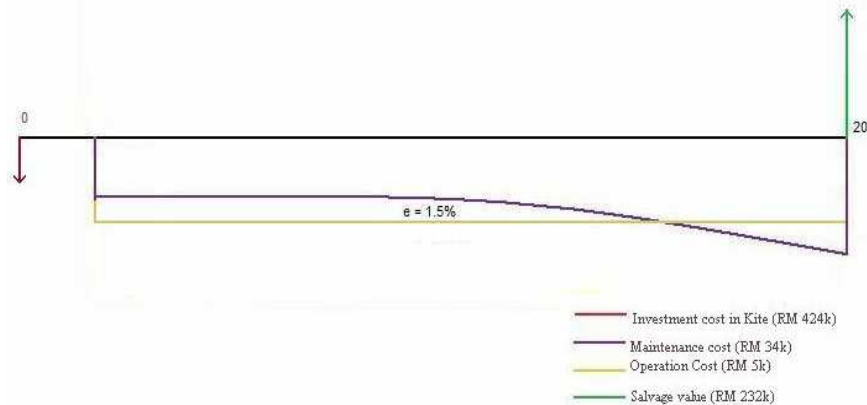
Fig. 16: Cash Flow Diagram (with kite sail)

From calculation for both cases which are, with kite sail and without kite sail, the AAC is negative, which means that, the both alternatives are not profitable. This is due to the function of this boat which is only used for research purpose. The result finds that, the total annual average cost without kite is higher than total average cost with kite. Whereas, AAC without kite sail is – RM 45618.80 per year, while AAC with kite sail is – RM 39623.7 per year. This result proved that the boat which has been fitted with kite sail is more economical compared to the boat without the kite sail.

4.5 Return Investment

Assuming that, the oil price, interest rate (i), and others value that influence on calculation of economic analysis is constant each year. Therefore, the capital investment recovery that has been determined is 9 year.

5. CONCLUSIONS

The first part on this research describes the potential of wind energy and kite ship. The study shows that the development of wind devices in Malaysia in the preliminary stages. The potential of wind energy in Malaysia is deeply advice due to average wind speed around 8Knot per year.

In the second part, the research is focused on case study of kite attached to UMT boat, it is to approves the potential of use of wind devices in Malaysia. The major analyses on this part are introduced by three previous researches. Meaning, the kite position on flight envelope and calculation of apparent wind speed are based on many assumptions. Without promising data from experiment or simulation for kite flying altitude, it is difficult to predict the velocity calculation. The accuracy of this calculation is mainly depends on relative velocity, lift and drag coefficient. In this case study, the wind speed at any height from sea level is calculated using the formula developed by previous research. Using kite propulsion technology, fuel consumption can be reduced thus resulting in lower and operation costs on the particular routes.

The results of the economic assessment indicate that, annual average cost for boat with kite sail is lesser than annual average cost for boat without kite sail. It is expected that the capital investment in the new device will be recovered within 9 years. Thus, the actual condition of wind speed at different height is about 90% accurate and directly reflects the overall calculation and estimation in this project.

This lead to the conclusion of the fuel saving value that was calculated is purely theoretical value and several uncertainties involved in the analysis of the kite force estimation and ship powering. Hence, further validation of the kite force calculation is desired as well as research on the optimization of the ship routing and behavior.

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FLOATING OFFSHORE WIND FARMS: THE SEED OF ARTIFICIAL

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A floating wind turbine is an offshore wind turbine mounted on a floating structure that allows the turbine to generate electricity in water depths where bottom-mounted towers are not feasible. The wind can be stronger and steadier over water due to the absence of topographic features that may disrupt wind flow. The electricity generated is sent to shore through undersea cables. The concept for large-scale offshore floating wind turbines was introduced by Professor William E. Heronemus at the University of Massachusetts in 1972. It was not until the mid 1990's, after the commercial wind industry was well established, that the topic was taken up again by the mainstream research community. As of 2003, existing offshore fixed-bottom wind turbine technology deployments had been limited to water depths of 30 meters in the case of monopoles, and 50 m in the case of jacket/tripod type. Worldwide deep-water wind resources are extremely abundant in subsea areas with depths up to 600 meters, which are thought to best facilitate transmission of the generated electric power to shore communities.

1. FLOATING WIND FARMS: THE NEXT FRONTIER

Wind is the fastest growing renewable energy source, increasing at an annual rate of 25% with a worldwide installed capacity of 74 GW in 2007. The vast majority of wind power is generated from onshore wind farms. Their growth is however limited by the lack of inexpensive land near major population centers and the visual pollution caused by large wind turbines.

Wind energy generated from offshore wind farms is the next frontier. Large sea areas with stronger and steadier winds are available for wind farm development and 5MW wind turbine towers located 20 miles from the coastline are invisible. Current offshore wind turbines are supported by monopoles driven into the seafloor at coastal sites a few miles from shore and in water depths of 10-15m. The primary impediment to their growth is visual pollution and the prohibitive cost of seafloor mounted monopoles in larger water depths (Sclavounos, Tracy, & Lee, 2007).

2. CURRENT AND FUTURE WORLDWIDE SCENARIO

In Europe, where vacant land is scarce and vast shallow water wind resources are available, more than 900 MW of offshore wind energy capacity has been installed in and around the North and Baltic Seas. Although offshore wind turbines are not currently installed outside Europe, interest is growing worldwide because the global offshore wind resource is abundant, with the U.S. potential ranked second only to China. For instance, the wind

resource potential at 5 to 50 nautical miles off the U.S. coast is estimated to be more than the total currently installed electrical generating capacity of the United States (more than 900 GW) (Jonkman & Buhl, June 3-6,2007).

Most of the offshore wind resource potential in the United States, China, Japan, Norway, and many other countries is available in water deeper than 30 m. In contrast, all of the European offshore wind turbines installed to date are fixed-bottom substructures, and have mostly been installed in water shallower than 20 m by driving monopiles into the seabed or by relying on conventional concrete gravity bases. These technologies are not economically feasible in deeper water. Instead, space frame substructures, including tripods, quadpods, or lattice frames (e.g., "jackets"), will be required to maintain the strength and stiffness requirements at the lowest possible cost. The Beatrice Wind Farm Demonstrator Project, where two 5MW wind turbines will be installed on a jacket structure in 45 m of water, is a good example of this technology.

At some depth, however, floating support platforms will be the most economical. This natural progression is illustrated in Figure 1.
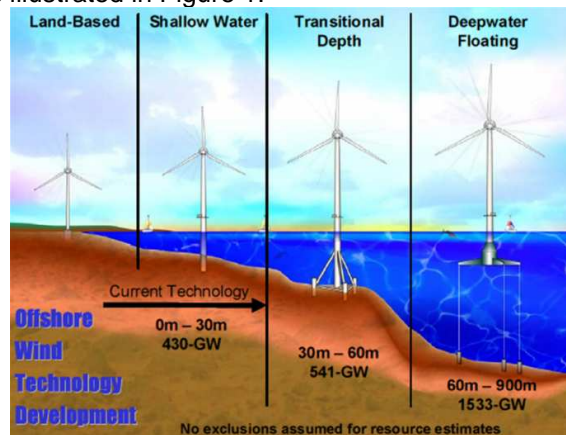
**Fig. 1. The natural progression of substructure designs from shallow to deep water.
SOURCE: NREL**

Without performing a dynamic analysis, Musial, Butterfield, and Boone have demonstrated the economic potential of one floating platform design (Musial, Butterfield, & Boone, January, 2004). We will discuss the economic feasibility in a dedicated chapter.

The initial capital cost of floating turbines is competitive with bottom-mounted, near-shore wind turbines while the rate of energy generation is higher out in the sea as the wind flow is often more steady and unobstructed by terrain features. The relocation of wind farms into the sea can reduce visual pollution if the windmills are sited more than 12 miles (19 km) offshore, provide better accommodation of fishing and shipping lanes, and allow siting near heavily developed coastal cities.

So we can conclude that in the next years we will see an increasing development in offshore wind, and also the explotation of floating offshore wind market. We list here the causes (Gonçalo Maciel, May 2010):
- Why Offshore Wind?
    - Higher wind resource and less turbulence.
    - Large ocean areas available.
    - Best spots in wind onshore are becoming scarce.
    - Offshore wind, including deep offshore, has the capacity to deliver high quantities of energy.

- Why Floating Offshore Wind?
  - Limited spots with shallow waters (mostly in the North Sea).
  - Most of the resource is in deep waters.
  - Huge scale ocean areas available.
  - Less restrictions for offshore deployments and reduced visual impacts.
  - Enormous potential around the world: Portugal, Spain, UK, France, Norway, Italy, USA, Canada.

In resume, deep offshore wind provides a significant growth opportunity in the long term and is the only wind energy source with growth capacity in the long term, as shown in figure 2, below, from EDP-Inovaçao:
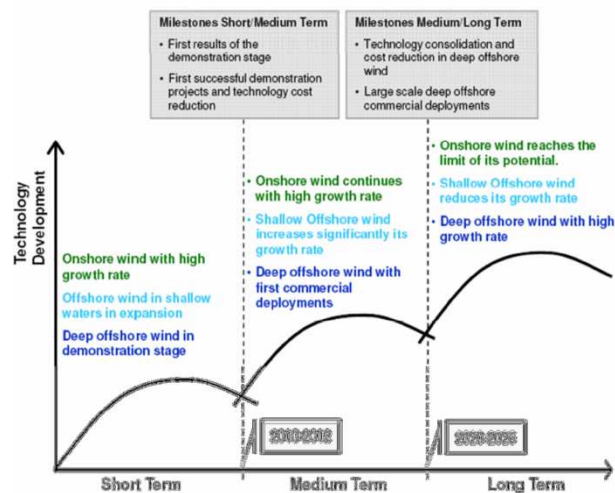
Fig. 2. Technology Development versus Time. SOURCE: EDP-Inovaçao

3. TECHNICAL FLEXIBILITY: FLOATING WIND TURBINE CONCEPTS

Numerous floating support platform configurations are possible for offshore wind turbines when one considers the variety of mooring systems, tanks, and ballast options that are used in the offshore oil and gas industries.

1. Oil & Gas Industry: differences and lessons learned

Although the characteristics of proven offshore floating platforms used by the oil and gas industries are similar to the concepts being considered for floating wind turbine platforms, it is their differences that will allow the necessary cost reductions:

- Oil platforms must provide additional safety margin to provide permanent residences for personnel. Wind platforms do not.

- Oil platforms must provide additional safety margin and stability for spill prevention. This is not a concern with wind platforms.

- Wind platforms will be deployed in water depths up to 600 ft (182.4m). Oil platforms are deployed in depths from 1500 ft (456m) to 8000 ft (2432m).

- Submerging wind platforms minimizes the structure exposed to wave loading. Oil platforms maximize above-water deck/payload area.

Wind platforms will be mass-produced and will benefit from a steep learning curve.

Fig. 3. Synergies between offshore petroleum industry and wind structures
SOURCE: NREL

In any case, if we see the evolution of the O&G rigs in depth, we can expect that same evolution will occur to floating wind farms, but at a higher speed, as a lot of knowledge is already available.

Therefore, the technical challenges affects more to the turbine than to the platform itself.
Technical solution:

- Wind Energy conversion stabilized and well known.
  - o Technological challenges:
  - o Wind turbine and maritime environment.
  - o Adapt wind turbine to platform motion.
  - o Adapt an O&G structure to energy production at a reasonable cost.
  - o O&M operations.

Deploying wind turbines offshore creates the potential for innovative designs. For instance, wind turbines may have faster rotor speeds due to less stringent noise restrictions. In addition, some groups are investigating the use of downwind and vertical axis turbines due to their potential for reduced maintenance and higher fatigue resistance.

The financial risk involved with building these large scale projects is deterring such innovations. Companies like StatoilHydro, the developer of the HyWind project, and Principle Power, which is working on the WindFloat concept, are partnered with existing commercial offshore wind turbine manufacturers and are designing their floating foundations to be compatible with many kinds of turbines. This reduces the technical and financial risks significantly, since the hulls are designed according to offshore oil and gas rules, leveraging the knowledge base of an industry with decades of experience in building floating structures.

2. Current concepts

Figure 4, below, illustrates several of the concepts, which are classified in terms of how the designs achieve static stability.

- The Spar-buoy concept achieves stability by using ballast to lower the center of gravity below the center of buoyancy and can be moored by catenary or taut lines.
- The Tension Leg Platform (TLP) achieves stability through the use of mooring line tension brought about by excess buoyancy in the tank.
- The Barge concept achieves stability through its waterplane area and is generally moored by catenary lines.

- Hybrid concepts, which use features from all three classes, are also an option.
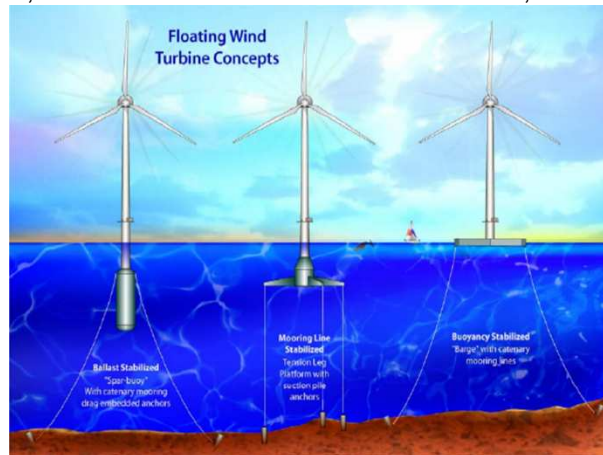
Fig. 4. Floating support platform concepts for offshore wind turbines. SOURCE: NREL

Previous concepts with concepts that already are being used today in the North Sea are shown in the following Figure 5:
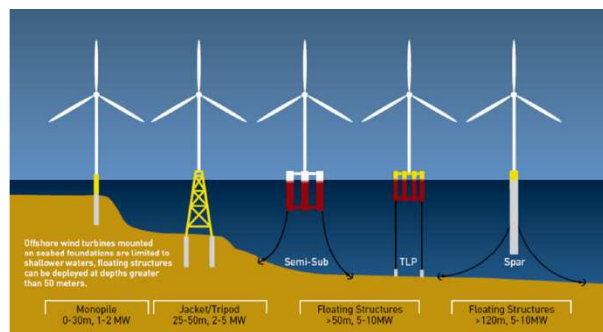
Fig. 5. Bottom mounted and floating wind turbines. SOURCE: PRINCIPLE POWER

Below we briefly summarize the characteristics of the solutions used today and the floating:

- Monopiles
  - Basic extension of turbine tower w/ transition piece.
  - Economically feasible in shallow water depths (10-30m).
- Jackets
  - Economically feasible in transitional water depths (30-50m).
  - Derivatives from Oil & Gas technology.
  - Beatrice successfully deployed (2 jackets x RePower 5M).
- Floating
  - Economically feasible in deep water (50-900m).
  - Two prototypes have been deployed (Hywind and Blue H).

The following figure 6 shows the potential of floating wind turbines on the solutions anchored to the bottom of very schematically: as depth increases, increases exponentially the cost of the latter, while the cost of the float rises as linear but very gently.
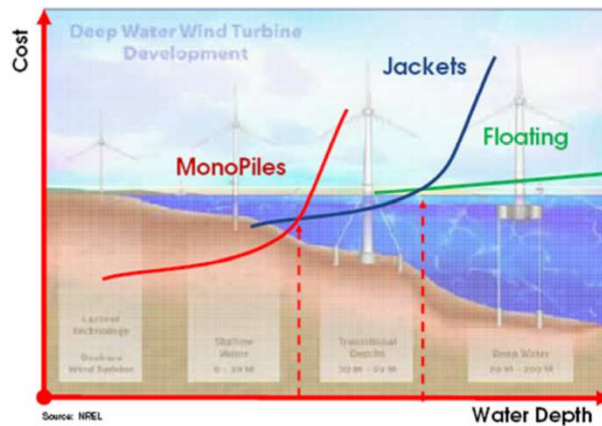
Fig. 6. Coste de los distintos concepto de turbinas eólicas. SOURCE: EDP-INOVAÇAO

4. ECONOMIC FLEXIBILITY OF FLOATING WIND FARMS

Floating wind parks are wind farms that site several floating wind turbines closely together to take advantage of common infrastructure such as power transmission facilities.

The following figure 7 shows a provision of a floating wind farm:
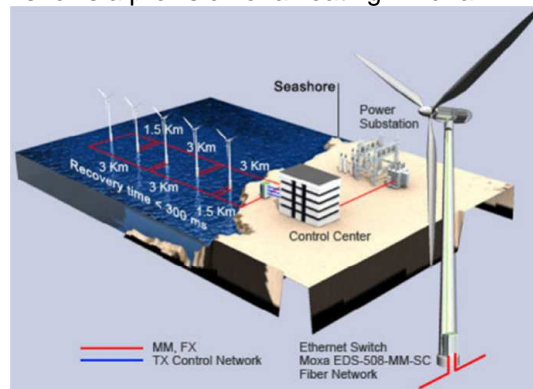
Fig. 7. Bottom mounted Wind Farm

Cost is an essential consideration for the successful commercial deployment of the present floating wind turbine concepts into large scale offshore wind farms (Sclavounos, Tracy, & Lee, 2007). Main cost drivers:

1. The full assembly of the wind turbine floater system at a coastal facility offers essential cost benefits relative to offshore assembly.

2. Other important cost drivers include the floater weight – consisting of steel and concrete – and the tension of the tethers and mooring lines at their anchors.

3. The latter drive the cost of the foundation structure. In the case of the TLP this may be a gravity caisson while for the catenaries it will consist of anchors widely used by the offshore industry.

Therefore an important objective of the present study is the selection of floater and mooring system designs with:

• Acceptable dynamic response properties.

90

- Low construction and installation costs.

The 5MW wind turbine used in the present study is assumed to be a marinized version of an onshore system. The same would be the case if a smaller or larger wind turbine system were to be used. The weight of larger wind turbines may be easily supported by a floater of larger displacement. Otherwise, buoyancy is free.

Guidance on the economic attributes of offshore wind farms is offered by the recent economic analysis carried out by Pace Global Energy Services LLC carried out for a proposed 144 MW offshore wind farm off the Long Island coastline consisting of 40 3.6 MW General Electric wind turbines supported by bottom mounted truss towers. As part of this analysis Pace Global evaluated the economics of the proposed wind farm against the 20-year costs of an standard Combined Cycle Gas-Fired Turbine (CCGT) consistent with the Long Island Power Authority's resource planning in the non-renewable domain. The conclusion of the Pace Global analysis is that the breakeven cost for an offshore wind farm to be competitive with the CCGT is approximately $3,000 per installed Kilowatt including interconnection costs. The estimated cost of the proposed 144 MW offshore wind farm alone was estimated at $5,231 per KW of nameplate capacity. The underwater cable and substation upgrade costs were estimated at $400 per KW. The offshore wind farm was assumed to be operating at an annual average capacity factor of 36% and the projected cost of natural gas would range from $9.21-$15.68/MMBtu over the 2010-2027 period. Further details of the economic analysis are provided in the Pace Global report.

An analogous economic analysis applies to an offshore wind farm with turbines supported by floaters. The breakeven cost would be $3M per installed MW or $15M per floater supporting a 5MW wind turbine, including interconnection costs. For a hypothetical 10MW wind turbine the breakeven costs range from $30M per floating unit. Floaters may be deployed in shallow and deeper waters and their economic advantages versus bottom mounted support structures become evident as the water depth increases. Moreover, the rate of increase of the costs of the floater as the wind turbine size increases and the cost of the mooring system with increasing (Musial, Butterfield, & Boone, January, 2004) water depth is likely to be moderate.

The paper of Musial, Butterfield, & Boone, January (2004) provides a rough cost comparison performed for two different platform architectures using a generic 5MW wind turbine. One platform is a Dutch study of a tri-floater platform using a catenaries mooring system, and the other is a mono-column tension-leg platform developed at the National Renewable Energy Laboratory. Cost estimates showed that single unit production cost is $7.1 M for the Dutch tri-floater, and $6.5 M for the NREL TLP concept.

However, value engineering, multiple unit series production, and platform/turbine system optimization can lower the unit platform costs to $4.26 M and $2.88 M, respectively, with significant potential to reduce cost further with system optimization. These foundation costs are within the range necessary to bring the cost of energy down to the DOE target range of $0.05/kWh for large-scale deployment of offshore floating wind turbines.

Although the vision for large-scale offshore floating wind turbines was introduced by Professor William E. Heronemus at the University of Massachusetts in 1972, it was not until the mid 1990's, after the commercial wind industry was well established, that the topic was taken up again by the mainstream research community. A recent Dutch report presents a complete bibliography and a summary of the research to date, and is the basis for some of the later cost studies. Current fixed-bottom technology has seen limited deployment to water depths of 30 meters thus far. Although this technology may be extended to deeper water, eventually floating wind turbine platforms may be the most economical means for deploying wind turbines in the coastal waters beyond the view shed of densely populated urban load centres. Worldwide, the deep-water wind resource has been shown to be extremely

abundant, with the U.S. potential ranked second only to China.

Technically, the feasibility of deepwater wind turbines is not questioned as long-term survivability of floating structures has already been successfully demonstrated by the marine and offshore oil industries over many decades. However, the economics that allowed the deployment of thousands of offshore oilrigs have yet to be demonstrated for floating wind turbine platforms. For deepwater wind turbines, a floating structure will replace pile-driven monopoles or conventional concrete bases that are commonly used as foundations for shallow water and land based turbines. The floating structure must provide enough buoyancy to support the weight of the turbine and to restrain pitch, roll and heave motions within acceptable limits. The capital costs for the wind turbine itself will not be significantly higher than current marinized turbine costs in shallow water. Therefore, the economics of deepwater wind turbines will be determined primarily by the additional costs of the floating structure and power distribution system, which are offset by higher offshore winds and close proximity to large load centres (e.g. shorter transmission runs). Integrated cost of energy models indicate that if platform costs can be held near 25% of the total system capital cost that DOE cost goals of $0.05/kWh are attainable.

Thus, the major objective of this paper is to demonstrate, with a simple static cost model, that platform cost can be brought into this economic range.

5. EUROPEAN SCENARIO

1. Summary of the offshore wind energy market in the EU
Year 2010:
- Total installed capacity of 3,000 MW.
- Meeting 0,3 % of total EU electricity demand.
- Avoiding almost 7 Mio tons of CO_2 annually.

Year 2030:
- Total installed capacity of 150,000 MW.
- Meeting between 13 % and 17 % of total EU electricity demand.
- Avoiding almost 300 Mio tons of CO_2 annually.

Time to market:
- 5 – 10 years.

Players in the market:
- Market Leaders are involved: Statoil / Siemens.
- Two floating platforms already installed.

2. Status and Trends: Location
Offshore Wind farming development – deeper and further, Trend until 2025.
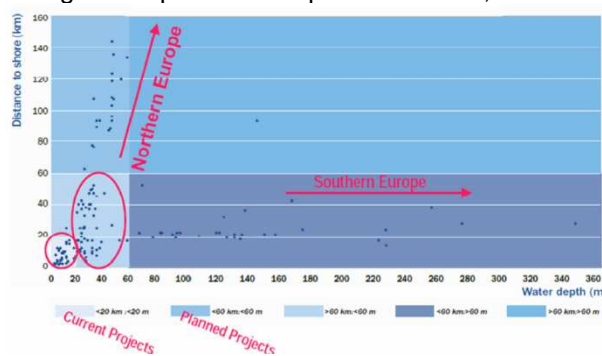
Fig. 8. Location of Wind Farm

3. Status and Trends: Turbines

- Increasing Turbine Sizes and Weights.
- Already the world's biggest rotating machines.

Table 1. Turbine sizes

TURBINE SIZE	NACELLE WEIGHT (INCL. ROTOR)	HUB HEIGHT	TOWER WEIGHT
3.0	110 Tons	75-90 meters	110 Tons
3.6	180 Tons	75-90 meters	170 Tons
6.0	310-400 Tons	100-120 meters	300-500 Tons

2.3 MW   3.6 MW   Boeing 747
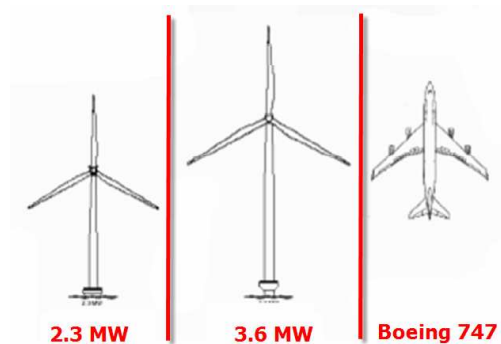
Fig. 9. Size of Wind farms. SOURCE: SIEMENS

4. Status and Trends: Foundations

Although the characteristics of proven offshore floating platforms used by the oil and gas industries are similar to the concepts being considered for floating wind turbine platforms, it is their differences that will allow the necessary cost reductions.

Table 2. Typical waterdepth, size and weight

TYPE	TYP. WATERDEPTH	TYPICAL SIZE	TYPICAL WEIGHT
Monopile	35 m	4-5 meters	600-700 Tons
Gravity	20 m	30 meters	1000-1500 Tons
Jacket	Up to 70 m	25x60 meters	700-900 Tons
Tripod	50 m	35x60 meters	1000 Tons

1   2   3   4
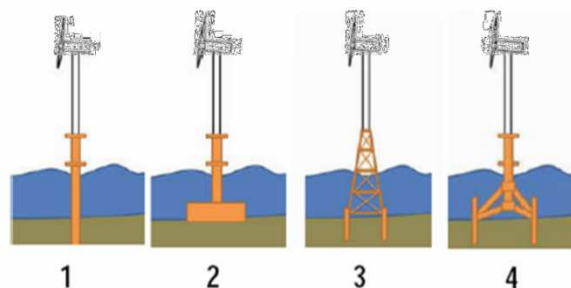
Fig. 10. Bottom of Wind farms

5. Potencial market

EU15 Potential:
- Good offshore wind resource (load factor > 3.000h).
- Offshore wind potential is mostly in transitional and deep waters(~65 %).
- Energy Potential >700 TWh (~220 GW)
- Ports and docks available along European coast.

Portuguese & Spanish Potential:
- Continental shelf ends near the coast.
- Grid connection available near the coast.
- Limited Potential for water depths < 40m.
- Energy Potential in PT >40 TWh (~12 GW).
- Energy Potential in SP >290 TWh (~98 GW).

Offshore Potential in GW:

Table 3. Potential market

DEPTH	EU15	PORTUGAL	SPAIN
0-30	77	2	18
40 - >200	>140	>10	>80

Fig. 11. Simplified pan-European bathymetry. SOURCE: ACCIONA, 1-TECH

6. CURRENT PROTOTIPES IN TEST PHASE

As of 2011, there have been only two operational floating wind turbines used to farm wind energy over deep-water, and one more expected to be tested in summer 2011.

1. Blue H Technologies

Blue H Technologies of the Netherlands operated the first floating wind turbine, a prototype deep-water platform with an 80kW turbine off of Puglia, southeast Italy in 2008. Installed 21 km off the coast in waters 113 meters deep in order to gather test data on wind and sea conditions, the small prototype unit was decommissioned at the end of 2008. Blue H has successfully decommissioned the unit as it embarks on plans to build a 38-unit deepwater wind farm at the same location.

The Blue H technology utilizes a tension-leg platform design and a two-bladed turbine. The two-bladed design can have a much larger chord, which allows a higher tip speed than those of three-bladers. The resulting increased background noise of the two-blade rotor is not a limiting factor for offshore sites.

As of 2009, Blue H is building the first full-scale commercial 2.4 MWe unit in Brindisi, Italy which it expects to deploy at the same site of the prototype in the southern Adriatic Sea in 2010. This is the first unit in the planned 90 MW Tricase offshore wind farm, located more than 20 km off the Puglia coast line.
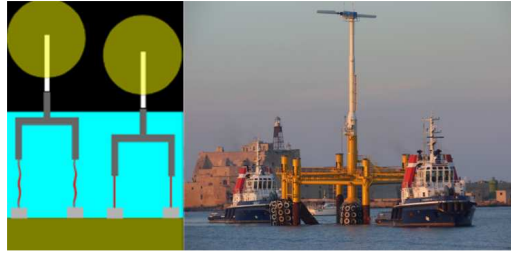
Fig. 12. Scheme and Picture of the prototype

2. Hywind by Statoil

The world's first operational deep-water floating large-capacity wind turbine is the Hywind, in the North Sea off of Norway. The Hywind was towed out to sea in early June 2009. The 2.3 megawatt turbine was constructed by Siemens Wind Power and mounted on a floating tower with a 100 metre deep draft. The float tower was constructed by Technip, and Nowitech contributed to the design. Nowitech (Norwegian Research Centre for Offshore Wind Technology) is a consortium of 30 members, including SINTEF and the Norwegian University of Science and Technology at Trondheim. Statoil says that floating wind turbines are still immature and commercialization is distant.

The installation is owned by Statoil and will be tested for two years. After assembly in the calmer waters of Åmøy Fjord near Stavanger, Norway, the 120 meter tall tower with a 2.3 MW turbine was towed 10 km offshore into 220 meter deep water, 10 km southwest of Karmøy, on 6 June 2009 for a two year test deployment.

Alexandra Beck Gjorv of Statoil said, "[The experiment] should help move offshore wind farms out of sight ... The global market for such turbines is potentially enormous, depending on how low we can press costs".

The unit became operational in the summer of 2009.

Hywind was inaugurated on 8 September 2009.

As of October 2010, after a full year of operation, the Hywind turbine is still operating and generating electricity for the Norwegian grid.

The turbine cost 400 million kroner (around US$62 million) to build and deploy.

The 13 kilometre (8 mile) long submarine power transmission cable was installed in July, 2009 and system test including rotor blades and initial power transmission was conducted shortly thereafter.

The installation is expected to generate about 9 GW•h of electricity annually.

The SWATH (Small Waterplane Area Twin Hull), a new class of offshore wind turbine service boat, will be tested at Hywind.
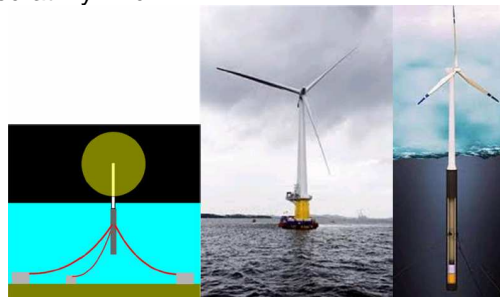
Fig. 13. Scheme and Picture of the prototype

3. Resume and comparison

As of 2011, there have been only two operational floating wind turbines used to farm wind energy over deep-water, and one more expected to be tested in summer 2011.

Year 2007:

- Statoil Hydro and Siemens sign agreement for Hywind project.
- Sway raises €16.5M in private placement.

Year 2008:

- Blue H half-scale prototype installation.
- EDP and Principle partner to deploy WindFloat technology.

Year 2009:

- Hywind full-scale prototype installation 2.3MW turbine.

Year 2011:

- EDP and Principle Power will start in summer the test of the Windfloat.

Trade name	WindFloat	Hywind	Blue H	Sway
Developer	Principle Power (US)	Statoil Hydro (NO)	Blue H (NL)	Norwegian consortium (NO)
Foundation type	Semi-submersible (moored 4-6 lines)	Spar (moored 3 lines)	Tension Leg Platform	Hybrid Spar/TLP (single tendon)
Water Depths	> 40 m	>100 m	> 40 m	100 m - 400 m
Turbine	3-10MW Existing technology!	2.3 MW Siemens	2 bladed "Omega" under development	AREVA Downwind 5MW
Installation	Tow out fully commissioned	Dedicated vessel-tow out and upending	Tow out on buoyancy modules until connection	Dedicated vessel-tow out and upending
Turbine installation	Onshore	Offshore	Onshore	Offshore
Strengths	Dynamic motions, installation, overall simplicity of design	Existing turbine and hull technology, well funded	First sub-scale demo deployed	Low steel weight
Challenges	Steel cost	Dynamic motions, installation	Mooring cost, turbine design, turbine coupling with tendons	Installation and maintenance, downwind 3-blade turbine
Stage of Development	Ready for prototype testing	Full-scale prototype installed in 2009	Half-scale prototype installed in 2008	Development of the concept

Fig. 14. Comparation of the current prototipes

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THE EFFECT OF HUMAN FACTORS ON PORT OPERATIONS

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A study was done to look into the handling efficiency of a container port, Malaysia's port. This study was focus on human factors that affected the operation process. A survey was conducted and Kruskal-Wallis and Mann-Whitney tests were used to analyse the variables. As a result, Kruskal- Wallis test showed that the educational background (0.005) and job specifications (0.000) might affect the degree of job involvement. Based on the result, the study indicated that educational background and job specifications have a significant relationship with job involvement.

1. INTRODUCTION

Everyone employed in organization has a part in making the associate work as efficiently as possible. Among the various views on human factors, the most realistic one would be that it is a function of personality. Therefore, an attempt was made to study the variables of personality. Job involvement (JI) as an attitude is an important variable that helps in maximizing organizational effectiveness (Elankumaran, 2004). Therefore, any effort to maximize organizational effectiveness depends on achieving the highest degree of JI among members of an organization. So, job involvement is treated as an efficiency measurement.This research is one effort to study the personality factors that affected the degree of job involvement. For these reason, the objective of this paper is to test the variables of personality and job involvement. It tries to identify the impact of variables of personality on job involvement.

2. JOB INVOLVEMENT

Job involvement (JI) in simple terms refers to the commitment that a person shows to the job specified to him or her or of their work. It is a devotion to duty in body and spirit. It is something intrinsic to the individual that makes him or her consider work as the most important part of his or her life, and the major satisfaction that he or she could derive is by accomplishing his or her duty effectively (Elankumaran, 2004).

JI is an important attitude variable that helps in maximizing organizational effectiveness. The higher the degree of job involvement of the members of an organization, the greater is its effectiveness. Therefore, any effort to maximize organizational effectiveness depends on achieving the highest degree of JI among members of an organization. In order to improve

the degree of job involvement, one must have a realistic view of what determine the involvement. Among the various views on job involvement, the most realistic one would be that it is a function of personality and organizational climate (Elankumaran, 2004).

JI defined as a belief descriptive of the present job and tends to be a function of how much the job can satisfy present needs On the other hand, some researchers argue that JI is a personal characteristic. Therefore, it is less likely to be influenced by organizational factors and more likely to be influenced by personal characteristics (Rabinowitz et al, 1977). For highly involved employees, their jobs seem inexorably connected with their identities, interests, life goals and are crucially important. Individuals may become involved in their job in response to specific attributes of the work situation itself. Alternatively, some persons may process a constellation of needs, value, or traits that predispose them to become involved in their job.

Highly JI individuals seem to be satisfied with their jobs, to be in characteristic positive working attitude at work, and to be highly committed to their employing organizations, their careers, and their professions. Highly job involved persons rarely think about quitting their jobs and expect to be working for the same organization in the foreseeable future. JI individuals feel competent and successful at work (Holton et al, 1997). JI individuals believe that personal and organizational goals are compatible. As highly job involved persons seem uninterested in non-work activities It made sense that such individuals might tend to focus on job activities such as thinking of ways to perform work better, even in their spare time.JI would give a positive work affect and a sense of optimism an organization productive in the future. The high JI is linked with a host of apparently positive and desirable employee characteristics, such as high satisfaction, high commitment, positive affect and low stress.

A study proposed and tested a model that attempts to explain the role of situation and personal related factors relating to top executives become involved in their jobs (Carmeli, 2005). The findings show that the relationship between perceived external prestige and job involvement is mediated by affective commitment, and that the relationship between protestant work ethic and job involvement is mediated by normative commitment. Top executives see their work as an essential issue in their life, but the degree to which one develops high involvement in his/her job depends on the level of his/her normative commitment. A high degree of job involvement is considered to augment work outcomes.

3. METHODS

In this chapter, job involvement is used to be included in handling efficiency definition. According to Lodhal and Kejner (1965), job involvement scale was modified to measure job involvement. Job involvement scale consisted of 10 items. These 10 items were being analysed and computed. Moreover, they conducted also the degree of JI for each personality variables. Carmeli (2005), on the other hand, showed that variables that are usually used for personality variables included age, marital status, educational background, and job specifications. Therefore, this chapter focuses on four variables only; these are age, marital status, and educational background and job specifications. Besides, these variables have been tested and confirmed by the pilot studies. An extensive observation and pilot tests data search were done in four stages; in January 2003, January 2004, March until May 2004 and January 2005. Based on the pilot test results, four personality variables were chosen. After that, primary data were collected during April 2005. A set of questionnaires were obtained from interviews with relevant respondents. The number of respondents according to group is detailed out in table 1.

Table 1. Proportionate and disproportionate stratified random sampling

Job Level	Number of Personnel	Number of Subjects in the Sample	
		Proportionate Sampling (20% of the Personnel)	Disproportionate Sampling
Manager	10	2	10
Executive	28	5.6	28
QC operator	93	18.6	50
RTG operator	164	32.8	53
PM operator	300	60	60
Total	595	119	201

Data analysis technique is a carefully planned step in the research process to test the objectives and to prove the hypotheses. Statistical Package for Social Science (SPSS 10.0 for Windows) was used for statistical analysis. The data were first checked for normality and reliability. The analysis is presented in the form of Mann-Whitney and Kruskal-Wallis tests. The Kruskal-Wallis is an extremely useful test for deciding whether independent samples are from different populations. Sample values almost invariably differed somewhat and arise question is whether the differences among the samples signified genuine population differences or whether they represented merely the kind of variations that are to be expected among random samples from the same population. The Kruskal-Wallis also tests the null hypothesis that the k-samples come from the same population or from identical populations with the same median. The region of rejection consists of all values of Kruskal-Wallis which are so large that the probability associated with their occurrence when H_O is true when df = k – 1 is equal to or less than alpha = 0.05 (Siegel, 1988).

The Wilcoxon-Mann-Whitney test, on other hand, may be used to test whether two independent groups have been drawn from the same population. This is one of the most powerful of the non-parametric tests and it is a very useful alternative to the parametric t-test when the researcher wishes to avoid the t-test's assumptions or when the measurement in the research is weaker than interval scaling. H_O is true when it is equal to or less than alpha = 0.05 (Siegel, 1988).

Based on the research objective, some hypotheses are made to test relationships among personality variables on job involvement.

Hypotheses:-

H_{O1} : There is no significant difference between job involvement and age.

H_{A1} : There is significant difference between job involvement and age.

H_{O2} : There is no significant difference between job involvement and marital status.

H_{A2} : There is significant difference between job involvement and marital status.

H_{O3} : There is no significant difference between job involvement and educational background.

H_{A3} : There is significant difference between job involvement and educational background.

H_{O4} : There is no significant difference between job involvement and job specifications.

H_{A4} : There is significant difference between job involvement and job specifications.

H_{O5} : There is no significant difference in mean degree of job involvement between management and non-management levels

H_{A5} : There is significant difference in mean degree of job involvement between management and non-management levels

4. Results and Discussion

1. Tests of normality

Table 2. Tests of normality variables of personality and job involvement

Tests of Normality			
	Kolmogorov-Smirnov [a]		
	Statistic	df	Sig.
Age	.221	201	.000
Marital Status	.392	201	.000
Education Background	.398	201	.000
Job Specifications	.199	201	.000
Monetary Benefits	.185	201	.000
Satisfaction Life	.197	201	.000
Interested	.333	201	.000
Keep Working	.194	201	.000
Overtime	.269	201	.000
First Few Hours	.278	201	.000
Working Everyday	.285	201	.000
Tasks and Responsibilities	.326	201	.000
Test Myself	.287	201	.000
Show Up for Work	.266	201	.000

[a.] Lilliefors Significance Correction

Table 2 shows tests of normality variables of personality and job involvement. The Kolmogorov-Smirnov statistic tests the hypothesis that the data are normality distributed. A low significant value (<0.05) indicates that the distribution of the data differ significantly from a normal distribution. Since the significant value for age, marital status, education background, job specifications and job involvement (Table 2) is lower than 0.05, it can be assumed that they are non-normality distributed.

5.   Reliability Analysis

Table 3. Variables of personality and job involvement reliability analysis

Reliability Analysis-Scale (Alpha)

Reliability Coefficients	
Item	Value
N of Cases	201
N of Items	14
Alpha	0.6813

Table 3 shows variables of personality and job involvement reliability analysis. Reliability analysis was tested on the level of reliability of the questionnaires data that are collected. Abu et al (2001) show that an alpha value above or equal to 0.6 can be assumed as good and it is acceptable. In table 3, the alpha value is 0.6813. So, it can be assumed as reliable.

1   Kruskal-Wallis Test

(i)   Age

Table 4. Kruskal-Wallis test statistics on age

Test Statistics [a,b]	
	Job Involvement
Chi-Square	10.209
df	6
Asymp. Sig.	.116

[a]. Kruskal Wallis Test

[b]. Grouping Variable: Age

In the Kruskal-Wallis test, the scores are ranked without regard to group membership. 'N' identifies the distribution of cases across groups. 'Mean rank' lists the average rank for each group.

The Kruskal-Wallis test is a non-parametric alternative to one-way Analysis of Variance (ANOVA). Significant levels below 0.05 indicate that the group locations differ. In table 4, the significant value is more than 0.05 (0.116), hence it can be assumed that the degree of job involvement do not differ between age. Therefore, H_{O1} is accepted and H_{A1} is rejected.

(ii) Marital Status

Table 5. Kruskal-Wallis test statistics on marital status

Test Statistics[a,b]

	Job Involvement
Chi-Square	.126
df	2
Asymp. Sig.	.939

a. Kruskal Wallis Test

b. Grouping Variable: Marital Status

Table 5 shows that the significance value is more than 0.05 (0.939) and it can be assumed that the degree of job involvement is not affected by marital status. Therefore, H_{O2} is accepted and H_{A2} is rejected.

(iii) Educational Background

Table 6. Kruskal-Wallis test statistics on educational background

Test Statistics[a,b]

	Job Involvement
Chi-Square	20.208
df	7
Asymp. Sig.	.005

a. Kruskal Wallis Test

b. Grouping Variable: Education Background

Table 6 shows the significant value is below 0.05 (0.005) and it can be assumed that the degree of job involvement is different between educational background. As a result, H_{O3} is rejected and H_{A3} is accepted.

(iv) Job Specifications

Table 7 Kruskal-Wallis test statistics on job specifications

Test Statistics[a,b]

	Job Involvement
Chi-Square	28.902
df	4
Asymp. Sig.	.000

a. Kruskal Wallis Test

b. Grouping Variable: Job Specifications

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Table 7 shows the significant value is below 0.05 (0.000), hence it can be assumed that the degree of job involvement may be influenced by job specifications. Thus, H_{O4} is rejected and H_{A4} is accepted.

2.   Mann-Whitney Test

Table 8. Mann-Whitney test statistics on job specifications

Test Statistics[a]

	Job Involvement
Mann-Whitney U	2054.500
Wilcoxon W	15420.500
Z	-3.239
Asymp. Sig. (2-tailed)	.001

[a.] Grouping Variable: Job Specifications

The Mann-Whitney test is a non-parametric test alternative to two independent samples. Small significant value (<0.05) indicates that the two groups are from different locations. In table 8, the significant value is smaller than 0.05 (0.001). It shows that the degree of job involvement may differ between the operator and the management levels. Therefore, H_{A5} is accepted and H_{O5} is rejected.

7.   DISCUSSION

Table 9. Findings for Kruskal-Wallis and Mann-Whitney Tests

	Kruskal - Wallis Test				Mann - Whitney Test
	Age	Marital Status	Education Background	Job Specifications	Job Specifications
Asymp. Sig.	0.116	0.939	0.005	0.000	0.001
Hypotheses Accepted	H_{O9}	H_{O10}	H_{A11}	H_{A12}	H_{A13}

Table 9 shows the findings for Kruskal-Wallis and Mann-Whitney Tests. Kruskal-Wallis test was done to test the difference between age, marital status, educational background and job specifications. Results show that the educational background and job specifications may affect the degree of job involvement. However, the results show that age and marital status do not have any significant difference between groups. Further, the Mann-Whitney test was used to test the job specifications. Between the two categories of job specifications, results show that the job specifications level may affect the degree of job involvement. It shows that the management level has a higher degree of job involvement compared to the operator level. The overall results of the study in human factors are summarized in Figure 1.
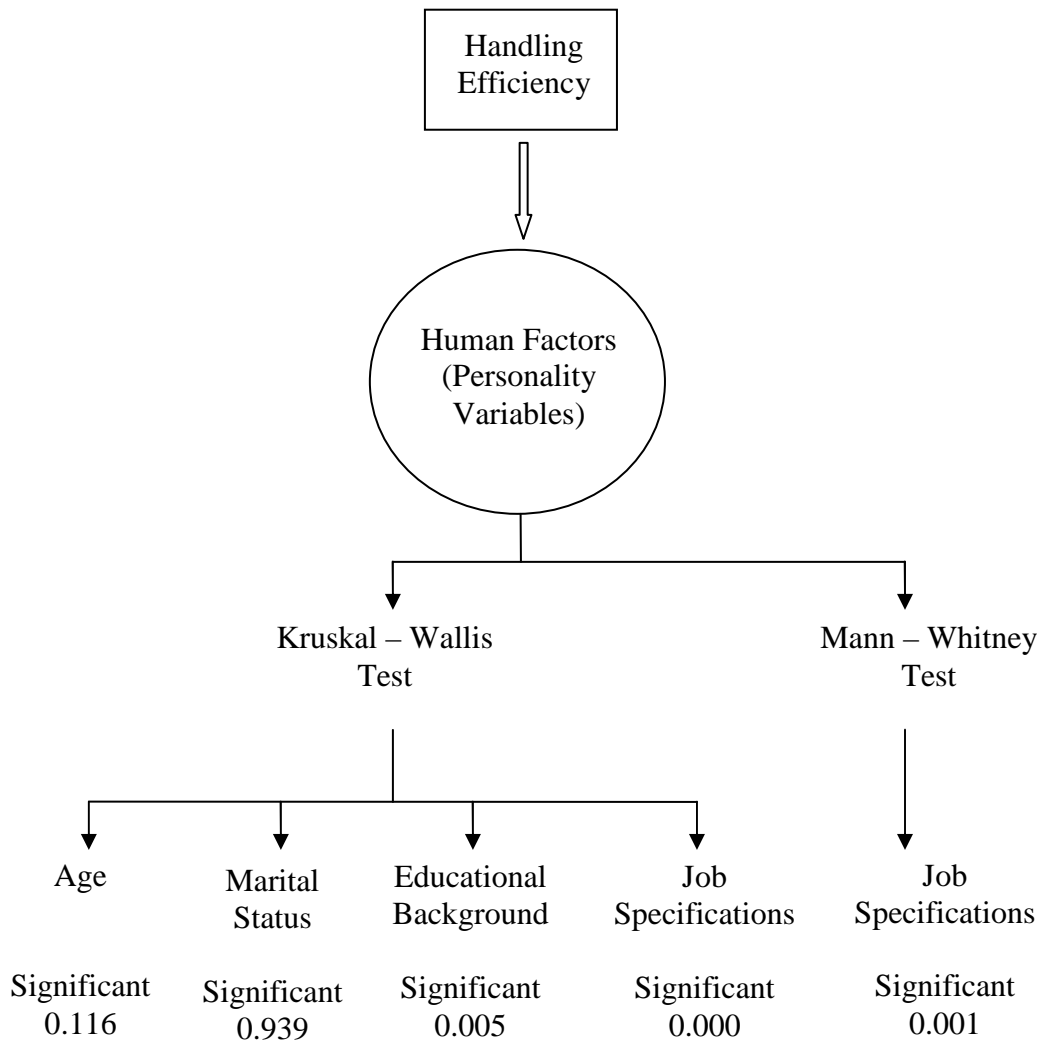
Fig. 1. **Human factors result finding**

From the initial findings, the results show that there are significant differences in educational background and job specifications. Carmeli (2005) indicated that top executives are more involved in their jobs. Moreover, Carmeli (2005) suggested that organizations should devote efforts to create a factorable image because it fosters organizational identification and satisfaction and eventually leads to high job involvement. Furthermore, the results show that the management level has higher degree of job involvement compared to operator level and employees with higher educational background have a higher degree of job involvement. Therefore, Malaysian Port should involve everyone (including management level and operator level employees) in decision-making policy and management issues. For example, all of them are encouraged to give suggestions for improving quality, efficiency, services and

others. Besides, Malaysian Port also encourage study opportunity of their employees who aim to improve their educational level and position.

For the age and marital status variables, the results show that there are no influences on the degree of job involvement. It may be because most of the employees in Operation Department Malaysian Port are young and as many as 91.1% of the employees are below 36 years old (Appendix A). On the other hand, 60.2% of the employees are married (Appendix B). People play an important role in any job. People do the job; hence the way people do work affects the work effectiveness. Therefore, human factor is also another important part of the research. This study tested the relationship between variables of personality and job involvement (JI). To maximize organizational effectiveness, it depends on the highest degree of JI. Thus, it examined the variables of personality that influence job involvement. Four personality variables were studied; age, marital status, educational background and job specifications.The results showed that age and marital status do not affect the degree of job involvement. Therefore, age and marital status do not play an important role in job effectiveness.

On the other hand, educational background and job specifications have a significant impact on job involvement. Thus, educational background and job specifications play an important role in job effectiveness. According to Carmeli (2005), the top executives have higher job involvement. Besides, the higher the people are educated, the more degree of job involvement is achieved. This may occur because people who are highly educated work in the management level.

8. CONCLUSIONS

The degree to which employees are involved in their job can be influenced by favourable organization image that fosters the identification of an employee with his/her organization.An employee is likely to be satisfied and develop a strong attachment to an organization that possesses a certain level of glory. Strong identification with one's organization may translate into a high degree of job involvement (Carmeli, 2005). Therefore, Carmeli (2005) suggested the organizations should devote efforts to creating a factorable image because it fosters organizational identification and satisfaction and eventually leads to high job involvement.

In addition, the results showed that the management level has higher degree of job involvement compared to operator level and the higher the employee are educated the higher the degree of job involvement. Therefore, Malaysian Port should involve everyone (include management level and operator level employees) in related policy and management issues. For example, all of them are encouraged to give suggestions for improving quality, efficiency, services and others. Besides, education opportunity may be given to employee who aims to improve their education level and status.

Japanese firms gained competitive advantage over the West precisely because they involve everyone in the company in the quest for quality, suggestion for improving their products and process, policy and management issues. For example, in a year Toyota employees made 687,000 suggestions for improving their products and processes (Toyota has less than 40,000 employees) (Bank, 1992). It gives an idea about the people who are more concern with their work would more involved in their job. This is because they feel that they are a part of the management team. Thus, this study suggested that Malaysian Port authority should give the chance to all employees to be involved in policy and management issues. Moreover, the people who have done their work everyday would be more familiar in their work and they can contribute in giving good suggestions to increase the productivity and efficiency.

FURTHER RESEARCH

The result showed that top executives are more involved in their jobs. Therefore, further research is suggested to examine what motivates top executives to be involved in their jobs. Thus it tries to relate the motivational factors of the management level to the operator level. For human factors, it is limited to test the degree of job involvement across four personality variables. Besides, this survey is limited to operation workers and management level staffs that are directly involved in the operation process.

Acknowledgements

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MARINE ENGINEERING AS FUTURE CAREER IN MALAYSIA

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The employability of seafarers is directly linked to their competency level. Perhaps, this is the main reason why crew members from certain countries enjoy preference in the employment market. Therefore, the sea career prospects of Malaysian seafarers should be viewed from their competency which strongly related to the kind of training offered by Marine Education Training (MET) institutions. In this paper, the developments of maritime industry in the last 10-15 years reviewed the limitations of the STCW 95 training standards in achieving the knowledge demands of high technological equipment on board new merchant ships is reviewed. The authors identified essential training for Malaysian seafarers. Malaysian Maritime Academy (ALAM) has taken important initiatives of enriching MET curriculum work done, beyond the minimum stipulation of the STCW 95, and benchmarking with leading world class MET institutions is reported. The DNV Sea-Skill audit and certification is an example of the commitment by ALAM which offer a program for competence beyond compliance. The paper also reviewed discusses the importance of University Malaysia Terengganu (UMT) degree program maritime Technology as support to need for more theoretical knowledge required to compliment STCW.

1.   INTRODUCTION

Due to ever rising fuel prices, stringent environmental restrictions, deteriorating global security and sharp increase in the salary of seafarers the shipping business has become very competitive. This compel ship owners to adopt new and more advanced technologies which can bring down the overall ship operating cost and guarantee them viable return on their investment. This new shipping business environment is gradually bringing about changes in the ship design practices, shipboard operational procedures optimization in routing and voyage planning to ensure optimal most economical operation of the vessels.

In new ships, now it is quite common to find increasing use of ICT and other advanced technologies such as Distributed Control Systems (DCS), on line machinery fault diagnosis system using neural network/Fuzzy logic based mathematical models of the propulsion plant and vibration analysis techniques for condition monitoring etc to achieve best performance. , in terms of reduced man power and lower cost of maintenance. The new ships are, therefore, technologically more advanced in comparison to their earlier generations and offer significant benefits in terms of less fuel consumption, low maintenance, cargo carrying capacity, safer environment tolerant and reduced manpower. These benefits have been obtained at the cost of using high technology components and systems for the hull,

machinery and propulsion controls which places high competency demands from shipboard personnel.

Because of all these developments, the technical and commercial viability of traditional propulsion plants are already under close scrutiny and new more fuel efficient alternatives are slowly replacing the old installations. Some of the most promising alternative propulsions under considerations by many ship owners are the all electric integrated system, fuel cell systems and GT based hybrid cogeneration conventional mechanical propulsion systems. These new alternative propulsion systems integrated with advanced technology tools offer better fuel consumption, less maintenance, longer machinery life, environmental safety resulting in increased ship availability and better overall financial returns to the ship owners.

The introduction of these advanced technologies in the new and future ships has obvious implications on the education and training of seafarers. The old traditional methods of MET conceptualized by the IMO which is implemented through the instruments of STCW 95 is no longer able to meet the challenges of these new shipboard technologies. This is already becoming evident from the many catastrophic accidents reported from time to time where the lack of crew competence in the operation of high technology equipment have been pointed out to be the main contributing factor in the incident.

To address this issue effectively, the MET institutions will require taking urgent steps to produce competent seafarers who can confidently and safely handle the advanced technology equipment on board new ships. This calls for the MET institutions to take a serious review of their current STCW 95 compliant training curriculum and realign with the future technology needs of the maritime industry. Some countries that were more proactive anticipated these events long time ago and have taken timely measures to improvise and upgrade their training curriculum in line with the future needs of the maritime industry. But, in Malaysia we have not been so alert to this issue which will have a definite impact on the future employment prospects of our seafarers.

Recognizing that, we at ALAM, taking advantage of our networking with a few leading world classes MET institutions, have taken note of these technological developments and are carrying out the necessary changes in our curriculum. There is also a need for the other institutions of higher learning in the country to share this responsibility by introducing appropriate technical courses in their programs which fall well outside the academic scope of ALAM.

2. REVIEW OF SHIP PROPULSION SYSTEM AND FUTURE OF MARINE ENGINEERING

Traditionally, for the reasons of fuel economy and reliability, merchant ships have been fitted with steam turbines and slow speed direct coupled diesel propulsion systems. However, with rising cost of fuel and increasing uses of ICT in merchant ships the search for low maintenance, reliable and fuel efficient propulsion systems has gained priority. The following paragraphs discuss some of the most promising propulsion systems which are emerging attractive alternatives that will be giving direction for future career in marine engineering.

2.1. Diesel Propulsion

The single, slow speed two-stroke diesel engine, burning heavy fuel oil and connected directly to a fixed pitch propeller, is the marine industry's established benchmark for optimum fuel efficiency. But, while these engines give satisfactory performance in smaller ships, for the power requirements of large tankers these advantages are greatly lost mainly due to the increased size of the hull which requires bigger power packs sometimes with twin shaft

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configurations. Sometimes to improve the fuel efficiency of these propulsion systems for larger ships, exhaust gas fed cogeneration system has been proposed which considerably improves the fuel savings. The search for alternative propulsion system for LNG tankers has been even more urgent to prevent losses from forced burning of the valuable boil off. Configuration of a typical proposed propulsion system for LNG tankers which is incorporated with sophisticated fault diagnostics tools are shown in Fig-1 below (Sulaiman et al).
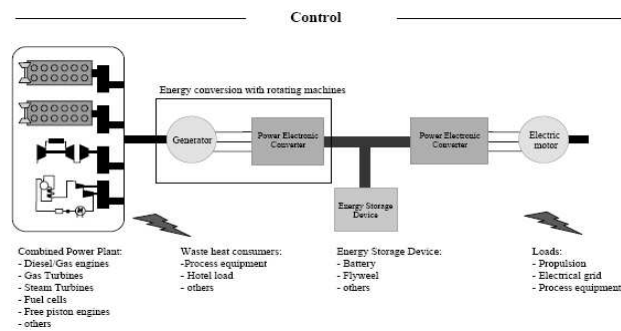
Fig. 1: Two- stroke diesel with reliquefaction

2.2. Gas Turbine Propulsion

Because of the light weight and low mechanical vibrations gas turbines have been a preferred propulsion system for the naval warships for a long time despite their high fuel consumption. However,   with enhanced technology of the gas turbine designs they are also now becoming more fuel efficient and attractive for powering many special types of merchant ships. From their experience of gas turbine propulsion systems in naval and cruise ships, Lloyd's Register have issued an approval in principle of GE Energy's LM2500-based, gas turbine propulsion system for use in liquefied natural gas (LNG) ships (Harper Tan, 2002). In another paper, Lloyd's Register Asia (2005) report a recently completed study of the first full safety case of a gas turbine propulsion system for LNG carriers of 250,000 cubic meters and above for Rolls-Royce's MT30 system. This study was carried out in conjunction with Daewoo Shipbuilding & Marine Engineering Co, Ltd (DSME) and Rolls-Royce, this work was designed to fulfill the requirement of the fuel source involved in the Qatargas and RasGas projects that ship-owners, yards and class ensure that proposed ship design concepts are as sound as practicable. The turbines have duel fuel capability and drive 6.6-11 kV generators which will drive propulsion motors and also power all the auxiliary electrical loads. The system is proposed to operate as combined cycle cogeneration plant to raise efficiency level comparable to 2 stroke slow speed diesel engines.

2.3. Electrical Propulsion System

In some applications, the electrical propulsion system has been identified as preferred solution because of its certain very specific features which offered inherent benefits in terms of overall operating cost and flexibility of design. Because of that electrical propulsion schemes have been now adopted for numerous applications ranging from warships to research vessels, icebreakers, cruise liners, shuttle tankers, offshore support vessels, survey ships etc (Poten and Partners, unknown). In particular, the following factors make electric propulsion a superior alternative to conventional systems for new merchant ships.

    i.   Gas Turbines propulsion with cogeneration.
    ii.   Reduced total installed power.
    iii.   Low fuel consumption and emissions.
    iv.   Enhanced maneuverability and crash stop.

    v.   Flexible, redundant configurations.
    vi.   Increased cargo capacity.
   vii.   Reliability and availability.

The type of propulsion system for merchant ships will primarily depend upon their size and cargo carrying capacity. In integrated electrical propulsion system a common power plant can be used for both propulsion and cargo handling which offers opportunity for load optimization resulting in substantial reduction in total installed power. Schematic layout of a typical integrated electrical propulsion system used in a medium size LNG ship of 153 km^3 capacity supplied by ABB is shown in Fig-2 (Sulaiman et al).
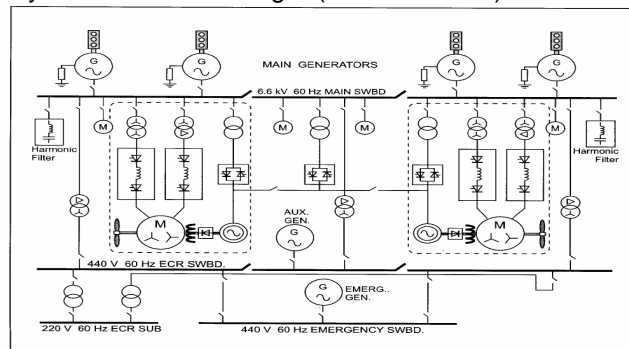
Fig. 2: Schematic layout of a typical integrated electrical propulsion system

In this propulsion system, four medium speed duel fuel diesel engine drive respective AC generators to produce 6.6 kV, 60 Hzs electrical power which energise propulsion motors and also the auxiliary services after stepping down to 440 V. The 2 x 14 MW medium speed propulsion motors are connected to a common gear-box for driving a single fixed pitch propeller. Each motor is controlled by an ACS 6000SD frequency converter, which is the latest generation of MV (medium voltage) drives from ABB utilizing IGCTs (Integrated Gate Commutated Thyristors) as switching devices and the ABB patented DTC (Direct Torque Control) principle for synchronous motor drive. The DTC control is developed for optimizing the dynamic torque response and minimizing the torque ripple on the motor shafts, hence leading to minimized machinery induced vibration and noise levels (Rune et al, 2004). The above review reveals that, the following advanced technologies are progressively entering into the shipboard engineering systems though implementation of advanced design procedures and operating practices.

    i.   Gas Turbines propulsion with cogeneration
    ii.   Fuel Cells propulsion with advanced power electronics
   iii.   High Voltage Systems
   iv.   Permanent Magnet Motors/ Generators
    v.   Power Electronics and AC Variable Speed Drives
   vi.   Microprocessors based instrumentation and controls
  vii.   Distributed Control Systems
 viii.   Vibration analysis and condition monitoring
   ix.   Neural Networks and Fuzzy Logics
    x.   Model Based Machinery Fault Diagnosis

The current MET programs which mostly comply with the STCW 95 guidelines are based on the shipboard technology of the 1980-1990s and hence fail to adequately address the training needs of these new technologies. Therefore, the revised MET programs for the seafarers should be tailored to include these technologies.

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3. CURRENT MET CURRICULUM OF ALAM

ALAM offers comprehensive MET programs comprising of Pre-Sea, Post Sea and short modules of ship safety and HSE courses.

3.1 Pre Sea Training Programs

ALAM offers a 3 years diploma program of 99 credits which focuses mainly on the operational and applied aspects of the marine engineering. The curriculum is based on the STCW 95 guidelines and is conducted in six semesters as shown in Appendix 1. The course contents of the post sea training program is also tailored to the guidelines of STCW 95 and is placed in Appendix 1 for reference (Unknown, 2005).

3.2 MET Competency Gaps

Review of the current MET programs of ALAM mainly on the development of competency skills and the coverage of new shipboard technology is totally lacking. The most glaring technology discrepancies are found in the following areas.

3.3. Initiatives Taken By ALAM

To address this technology gap in the MET curriculum, ALAM has been taken a number of initiatives and is implementing the following action plans.

3.4 Review of the Existing MET Curriculum

A thorough review of the existing curriculum of marine engineering program has been taken up on priority with the objective of replacing the out dated topics under STCW 95 with the more relevant ones which can support the training needs of new shipboard equipment.

3.5 Certification of Curriculum by DNV Sea – Skills

ALAM has hired the services of world renowned MET consultants the DNV Sea-skills of Norway to benchmark the curriculum with world class MET institutions. The first phase of this benchmarking has been already completed and the DNV is continually auditing the curriculum to raise the course contents to the required world class levels.

3.6. Mechanical Engineering Diploma Bridging Program

A proposal to induct mechanical engineering diploma or degree holders through a bridging program has been submitted to the Marine Department for approval. This scheme is intended to cut short the duration of the overall MET program to almost half and also introduce some additional technical skills which could not be included in the marine engineering diploma program of ALAM due the constraints of credit hours.

3.7. Networking and Benchmarking with leading METs

To promote academic exchange and share their experience ALAM has signed MOU with various distinguished world class MET institutions such as World Maritime University, Merchant Marine Academy of USA, Australian Maritime College and South Tensyde College, UK, besides of course with few local universities which also include Univeristy Malaysia Terengganu (UMT) and University Technology Malaysia (UTM). This networking provides opportunity for benchmarking and in the long run it is intended to bring global recognition to ALAM as MET institution of good standing. Also regular faculty exchange with some of these institutions has been practiced to derive mutual benefits.

3.8. Ship Simulation Center

Simulation based training has been popular and effective in the shipping industry and all established MET institutions are offering this mode of training. Recognizing this requirement, ALAM has set up a ship simulation center which offers following courses.

i.   Ship Handling Simulation Course
ii.   Engine Room Simulation Course
iii.   Cargo Handling Simulation Course

The simulation center is also well equipped for conducting research and consultancy work by the maritime professionals and academia.

3.9   Enhanced utilization of training ship

Availability of ship training facility has great learning value and any MET institution of some standing always aspires to provide this training if they can afford to. In this regard, ALAM has been very fortunate to be gifted with a fully operational chemical tanker by the MISC which is utilized to the fullest extent for conducting the pre-sea as well as post sea training. To reinforce the practical ship training further, the Malaysian International Shipping Cooperation (MISC) has also converting two LNG tankers into cadets training ship with additional accommodation for 30 cadets in each.

4. CONDUCTING SHORT TECHNOLOGY SPECIFIC COURSES FOR THE INDUSTRY

Due to gradual entry of new technology in the shipping industry frequent requests come from the ship owners to conduct special short courses to meet their urgent operational needs. The following short courses of durations varying from 3-7 days have been developed and offered to the industry on demand.

i.   Distributed Control Systems Course
ii.   Marine Electrical and Electronics Course
iii.   High Voltage Course
iv.   Energy Conservation Management Course
v.   Hydraulic and Pneumatic Controls Course
vi.   Gas Turbine Technology Course
vii.   Cryogenics and liquefaction of Natural gases
viii.   Shaft and Machinery Alignment Course

Although these courses have been offered on regular basis but their effectiveness is limited mainly because the participants lack the required foundations to grasp the technology. To ensure proper understanding of these courses the participants need to be exposed to the fundamentals of these technologies at pre-sea stage of their training.

4.1 ROLE OF OTHER NATIONAL MET INSTITUTIONS

Since ALAM is permitted to conduct only diploma level programs, there is restriction to the technical contents that may be included in its MET curriculum. Therefore, other national institutions who also offer MET programs and particularly those offering degree and higher level courses need to come forward and join ALAM in addressing this issue. In particular, UTM and UMT who offer undergraduate, post graduate and Ph.D programs in the MET related fields are better placed to address the advanced technology end of the issue by promoting research and development in those areas. This may be better achieved by suitably restructuring their post graduate programs which facilitates registration of the working professional from the maritime industry for those courses. This will ensure that Malaysian seafarers are adequately trained to meet the challenges of future shipboard technology and thereby remain globally employable.

In fact technical topics such as neural networks, fuzzy logic, distributed controls, vibration analysis and high voltage technology etc are already active areas of post graduate research, particularly in UTM, and hence the issue of bridging technology gap merely requires effective integration of these research activities with the industry. In this regard recently created MISC professorship chair at UTM is very timely and should become the nucleus for maritime technology research at the national level.

5. PROSPECT OF MARINE ENGINEERING

For century human have used the earth's mighty oceans and waterways to do various kind of unparallel marine task, the diverse field of marine engineering offers many career opportunities, IT is one of the most growing and sustaining job markets. The nature of marine engineering requires working along the coast and at sea. The field has always served a crucial function. The maritime industry is responsible for the transport of goods and people via the water. Marine engineers are responsible for the design and construction of ships, the construction of ports and waterfront cargo facilities, and the operation of ships and support vessels. Marine engineers are responsible for selecting ships' machinery, which may include diesel engines, steam turbines, and gas turbines.

Marine engineers are also responsible for the design of mechanical, electrical, fluid and control systems of the vessel. Students interested in ship design, building and maintenance will see more opportunities in the future as new challenges arise. In an era where the primary trend affecting all aspects of the industry is the gradual movement to larger and larger container ships, this trend presents technical challenges to the ship designers and builders. It also creates environmental challenges to those engineers and managers seeking to ensure safe and environmentally sound navigation within our waterways.

Today the earth's oceans and waterways are used to harness power, and mine minerals from seabed. Offshore drilling is getting more and more challenging as companies are seeking oil in deeper waters. In the future, marine engineers will be dealing with more complicated structures that will create more complex problems to solve. Marine engineer are needed in the design of recent need for deep water offshore oil operations therefore opening opportunity for students who want to spend time on the open seas, including the design and maintenance of rigs, such as exploratory and jack-ups.

The major advantage of becoming a marine engineer is that students entering careers in marine engineering have nearly 100% placement rates because the demand for them is always so great. Recent years has also called for use of information technology for ship tracking devices and information systems to monitor what is coming into the port. Also the latest developments in moving natural gas from ports to the pipeline. Students with marine engineering backgrounds will be needed to develop and run these plants.

Marine engineering career guarantee a high starting salary, most maritime industry employers would prefer to see some understanding of the marine environment. However, entry-level employees will likely require training once they start their job. Marine engineering is a highly specialized and highly complex industry that spans oceans and national borders, and it deals with the risks associated with the ocean and the weather. For that reason, most entry-level engineers, analysts and managers will be given advance courses training either on the job or via graduate school, followed by a very exciting and challenging career.

Students interested in research work on marine engineering could also find opportunity hydro-elastic design of surface-piercing and prediction of the slamming pressure of sea waves from under-deck impact, different aspects of the largest moving structures in the world, stability calculations, hull forms, dynamics structural analysis and engine room arrangements, to name a few. The career opportunities available to future marine engineers are exciting; students may work on projects that have a global impact from mobile oilrigs in

deep waters to keeping the shore side safe through port security. Also, the added benefit of a good starting salary and secure job market should make any engineering student think about a career in marine engineering. However this career opportunities demand compliments for formidable institution of higher learning that offer marine engineering.

In Malaysia, institution that offer marine engineering course have course tailored for diploma awards only. It is only at ALAM student can have added value to this qualification that is being complimented with STCW courses that allow students to graduate with license to sail on world oceans and added discipline and leadership values from the regimentation. Recent time has also indicated scarcity of manpower and officers to man the ship, which is another open door for young people to have secured job as most stakeholder in the industry prefer to nurture, train and sponsor their future officer from cadetship. In order to meet this future challenge, ALAM has taken for broader steps to start awarding degree in the near future and in talk with UMT for collaboration on joint degree program.

6. CONCLUSIONS

To ensure that Malaysian seafarers remain competitive in the global employment market, they need to be trained in the advanced technology of current ships. The authors identify the technology base of current and future shipboard equipment/machinery and highlight the training gaps of the Malaysian seafarers. This requires many corrective actions at the national level to enhance their training much beyond the current scope of STCW 95 guidelines and make them competent to meet the technology challenge of new ships and thereby enhance their employability globally. ALAM is implementing a number of initiatives to meet this technology challenge which include revision of the MET curriculum, course certification by the DNV and also general enhancements of the training infrastructure. The authors also highlight the role other national institutions like UMT of higher learning need to play in addressing this issue and suggest restructuring their postgraduate programs which can facilitate participation of practicing engineers from the industry in applied research. This will greatly accelerate the industry academia interactions and promote shipboard technology transfer.

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EFFECT OF TRAINING ON SHIPBOARD OIL POLLUTION VIOLATIONS

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Industrialization has brought forth comforts and catastrophes. In the regular scheme of technological developments, the worst malady faced by man is the defiling of the environment. Shipping, being a heavily regulated industry, has contributed less in comparison to other land based polluters. But the enormity of an oil spill and the post-spill clean-ups are reasons enough for countries to tighten the pollution laws and today, any action violating these laws is seen as a crime. Ships are being detained, penalized for pollution violations. Environmental concerns and criminalizing incidents have become issues of concern. While considering these view points, a worthwhile approach would be to look at the seafarer training. Assessment of the competency of the shipboard officer is largely carried out by examinations and onboard assessments. This could be extended to other means such as research surveys. The Paper projects inputs from a study undertaken to assess the level of training and awareness in pollution matters amongst shipboard officers. The representative sample for the study was largely drawn from the Malaysian seafaring officers and also the Indian officers for better representation of the worldwide officers. Curriculum exposure to MARPOL, intensity and level of ship operational issues such as bypassing the separators and falsification of record books were analyzed in the study. Insight was obtained in difficulties experienced while following MARPOL practices. Typical training syllabi were compared to suggested Lesson Plans, survey results were analyzed by statistical methods to verify framed hypotheses on pollution violations and human factors such as experience, attitude and fatigue also, but the Paper focuses on the issue of training. Training appears to be adequate; ANOVA tests show no difference in levels of awareness. Attitude towards pollution prevention practices appear to diminish with increased training, though not significantly. From another Chi-square test, it was seen that involvement in pollution violation incidents does not relate to the quantity of training imparted. Further tests indicate attitude and fatigue as influencing causal factors for shipboard oil pollution violations. Training may be nominally improved with simulator packages and by upgrading trainers' knowledge. Environmental protection can be treated as a separate subject in the curriculum.

Keywords: Maritime Training, Oil pollution violations, Environment, Attitude

1. INTRODUCTION

For the year 2003, International Shipping Federation has listed almost twenty-four major issues facing the shipping industry and criminalizing accidents tops the listing and also features marine oil pollution. Concerned with this trend, BIMCO (Baltic International Maritime Council) conducted a study and analysed a number of cases. The noticeable feature of the report is that all of them were oil pollution related offences. Oil pollution and criminalisation cause great harm and the person concerned is the seafarer. If the reasons for seafarer

committing these violations are addressed, the severity of these issues can be mitigated. The fishbone chart of Figure 1 identifies possible factors affecting the performance of the ship board officer and leading to oil pollution violations. Each of the factors may be analysed with the associated reasons.
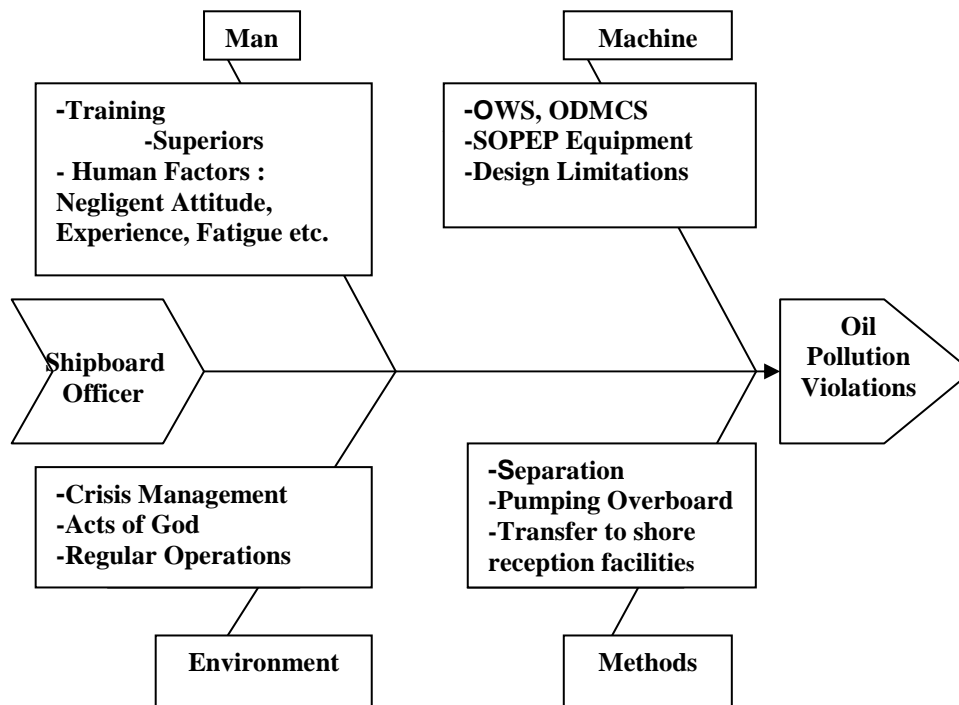
Fig. 1. Factors & Reasons leading to Oil Pollution Violations

Machines are designed according to regulations but there could be operational difficulties. Assessing the efficacy of machines will require a technical approach. SOPEP (Shipboard Oil Pollution Emergency Plans) materials are requirements under pollution prevention measures, such as self-absorbent pads, dispersants etc. The knowledge of employment and operation of machines and this equipment is imparted during training. The methods for oil pollution prevention are approved according to MARPOL (Marpol 73/78) regulations and are included in training. Limitations in some methods (e.g. insufficient shore reception facilities) might exist but would not hamper other prevention measures provided.

In the shipboard environment, acts of god (natural causes of storms and other calamities) are beyond normal control. MARPOL permits oil discharges in case of dire emergencies when lives of persons are in danger. This regulatory provision for crisis management is explained during training.

Man induced reasons for oil pollution include influence by superiors, training and human factors. Acting on instructions of superiors was an excuse for operational oil discharges but in the legal purview, the responsibilities are equally placed on all concerned parties. For example, when an incident of oil pollution is committed, the person committing the act, the Chief Engineer (if the incident is related to engine department), the Master and the Company are all held responsible. Such legal aspects are made clear while the seafarer is being trained. It is to be noted that training is concerned with all the factors discussed above. Further, any human error, resulting in a cause for violation say, collision, grounding, and

regular shipboard operations, is classified either as a wilful or an ignorant act. Ignorance refers to lack of understanding and skills. Lack of comprehension and deftness is normally attributed to lack of training. Negligence is an aspect of attitude where the reasons could be fatigue, lack of experience or simply behaviour.

Apparently, training and human factors remain as primary rationales. Figure 2 illustrates the analysis of the problem identified for the study. The problem statement made was - Are lack of training and human factors (experience, attitude, fatigue) the causes for the oil pollution violations by the seafarer?

Though training and human factors were perceived as variables for the problem, the paper has focussed on training to bring out the emphasis.
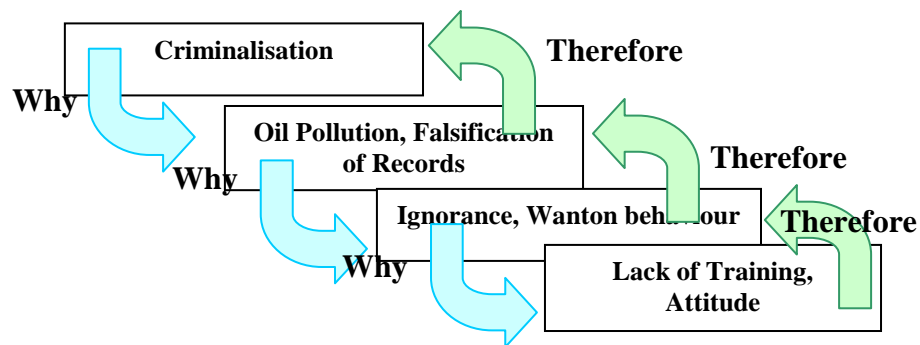
Fig. 2. Root Cause Analysis

1.1. Objectives of the Study

The main objective was to study the effect of maritime training with respect to oil pollution matters. The study also looked at the relationship between training, human factors (experience, attitude, fatigue) and pollution violations. In defining the scope of the study, only shipboard officers were considered and the violations were limited to oil pollution and falsification of records.

1.2. Framework of the Study

Two approaches, as shown in Figure 3 were chosen and the next step was to enquire if any relationship exists between training, human factors and oil pollution violations. Various hypotheses were formed assuming training and experience being the reasons, attitude and fatigue being the causes for oil pollution violations.

Study Maritime Training Syllabus and Lesson Plans related to environment and oil pollution	Conduct Survey amongst seafarers, Conduct Tests for understanding of pollution prevention awareness, Obtain opinions on shipboard pollution violations pointing to attitude

Relate training, experience and attitude from inputs

Analyse if any relationship exists between training, experience and attitude.
Analyse if training is adequate

Fig. 3. Framework of the Study

2. LITERATURE REVIEW

The grosser problem of criminalisation was established based on results of a study by BIMCO (BIMCO Report, 2006) and the enormity of oil pollution was projected with estimate approximations by a group of experts (GESAMP Report, 2007). Identifying procedural approaches for marine environmental excellence, some relevant factors mentioned are the training on board and ashore, waste management techniques, audits and improved equipment (Kumar & Loney, 2008).Maritime training formats and prescribed training requirements were reviewed with reference to STCW (Standards of Training, Certification and Watchkeeping) with relevance to human factors such as attitude and fatigue. As an exercise, the STCW was reviewed with reference to training on pollution matters.

In an analysis of contributory causes for oil tanker disasters (Manivannan, 2004), ship's Officers were seen as the major contributory cause, training and human factors being the apparent reasons. A report on ship manning (UK P & I Club, 2005) lists the factors affecting the performance of the ship's staff in which fatigue, training and experience were three factors out of eleven which emerged with relevance to context. In an analytical study of oil pollution caused by port operations (Gonzalez, 2000), training of the crew is cited as the major reason for the pollution incidents. Human errors causing oil pollution are attributed to lack of training and professional experience. Fatigue is identified as a common problem in all kind of errors and operations leading to pollution.

In assessing the quality of such training, the traditional measures include certification based on competency assessment and feedback from the student himself (Parsons, 1997). Further, any specific learning outcome needs demonstration of the acquired skill as an end product (IMO Model Course 1.29, 2000). Also, continual evaluation of the crew's ability is a must (Parsons, 1997). The study opines that, an assessment on the skills would be a better indicator of the competence rather than a qualitative feedback on what has been learnt. The framing of the survey questionnaire was an approach in conformance to such training assessment measures.

3. IDENTIFICATION OF VARIABLES AND METHODS OF APPROACH

Hypotheses were framed for training and other human factors. Table 1 projects the methodology for studying the effect of the primary factor, training. In all, 7 hypotheses were framed. One was based on content analysis while the rest were tested with appropriate statistical methods. The significance factor was pegged at 0.05 and the methods were chosen considering the nature of the data and the null hypotheses.

Table 1 Training: Hypotheses Testing Methodology

| Independent Variable	Measurement Methodology	Criteria	Tested Hypotheses
1. Learning content: Syllabus. IMO Lesson Plans & STCW'95 requirements	Content analysis of STCW'95, IMO Lesson Plans, training hours & Syllabi	Content & Training hours = or > prescribed	Adequacy of Training
2. Analyses based on test scores for groups with varying amount of training exposure (Awareness)	ANOVA	If Sig.F < 0.05, then Reject H_{O1}	H_{O1}: There is no significant difference in levels of oil pollution prevention awareness between officers with varied hours of training H_{A1}: There is significant difference in levels of oil pollution prevention awareness between officers with varied hours of training
3. Analyses based on acceptance and non-acceptance to violations for groups with varying amount of training exposure (Attitude)	ANOVA	If Sig.F < 0.05, then Reject H_{O2}	H_{O2}: There is no significant difference in attitude towards pollution prevention practices between officers with varied hours of training H_{A2}: There is significant difference in attitude towards pollution prevention practices between officers with varied hours of training
4. Analyses based on acceptance to involvements in pollution violations for groups with varying amount of training exposure	CHI SQUARE	If Sig.Ψ^2 < 0.05, then Reject H_{O3}	H_{O3}: There is no significant relationship between number of hours of training and involvement in oil pollution violation incidents H_{A3}: There is significant relationship between number of hours of training and involvement in oil pollution violation incidents

Adequacy of training on pollution matters was verified by comparing STCW requirements, IMO Lesson Plans and a Maritime Institute's Syllabi, methods of knowledge dissemination such as lectures or practical exercises and interviewing a cross-section of trainers.

The awareness was checked from scores obtained in the test, included in the questionnaires circulated amongst ship's officers. Groups with varying hours of training (pollution prevention) were compared with test scores and attitude measures, to identify difference in levels of awareness and to verify if more training will make a difference in awareness and attitude.

The survey respondents were officers drawn from various ranks of both Deck and Engine departments who are directly responsible for the ship operations, having ample scope for oil pollution. The major nationalities involved were Malaysian and Indian. A miniscule percentage of responses were obtained from officers from other nationalities. In total, 522 seafaring officers were surveyed, whereas the conservative requirement was 384 for a population greater than 100000 (Uma Sekaran, 1992).

4. RESULTS AND DISCUSSION

Firstly, the adequacy of training was assessed. The curriculum of a reputed maritime institute, ALAM (Akademi Laut Malaysia) was considered. The lesson plans and the syllabi of the institute were juxtaposed with the lesson plans of the IMO (International Maritime Organisation). The content of both pre-sea and post-sea competency levels on analysis showed a high level of agreement. Learning objectives, methods of knowledge dissemination, competency evaluation and hours of engagement were found to be in accordance with the IMO Lesson Plans, with particular reference to the marine pollution topics. The syllabi average 17 hours for training on marine pollution, which is well above the 15 hours indicated in the IMO Lesson Plans. Projections of training hours undergone by the respondents are shown by Figure 4 and the average of this works to 17.1 hours, which is also above the hours prescribed by IMO. The curriculum syllabi add up to 25.5 hours, including the pre-sea and post-sea sections. The training hours on pollution are further enhanced during the institute's modular course, Maritime Law. Given these quantum, the quantitative training appears sufficient.
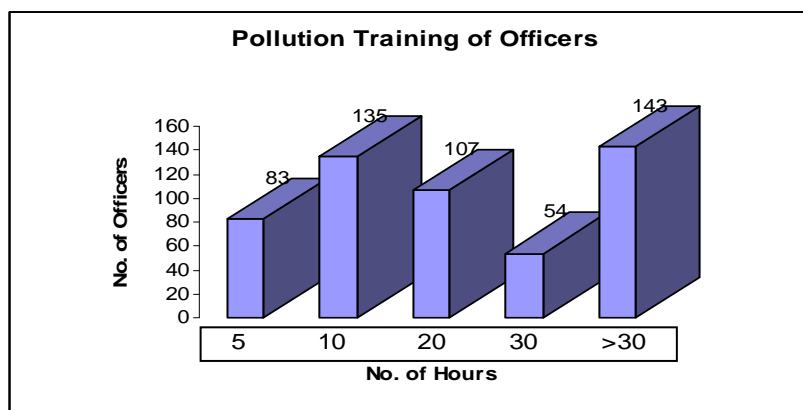

Fig. 4: Hours of Ship's Officers' Training on Pollution-Sample Population Grouping

Another indicative data was the average attempts taken by respondents to pass the competency examinations. Considering the number of attempts taken by the officer to pass the competency examinations, the numbers passing in single attempt is quite high as shown in Figure 5 & Figure 6. The average of the attempts to pass from these figures works to 1.04 for pre-sea examinations and 1.22 for the post-sea examinations. As a valid parameter for quality of training, this average is quite healthy being closer to the ideal figure of unity. But it may be cautiously said that demands of a training system at competency levels dictate the passing averages. Evaluation approaches, tough question papers and oral examination results etc. are factors which can make a difference to competency assessments which could be other aspects of the competency assessment process.
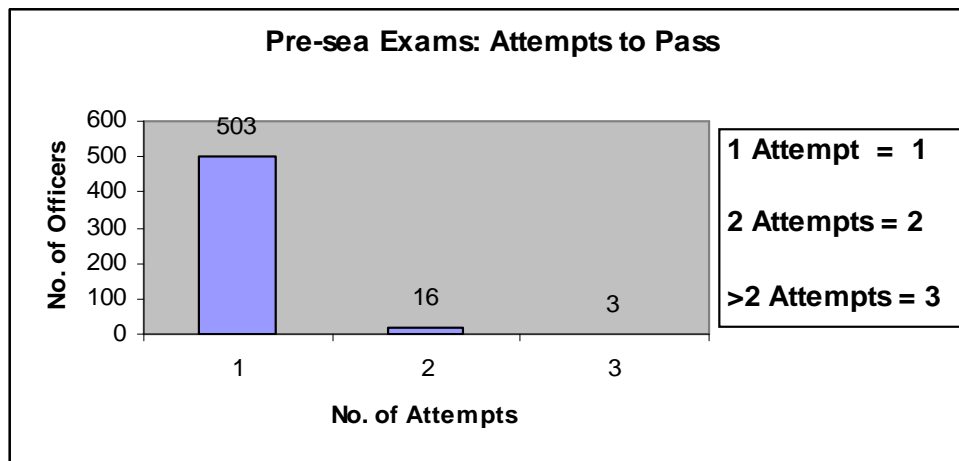
Fig. 5: Attempts to Pass Competency Exams: Pre-Sea Level
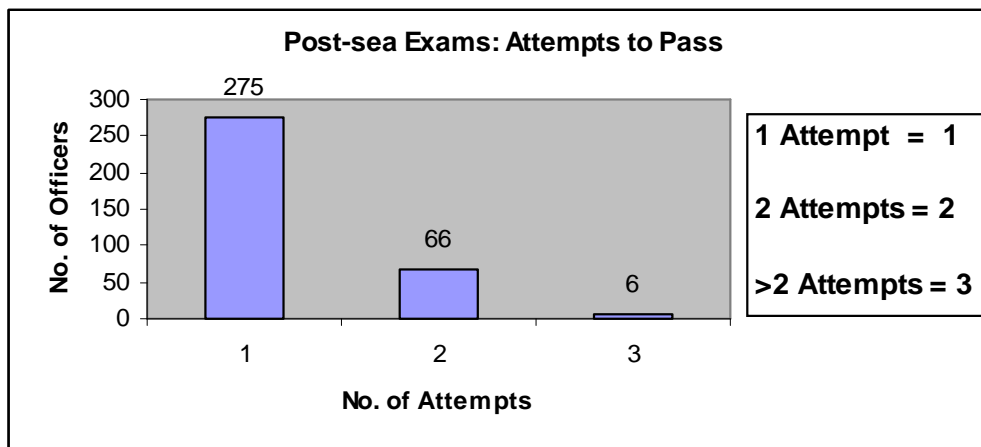
Fig. 6: Attempts to Pass Competency Exams: Post-Sea Level

Secondly, the hypothesis assuming variance in pollution awareness with varying hours of training was tested using ANOVA. A test with questions based on pollution regulations and shipboard practices that the officers have to be aware of before they board the ship at any level was included in the questionnaire. Test scores of five groups with 5, 10, 20, 30 and >30 hours of training were analysed. The results showed no significant difference in oil pollution prevention awareness amongst officers with varying hours of training.

The third testing of hypothesis assumed that with increase in training attitude towards oil pollution prevention practices improved. Questions based on operational practices, which reflected a good attitude or a negligent attitude were analysed using ANOVA. Negligent or bad attitude and good attitudes prevailed with equal intensities but, bad attitude appeared to diminish with increased training, though not significantly. Further tests on correlationship also did not show any significant association but ANOVA being the stronger indicator of variance with more than two groups (Caldwell, 2000), the ANOVA results were given more weight.

The fourth analysis was carried out using Chi-square tests. It was assumed that with increased training, involvement in pollution violation incidents might become lesser. Figure 7 shows the number and nature of pollution incidents where officers were directly involved. Violations from bilges, cargo and falsification are categorised as oil pollution violations. A higher percentage of violations are on the oil front and this confirms with the findings of the BIMCO (BIMCO Report, 2006).

Officers involved in these incidents were grouped according to the level of pollution training hours. The number of officers with no involvement was identified under the same groups and the test of Chi-square was carried out. The tests indicated no relationship between involvement and levels of training. It was inferred that and increase in training might not bring down the number of incidents.
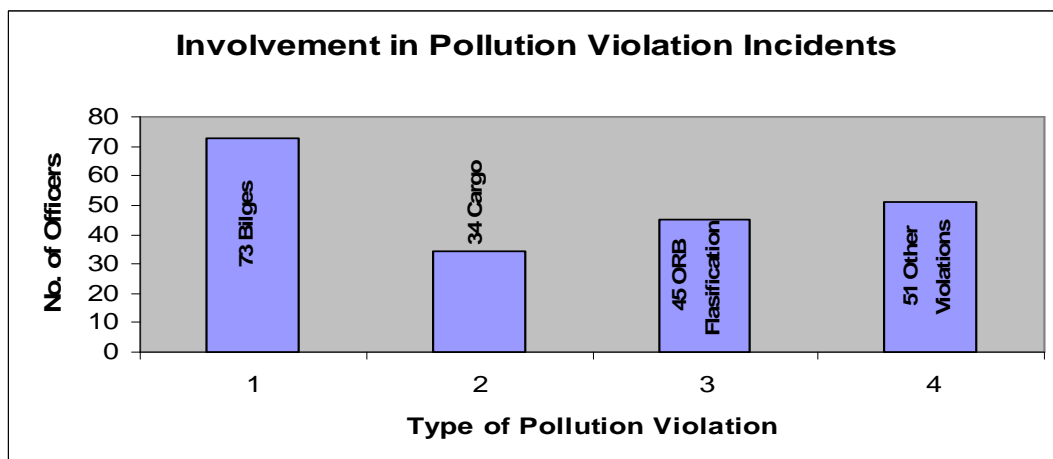
Fig. 7. Types of Pollution Violation Incidents Encountered by Officers

On the training front, the tests and analysis indicate a fairly good level of awareness and assimilation of knowledge. The causes for pollution violations might lie in the attitude of the shipboard officer as indicated in Figure 2 projecting the Root Cause Analysis. The results of the tests on various hypotheses relating to training are tabulated in Table 2.

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Table 2: Summary of Results-Hypotheses on Training

Hypotheses	Result
Training could be inadequate (Quantum of curriculum and intensity)	Training is adequate
H_{O1}: There is no significant difference in levels of oil pollution prevention awareness between officers with varied hours of training H_{A1}: There is significant difference in levels of oil pollution prevention awareness between officers with varied hours of training	Accept H_{O1} Sig. 0.910 > 0.05
H_{O2}: There is no significant difference in attitude towards pollution prevention practices between officers with varied hours of training H_{A2}: There is significant difference in attitude towards pollution prevention practices between officers with varied hours of training	Reject H_{O2} Sig. 0.05 = 0.05
H_{O3}: There is no significant relationship between number of hours of training and involvement in oil pollution violation incidents H_{A3}: There is significant relationship between number of hours of training and involvement in oil pollution violation incidents	Accept H_{O3} Sig. Ψ^2 = 0.832 > 0.05

Further, it may be inferred from the tests that irrespective of the level of training exposure, violations are occurring. The other point to consider is the number of pollution violations on other categories such as garbage etc. A total of 152 incidents of oil pollution and 51 other violations from the sample population of 522 are noticed. On a casual comparison, it indicates a fair prevalence of deviant behaviour in ship operations. If training is at satisfactory levels, the reasons and causes for pollution violations must lie in human factors.

Professional practices are primarily affected by training. While the training appears to be adequate in both quantitative and qualitative terms, the translation of the training into competence has also been verified by these exercises. It remains to be verified if any extraneous causes could be affecting the performance.

The study obtained inputs from officers on these fronts as well. A projection of the difficulties faced by shipboard officers is shown in Figure 8. Fatigue appears to be a major reason. While lack of training and ignorance constitute training, negligence and lack of experience may be identified as other causal factors for pollution violations. The later half of the study prevailed on these but this paper has focussed on training alone. Company's pro-activeness in supplying spares and policies get a mention as other reasons for facing difficulties in compliance. This is reflected in the observation that environmental non-compliance is identified as a management deficiency and environmental crimes indicate a management failure (Kumar & Loney, 2008).
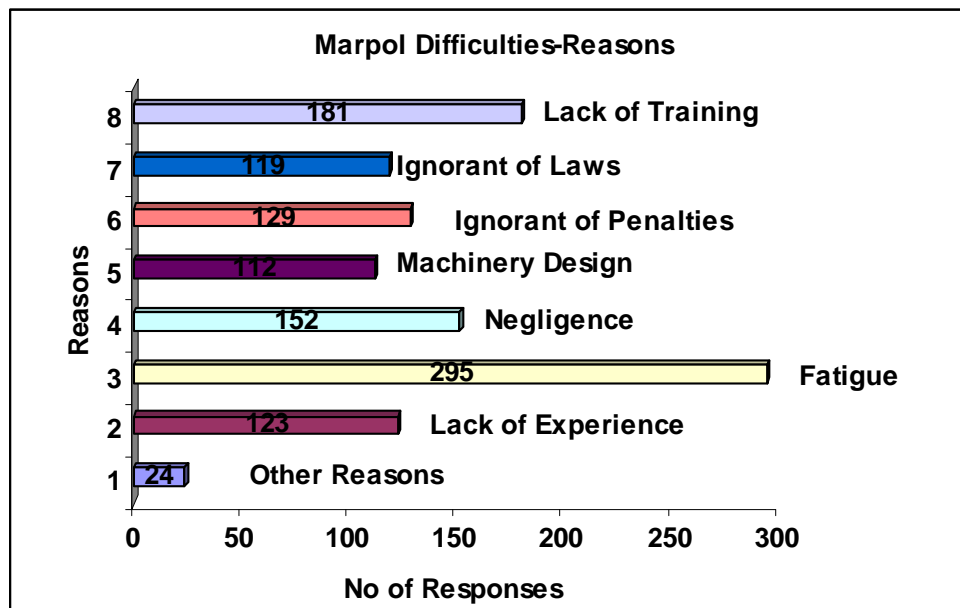
Fig. **8. Reasons for Facing Difficulties in MARPOL Practices**

5. CONCLUSIONS

Though the test results showed no major lacuna, the survey opinions were inclined towards a few changes in approach to pollution training. Inputs from surveys conducted amongst trainers as well were considered while making conclusive recommendations. The preferred changes in training for pollution matters are shown in Figure 9.
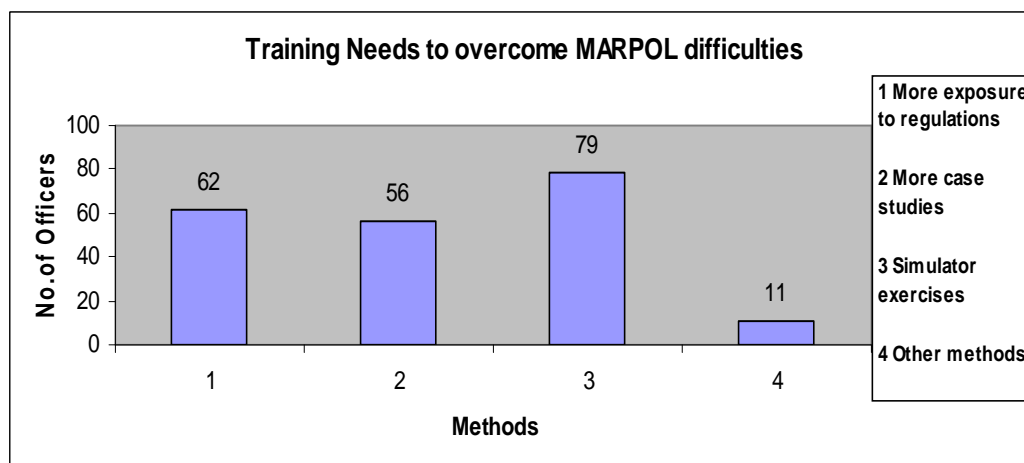
Fig. 9 Training on Pollution Matters – Suggested Methods

It has been observed that the modern OWS system design and operation have high difficulty levels and are also non-conducive to automation. Crew training at high levels is then imperative (Hendrik, 2006). Simulation platforms address such training needs. Simulator exercises which find maximum favour must be developed for pollution prevention particularly, rather than being generic. The physical and behaviour realism of simulator packages must be of high quality. Case studies on pollution matters/environmental protection must be included in both pre-sea and post-sea training lesson plans. Computer Based Training programs may be used for onboard training. Environment Protection may be treated as a separate subject and included at pre-sea levels. This will import the importance and the seriousness. It might do well that the Lesson Plans are updated as and when new regulations are ratified or in the process of being ratified. One of the factors identified in procedural approaches to training is the training on obligation to be truthful with port state authorities and in ship records (Kumar & Loney, 2008). Mechanisms for upgrading knowledge of trainers must be in place including equipment training by experts.

The primary aim of the study was to see the correlation between training of seafarers and the oil pollution-regulation violations. Additionally, the scope was expanded to other human factors such as experience, attitude and fatigue. With concerns on environment reaching serious levels and STCW being reviewed for strategic changes, such a study is timely. It is earnestly hoped that this study benefits the maritime community including the training institutes and the shipping companies.

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ENVIRONMENTAL RISK AND RELIABILITY FOR SUSTAINABLE DREDGING

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Dredging work and placement leads to changes to the environment. Environmental impact assessment has been employed to address these changes. Risk assessment which rarely covers large part of uncertainty associated with dredging work is captured in EIA. EIA focus on fixed and inflexible standards which have led to post dredging failures. This makes it necessary to do critical and dependability scientific risk analysis that quantitatively determine whether the changes are serious or irreversible. This paper discuss the new internationally recognized philosophy of risk analysis or formal and system risk based design that provide opportunity to focus on real concern of the dredging project. The paper will discuss case study of failed project based on conventional EIA and best practice performance of systemic risk base design approach.

1. INTRODUCTION

Dredging is process of digging under water for purpose to maintain the depth in navigation channels. Dredging is required to develop and maintain navigation infrastructure, reclamation, maintenance of river flow, beach nourishment, and environmental remediation of contaminated sediments. Study on environmental impact of dredging is not new and recently there is concerned about balance between the need to dredge, economic viability, social technical approval and adequate environmental protection can be challenge. Various methods has been implemented for management of dredging activities, but choose in the best practice approach is also a bog challenge that require high level of understanding of the technical and economical aspects of the dredging process. input from ecological experts and dredging specialists. Community participation from port authorities, regulatory agencies, the dredging industry and non-governmental organisations such as environmentalists and private sector consultancies.

2. THE NEED FOR AND DREDGING REQUIREMENT

Dredging is the excavation, lifting and transport of underwater sediments and soils for the construction and maintenance of ports and waterways, dikes and other infrastructures, for reclamation, maintenance of river flow, beach nourishment, to extract mineral resources, particularly sand and gravel, for use for example in the construction industry, and for the environmental remediation of contaminated sediments. Globally, many hundreds of millions of cubic meters (m3) of sediments are dredged annually, with most of this volume being

handled in coastal areas. A portion of this total represents capital dredging which involves the excavation of sediments to create ports, harbors, and navigable waterways. Maintenance dredging sustains sufficient water depths for safe navigation by periodic removal of sediment accumulated due to natural and human-induced sedimentation. Maintenance dredging may vary from an almost continuous activity throughout the year to an infrequent activity occurring only once every few years. Dredging activities offer social, economic and environmental benefits to the whole community. Hydrography chart and bathymetric map are used as guidance to vision of discrete bottom of water. Vigilant is requiring for the bottom as the, they are proned to sudden change leading to shoaling due to flood or drought. Survey of a navigation channel to locate dredging area done through drawing of isolines, or lines connecting points of equal depth, on the map so that captains and ships' pilots can get an idea of the "hills and valleys" underwater [1,3].

Remote sensing equipment is used by hydrographers' on top of the water of the water to see the bottom of the channel. Isoline are drowned based on statistical data record for accuracy and reducing risk of missing important underwater features, like rocks or shoals. Dredgers: dredger is a machine that scoops or sucks sediments from under the water. There are a few different types of dredgers, the three main types of dredges are mechanical dredges, hydraulic dredges, and airlift dredges. Mechanical dredges are often used in areas protected from waves and sea swells. They work well around docks and shallow channels, but not usually in the ocean. Hydraulic dredges work by sucking a mixture of dredged material and water from the channel bottom. There are two main types of hydraulic dredges - the cuter head pipeline dredge and the hopper dredges. Airlift dredges are special-use dredges that raise material from the bottom of the waterway by air pressure. Split hull hopper dredges are self-powered, so they can move to the dredging and disposal site by themselves. Figure 1 shows typical hydrographic survey of a channel.
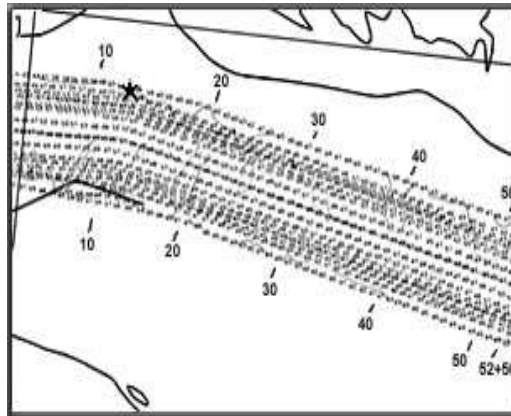
Fig.1 Typical hydrography survey Channel condition survey for a channel, 53m deep, the survey lines are at 50-foot intervals. Shaded areas are shoals.(PTP, 2008)

Dredge material: Dredging is necessary to maintain waterways channel. Nearly 400 million cubic yards of material is dredged each year. Consequently, about 400 million cubic yards of material must be placed in approved disposal sites or else used for another environmentally acceptable purpose. Sustainable disposal of dredge material is very imperative as it ends up saving a lot of money and maintains reliability and efficiency use of resources advantage of sustainable beneficial disposal are [2,3]:

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i.   Cost saving on money spent on finding and managing disposal sites.
ii. It avoids habitat and ecological impacts that disposal may cause.
iii. It saves capacity in existing disposal sites.
iv. It can be a low-cost alternative to purchasing expensive fill for construction projects.
v.   It can be used to enhance or restore habitat.

3. ENVIRONMENTAL REQUIREMENT OF DREDGING PROJECT

The tendering of a dredging contract typically occurs after a full engineering design has been completed (i.e. after the planning and design phase). However, for other types of contracting mechanisms (e.g., design-build), the tendering of contract may occur early in the overall project process, thus requiring the Contractor to perform much of the evaluation and design work himself. Table 1 shows phases of dredging project and the risk control components.

Table 1 Dredging project phases and risk components

Project Phase	Planning and design	Construction	Post construction
Impact	Need for dredging is translated into project design Physical and biological impacts will depends on project specification.	Project construction will cause temporary or permanents physical change, Advert effect should be mitigated through best practice method	Physical change may result to long term environmental effects that should be mitigated by appropriate project design , planning and execution
Scope	Functional requirements Conceptual design Potential environmental impacts Final design and specifications	Tendering and contract award Construction methods and equipments' selection Monitoring and feedback	Infrastructures in service and their may have additional mode of impact Long term monitoring and feedback may be needed to evaluate RCO
Environmental components	Planning and design decision RCO to prevent or reduce environmental impact if of the whole project	Construction decision RCO to prevent environment impact cause by physical change	Certain RCO may apply to mitigation of future impacts

The planning and design phase begins with defining overall functional requirements to meet the project objectives. This involves evaluating potential environmental impacts and any regulatory constraints, and concludes with preparing projects specifications. The planning and design phase is used to identify risk areas and risk control option in advance to help protect the environment during dredging, transport, and disposal activities and subsequent monitoring and possible remedial actions. Elements of project formulation include:

i. Functional Requirements
ii. Conceptual Design
iii. Regulatory Framework
iv. Baseline Environment
v. Stakeholder Input
vi. Potential impact Review the baseline condition as a consequence of construction and post-project activities.
vii. Environmental Impact Assessment (EIA)
viii. Risk control option
ix. Prepare Final Project Design and Specifications

A final design addresses all major elements of the project: engineering design, environmental management, construction sequencing, and construction management. The specification's level of detail will depend on the type of contract, the complexity of the project, and the experience with dredging of both the project proponent and contractor(s). Figure 2 shows example operational disposal control measure to limit impact of dredge disposal.
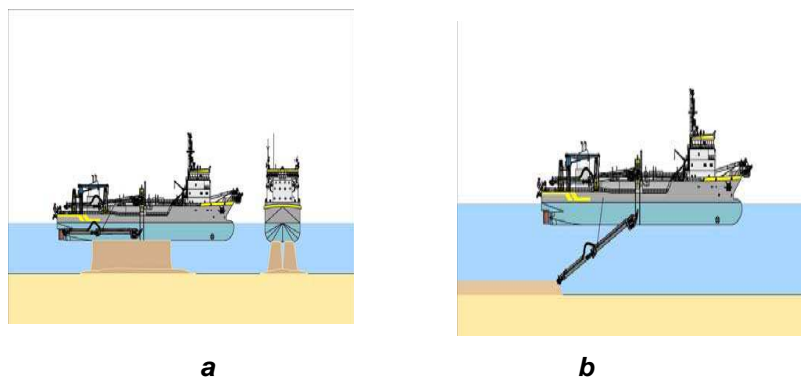
a   *b*
Fig. 2a. uncontrolled disposal, b. control disposal (PIANC)

It is important to integrate risk control option that have been evaluated in the environmental review process to ensure that the desired balance between minimizing potential environmental impacts and constraints on construction is achieved. Additional environmental review may be required to establish that any residual risk, or actual impact, is acceptable Risk control option must be based on a clear definition of the project's technical and regulatory requirements. Studies conducted during the EIA or project planning, as well as information from regulators and stakeholders can contribute technical information for informed risk control option including [3,4] :

a. Sediment characterization (e.g., grain size distribution, level of contamination, etc.)
b. Bathymetric/topographic surveys with design profiles, which establishes the volume of sediment to be dredged;

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c.   An understanding of hydraulic/hydrodynamic/oceanographic conditions that may restrict operations;
d.   The destination or final use of the dredged material, including placement options and locations;
e.   The environmental functions and value of the area to be dredged, establishing environmental boundary conditions;
f.   The environmental value of dredged material management areas (e.g., placement in confined or unconfined areas, or beneficial use options);
g.   Existing site uses (e.g., navigation, recreational use, commercial fishing, quality of life impacts [air, noise, light]) to establish reasonable operational measures;
h.   Legal conditions.

Environmental aspects related to future use and maintenance of the project's post construction condition should consider the areas of facility operations, future maintenance, long-term monitoring. During the construction phase, the contractor assumes primary responsibility for meeting the requirements of the project specifications, including meeting permit and contractual environmental conditions and implementation of risk control options. Major steps in the construction phase include:

a.   Tendering and Contract Award
b.   Contractor Defines Construction-Methods and Selects Equipment
c.   Project Execution: Risk control option should based on best practice

Figure 3 shows example of post dredging impact in Kuala Terengganu
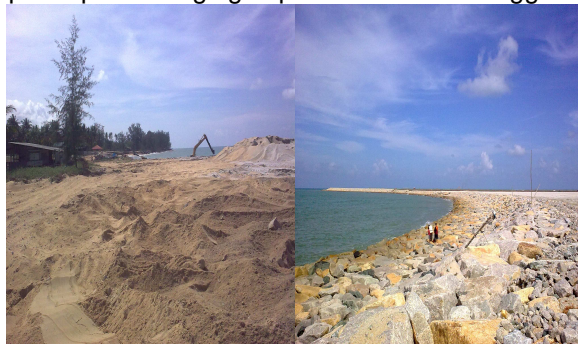
Fig. 3 Post dredging impact in Kuala Terengganu

## 5.   ENVIRONMENTAL RISK REQUIREMENTS OF DREDGING PROJECT

Risk analysis in a dredging project, including taking into account adherence to the Precautionary Principle. It involves methods for assessing the significance of the likely impacts and essential environmental characteristics that require consideration during both the planning and implementation phases and the mechanisms whereby impacts can occur.

5.1 Qualitative based environmental impact assessment

Dredging and disposal of dredged material have many potential implications for the environment, like disturbance of benthic invertebrates, disruption of their habitats and direct mortality. The scale of these impacts depends on several factors, including the magnitude, duration, frequency and methodology of the dredging activity and the sensitivity of the affected environment. The need for RCO to reduce the effects of dredging, transport, and

placement depends on the results of the impact assessment process and effectiveness to meet goal of protecting sensitive environmental resources, maintenance of healthy ecosystems, and ensuring sustainable development and exploitation of resources.

Understanding the environments in which dredging and dredged material placement occur is a prerequisite of prudent decision making for environmental protection. A thorough knowledge of baseline conditions is needed so that a dredging project's environmental effects can be assessed properly and monitored against an agreed baseline. The baseline data must address natural variations, seasonal patterns and longer term trends to provide a context for determining whether a change is the result of dredging or not. As a minimum, characterization of the potentially affected environment should consist of recent surveys (performed within the last three years) and studies of the relevant environmental attributes. Figure 4 shows the risk based model for dredging project
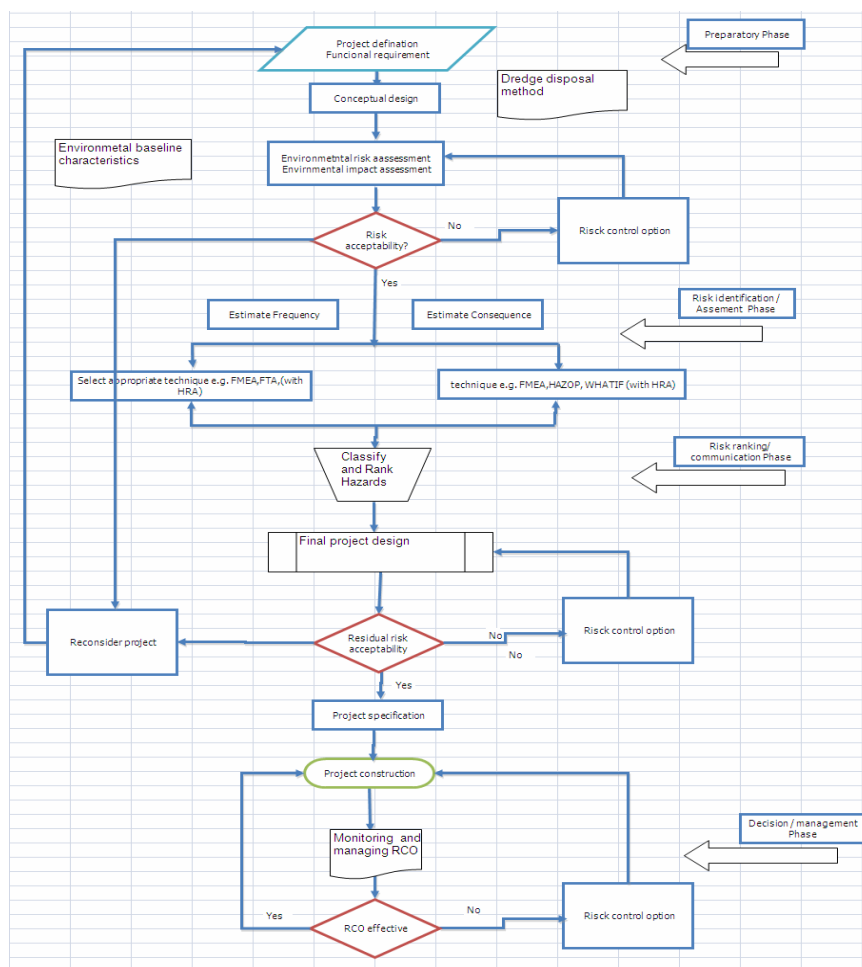
Fig. 4 Risk based model for dredging project

For reliability the studies must be conducted by qualified scientific and engineering personnel using accepted methods. The boundary includes the physiographic, hydrologic, ecologic, social, and political boundaries of the project areas. In general, the following types

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of data are required for characterization of the dredging and placement sites, the transport corridor, and the areas around these sites, which could be indirectly affected, to adequately address the range of management options [5, 6]:

i. Bathymetric and adjacent topographic data;
ii. Habitat and species distribution;
iii. Resources such as fish populations, shellfish beds, oil and gas fields, aggregate mining and spawning grounds;
iv. Physical and chemical nature of sediments;
v. Water quality;
vi. Hydrodynamic data;
vii. Cultural resources, including archaeological and anthropological conditions;
viii. Human demography and land use characteristics;
ix. Users of the environmental resources, such as commercial, recreational, and subsistence fisheries;
x. Navigation routes; and
xi. Services in the project area, such as pipelines and cables.

In addition, it is necessary to take into account any cumulative impacts. Certain ongoing activities, such as fisheries and navigation, could have impacts that in combination with the proposed dredging result in more significant effects than would result from the project activities alone. This information is generally included in the impact assessment.

5.2. Between environmental risk assessment and environmental impact assessment

In practice, different approach is used to evaluate and "measure" the environmental impacts of a dredging project. ERA is defined as the examination of risks resulting from the technology that threaten ecosystems, animals and people (EEA, 1998). There are three main types of ERA: human health, ecological, and applied industrial risk assessment. The origin of ERA is the assessment of risks in the industry. Then, the same approach was applied in a broader scale for assessing the risks of the release of chemicals posed to human health. The more recently developed ecological risk assessment follows the same approach as human health ERA, but extending the assessed "end-points" to species other than human beings.

A conventional approach of an environmental risk assessment begins with the problem formulation and the identification of the hazard (or hazards). Then, the possible ways of release of the hazard are estimated, and the exposure of those chosen target species is assessed. The final steps are the consequence assessment and the estimation of the risk. Some of the steps require the use of models (e.g. the assessment of the release and the exposure), and the outcome is usually a quantitative assessment. It should be noted that many choices have to be done in the design of the risk assessment, and thus the definition and method used in each of them will be of importance to the final outcome [7].

It has also been common that human health and ecological ERA are normally applied for assessing the risks regarding the release of one single chemical. They would need to be adapted for assessing the impacts of dredging operations, where more than one chemical might be released together. It is cleared that the consequences of dredging might be broader than the release of chemicals .Another group of tools widely used at present is environmental impact assessment (EIA).

There are also several methodologies for performing an EIA. They depend on the assessed activity, and of course the way the final impacts are presented and aggregated. The effects considered in an EIA are very wide, from pollution effects to a wider range of

ecological effects, and it is often a statutory requirement under holistic doctrine to consider all possible effects, including economic, social and political.

The difference between ERA and EIA is that the later do not treat risks as probabilities. Generally the potential impacts are predicted, and assessed quantitatively or qualitatively. However, it also uses models requires for making many decisions in the design of the assessment, which could influence the final result. Any evaluation of the impacts of a certain project has to face difficulties and uncertainties, in part due to the scientific uncertainties involved, but in part due to the decisions to be made for framing and defining the problem. The impact assessment will have to specify the range of species to include and thus get entangled in nontrivial normative (ethical, ecological and economic) issues.

### 5.3. Risk based design and precautionary principle

The "Communication from the Commission of the European Communities on the precautionary principle" (Commission of the European Communities, 2000) states that the Precautionary Principle should be applied within a structured approach to the analysis of risk. As outlined above, this comprises three elements: risk assessment, Risk analysis, risk management and risk communication. The Precautionary Principle is particularly relevant as an instrument in the management of risk.

In the context of dredging projects it can be stated that because of great natural variability there will often be a lack of full scientific certainty about the scales of potential impacts. In accordance with the Precautionary Principle decision to forego a project should be a last resort following exhaustive consideration of all reasonable RCO and reaching a conclusion that adequate environmental protection could not be achieved. Prohibiting dredging may ensure that no impacts occur, but may also generate high risk to human safety (e.g., lack of removal of shoals that pose navigation hazards) or result in lost commerce and harm to the economy. The RCO should be selected such that clear, defined, and ideally quantitative thresholds of protection can be achieved (e.g. to control measures of suspended sediment within a specified concentration / duration range). Figure 5 shows typical system risk components[8,9].
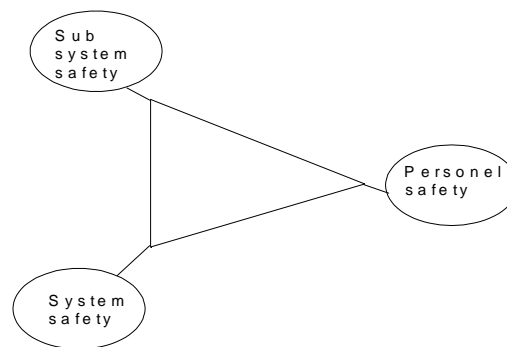
Fig. 5 Components of risk assessment and analysis

The approach to risk assessment begins with risk analysis, a systematic process for answering the three questions posed at the beginning of this chapter: What can go wrong? How likely is it? What are the impacts? The formal definition of a risk analysis proceeds from these simple questions, where a particular answer is S_i, a particular scenario; p_i, the likelihood of that scenario; and C_i, the associated consequences. See Figure 6.

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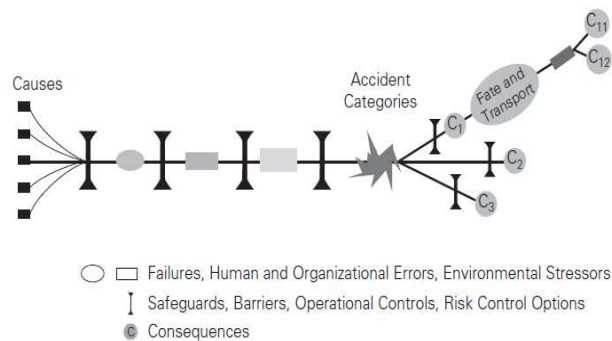
Fig.6 Risk based method

Thus cost of environmental sustainability is not cheap, but whenever we compare the benefit and longtime reliability with the cost, there is no doubt that the later will supersede the earlier. Dedication on Scientific analysis, environmental assessment work, never get attention in the past like to today. The fact that everything stays with us, is recently calling for philosophy for minimum used of toxic material in our daily activities. Yes, scientific work or test required prudent analysis over time, but once we have information we should restrain under the doctrine that prevention is better than cure.

Work on environmental issue has always involved dispute because of impacts analysis. Global climate Change might be regarded as a primary example where this strong interlinkage between science and policy making is broadly acknowledged, Social science studies have shown how the production of scientific knowledge played a crucial part in the rise of climate change as a topic of worldwide interest and to the political arena while, on the other hand, knowledge and research on climate change issues is influenced by social factors

In most countries, the majority of dredged material is placed at sea. Land disposal options are normally much more expensive therefore, they are applied only when either transport costs to sea are inhibitory, or beneficial use is not an option, or the material is too contaminated (Burt et al., 1997a). In order to meet sustainability requirement the following describe 3 case studies where beneficial work in dredging are translated to cost [10,11].

i.   On environmental sustainability According to US green port project, 2001, case study on Boston port navigation improvement project done in the US dredging and construction project use mitigation like Surface sediments contaminated with metals, PAHs, PCB, and other organics, Channels were over-dredged by 20 ft. Contaminated material was placed on barge and deposited into over-dredged in-channel disposal cells and covered with 3 ft. clean material, All clean material deposited in Mass Bay Disposal Site.

ii. Another case done in port of los Angelis use copper treatment by developing onsite system to treat copper contaminated marine sediments, Pilot study dredged, treated, and disposed of 100 tons of contaminated sediment, Full-scale project cleaned up 21,000 cubic yards of contaminated sediment, Saved $1.5 million in cleanup costs over alternative.

iii. Studies done in Europe also confirm use of processing plant for dredge material. Also regional sediment management program done by (USACE, 2003) compiled various methodologies to reduce shoaling.

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**5.4 Reliability and decision support framework**

Various studies have been carried out to find the best hybrid supply for given areas. Results from specific studies cannot be easily applied to other situations due to area-specific resources and energy-use profiles and environmental differences. Energy supply system, with a large percentage of renewable resources varies with the size and type of area, climate, location, typical demand profiles, and available renewable resource. A decision support framework is required in order to aid the design of future renewable energy supply systems, effectively manage transitional periods, and encourages and advance state-of-the-art deployment as systems become more economically desirable. The DSS could involve the technical feasibility of possible renewable energy supply systems, economic and political issues.

Reliability based DSS can facilitate possible supply scenarios to be quickly and easily tried, to see how well the demands for electricity, heat and transport for any given area can be matched with the outputs of a wide variety of possible generation methods. This includes the generation of electricity from intermittent hybrid sources. DSS framework provide the appropriate type and sizing of spinning reserve, fuel production and energy storage to be ascertained, and support the analysis of supplies and demands for an area of any type and geographical location, to allow potential renewable energy provision on the small to medium scale to be analyzed. DSS can provide energy provision for port and help guide the transition towards higher percentage sustainable energy provision in larger areas. The hybrid configuration of how the total energy needs of an area may be met in a sustainable manner, the problems and benefits associated with these, and the ways in which they may be used together to form reliable and efficient energy supply systems. The applicability and relevance of the decision support framework are shown through the use of a can simulate case study of the complex nature of sustainable energy supply system design.

5.5. Regulatory requirement and assessment

The current legal requirements have been developed based on reactive approach which leads to system failure. Reactive approach is not suitable for introduction of new technology of modern power generation systems. This call for alternative philosophy to the assessment of new power generation technologies together with associated equipment and systems from safety and reliability considerations, such system required analysis of system capability and regulatory capability. System based approaches for regulatory assessment is detailed under goal based design as shown in figure.

IMO has embraced the use of goal based standards for ship construction and this process can be equally well applied to machinery power plants. Figure 7 illustrates the goal based regulatory framework for new ship construction that could be readily adapted for marine system.
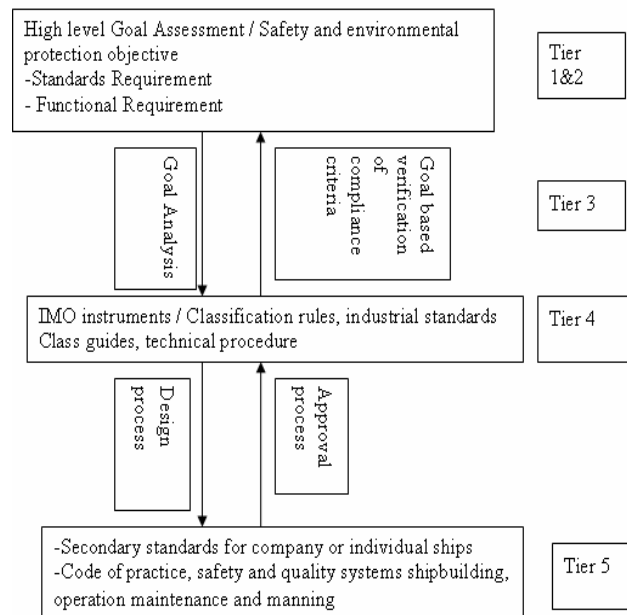
Fig. 7 Components of level goal standard assessment

5.5.1 Legal framework for dredging

The most important international agreements regarding dredging are the London Convention 10, issued in 1972 and reviewed in the 1996 Protocol 11; and the OSPAR Convention 12 from 1992. IMO also unveil Formal safety assessment for marine system. These international agreements establish frameworks within which the contracting countries are obliged to operate with respect to their handling of materials destined for placement in the sea. However, these Conventions do not include regulations of the dredging operations per se, which are mainly established at the national level, nor for the conditions of disposal of in land. Convention for the prevention of marine pollution by dumping of wastes and other matter (www.londonconvention.org).

A review of the Convention began in 1993 and was completed in 1996 with the acceptance of The 1996 Protocol to the London Convention. The 1996 Protocol has not yet come into force as it has not yet been ratified by a sufficient number of countries (19 out of 26). Conventions for the Protection of the Marine Environment of the North-East Atlantic (www.ospar.org).On the other hand, dredging activities are subject to national regulations, which can vary very much among the countries. In some cases there is a specific directive regarding dredging in Malaysia the royal Malaysia navy regulate the dredging. Thus the are other agencies but there is not integration for effectiveness of the system.(personal communication .

6. QUANTITATIVE AND FORMAL SYSTEM ENGINEERING BASED RISK ANALYSIS

"Risk" is generally understood as an expression of the quantified link between an environmental hazard or "stressor" and the potential negative consequences it may have on targets or "receptors". When discussing risk the types of stressors as well as the targets of

interest must be specified. Thus project risk can be distinguished from engineering risk, and environmental risk. But, in practice it may be very difficult to establish a quantifiable relationship between hazard and target response because of the many uncertainties in the cause-effect chain and the dynamic nature of aquatic ecosystems. Risk analysis provides a means to accommodate these uncertainties. Formal risk assessment procedures have not been adopted by many regulatory agencies or they have been applied mainly to dredging of contaminated sediments. Typically risk assessment takes the form of "professional judgment" based on the experience and expertise of parties engaged in project co-ordination [12].

Risk analysis provides an opportunity to focus on the real concerns of a project, instead of relying on fixed and inflexible standards such as threshold levels for contaminants or fixed percentages of allowable overflow of a dredger. For the purpose of this report, risk assessment is mainly captured in the EIA, whereas risk management takes the form of best management practice determination. Risk evaluation is the path from the scientific system based quantitative risk analysis is the internationally recognized best practice and modest concept of risk analysis. Table 2shows components of risk analysis.

Table 2 Components of Risk analysis for dredging

Components	Purpose / Process
Risk analysis	Involve the overall process of risk assessment and risk management, including screening and scoping
Risk assessment	Involve qualitative process of identifying risk potential to quantitative risk characterization
Risk screening	Involve the specification and setup of a general framework for managing risk
Risk evaluation	Involve: i. Scientific evaluation of risks through use of stochastic process ii. Public/political evaluation of risks
Risk management	Involve: i. Process of identifying and selecting measures **ii.** Procedures for implementation and evaluation of measures

An outline about risk assessment and the application of risk-informed decision making can be found in Bridges (2007). This document does not address the scientific methods to evaluate the human health and ecological risks of a project. In this case other guidance, like the PIANC Working Group Envicom 10 report on "Environmental Risk Assessment of Dredging and Disposal Operations", should be reviewed and properly qualified professionals engaged to perform the necessary work. Analysis tools that now gaining general acceptance

in the marine industry is Failure Mode and Effects Analysis (FMEA). The adoption of analysis tools requires a structure and the use of agreed standards. The use of analysis tools must also recognize lessons learnt from past incidents and experience and it is vital that the background to existing requirements stemming from rules are understood. Consistent with the current assessment philosophy, there needs to be two tenets to the process - safety and dependability. A safety analysis for a hybrid power generation system and its installation on board a ship could use a hazard assessment process such as outlined in Figure 8. The hazard assessment should review all stages of a systems life cycle from design to disposal.
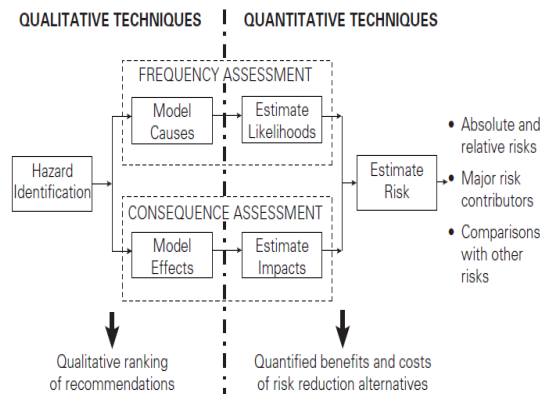
*Fig. 8 Components of risk and reliability analysis*

Figure 8 sohws the components of risk assessment and analysis. The analysis leads to risk curve or risk profile. The risk curve is developed from the complete set of risk triplets. Table shows elementsof risk analysis. The fourth column is included showing the cumulative probability, Pi (uppercase P), as shown. When the points $<C_i, P_i>$ are plotted, the result is the staircase function. The staircase function can be considered as discrete approximation of a nearly continuous reality. If a smooth curve is drawn through the staircase, that curve can be regarded as representing the actual risk, and it is the risk curve or risk profile that tells much about the reliability of the system. Combination of qualitative and quantitative analyses is advised to for risk estimates of complex and dynamic system.

Table 3 components of risk and reliability analysis

Scenario	Probability	Consequence	Cumulative Probability
S1	P1	C1	P1=P1+P2
S2	P2	C2	P2=P3+P2
Si	Pi	Ci	Pi=Pi+3+Pi
Sn+1	Pn+1	Cn+1	Pn-1=Pn+Pn+1
Sn	Pn	Cn	Pn=Pn

n=N

The analysis that describes and quantifies every scenario, the risk estimation of the triplets can be transformed into risk curve or risk matrix of frequency versus consequences that is shown in Figure 9.
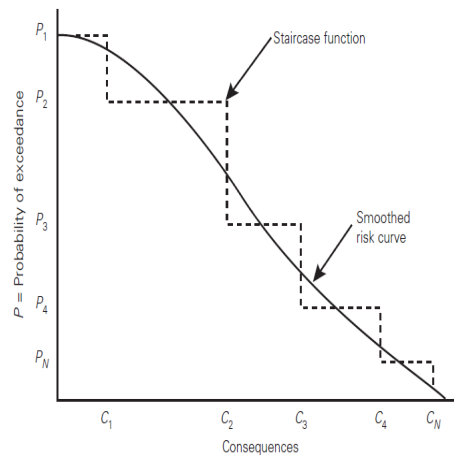
Fig. 9 Stair case risk curve
L = low risk; M _ moderate risk; H = high risk; VH _ very high risk.

The design concept needs to address the marine environment in terms of those imposed on the power plant and those that are internally controlled. It is also necessary to address the effects of fire, flooding, equipment failure and the capability of personnel required to operate the system. In carrying out a hazard assessment it is vital that there are clearly defined objectives in terms of what is to be demonstrated. The assessment should address the consequence of a hazard and possible effect on the system, its subsystems, personnel and the environment. An assessment for reliability and availability of a hybrid power generation system and its installation in a ship could use a FMEA tool. An effective FMEA needs a structured approach with clearly defined objectives

The assessment analysis processes for safety and reliability need to identify defined objectives under system functionality and capability matching. These two issues are concerned with system performance rather than compliance with a prescriptive requirement in a standard. The importance of performance and integration of systems that are related to safety and reliability is now recognized and the assessment tools now available offer such means. Formal Safety Assessment (FSA) is recognized by the IMO as being an important part of a process for developing requirements for marine regulations. IMO has approved Guidelines for Formal Safety Assessment (FSA) for use in the IMO rule-making process (MSC/Circ.1023/MEPC/ Circ.392). Further reliability and optimization can be done by using stochastic and simulation tools [8, 13].

Table 7: Component of holistic assessment of the system

6.1. Uncertainties and risk in dredging projects

The physical and biological characteristics of aquatic environments vary both spatially and temporally. Therefore characterizing these environments and assessing impacts and risk will always involve some uncertainty. This requires the need for basic understanding of how marine and the ecosystems function and how natural events and anthropogenic activities affect these functions. In the ideal situation, all environmental risks associated with a dredging project would be quantifiable, making the need for specific management practices clear. In reality, dredging can potentially affect diverse assemblages of organisms or their habitats on both spatial and temporal scales. Because the scales of the interactions between organisms and the dredging process are difficult to determine, often the consequences of a

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project are largely speculative. Some degree of uncertainty will therefore always be present indecisions regarding the need for special management practices to protect the environment.

It is important to recognize that even with extensive baseline data and input from qualified professionals, an element of uncertainty will always be associated with the results of an environmental assessment, simply due to the dynamic nature of marine and freshwater environments and the complexity of stressors and drivers apart from anthropogenic influences. Effects of dredging operations have to be seen against the background of similar natural effects. Figure 10a shows that in a typical dredging project the risk assessment is made after the preparation of the Conceptual Design. If at this stage it proves that the environmental risks are such that they cannot be mitigated by implementation of the appropriate best practice then the project should be reconsidered. This means that functional requirements will need to be redefined followed by a revision of the Conceptual Design.
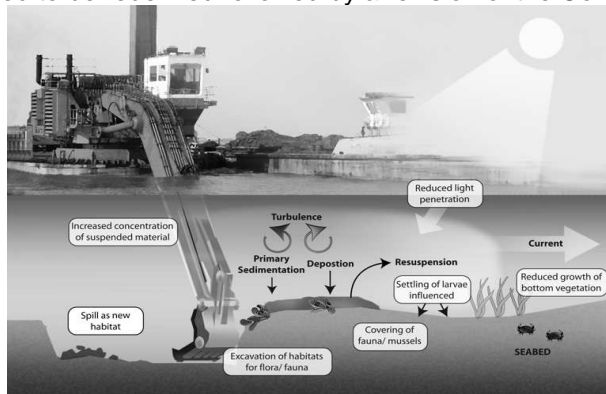
Fig. 10a Possible Environmental Effects of Dredging (PIANC, 2009)

In the process of risk work, newer refined RCOs may become necessary during the process of risk management. During the preparation of the final project design it is essential to establish the degree of "residual" risk. Figure 10b shows potential impact to marine aquatic.
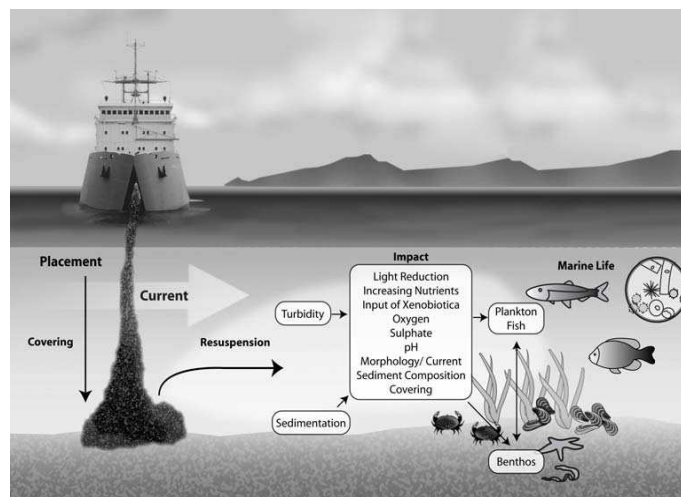

Fig.10b: Possible Environmental Effects of disposal (PIANC, 2009)

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6.2. Potential Physical Changes and Environmental Impacts from Dredging and Disposal of Dredged Material

Below water, the sound from the dredge vessel could have environmental effects such as interfering with fish behavior, possibly leading to disturbed migratory routes, although fish might easily avoid temporarily disturbed areas without consequence. Other potential environmental effects not directly related to dredging but associated with the presence of the dredger include spills of oil and fuel, exhaust emissions, and the possible introduction of invasive species via the release of ballast water.One of the less understood areas of concern is the impact of sediment released into the aquatic environment that may occur at any of the stages from excavation to placement. A high concentration of sand in suspension will have very low turbidity while a relatively low concentration of fine silt or clay in suspension will have a high turbidity. ALlso sediment effect on the flora and fauna, concentration, the turbidity, the total amount of loss of sediments or the spatial distribution of a sediment plume are other impacts.

Sediment re-suspended in the water column in high concentrations can directly lead to physical abrasion of, for example, filter-feeding organs or gill membranes of fish and shellfish. Indirectly, if present for sufficient duration, high turbidity (i.e. reduced light penetration), can result in decreased growth potential or total loss of submerged aquatic vegetation. The resuspension of sediments can also release toxic chemicals or nutrients such as phosphates and nitrates, which may increase the atrophic status of the system (this reinforces the need for appropriate sediment characterization).Release of anaerobic sediment and organic matter in high concentrations mayin some cases deplete the dissolved oxygen. Subsequent sedimentation around the dredging site can smother benthic flora and fauna or compromise habitat quality.

6.2.1 Spatial and Temporal Scales of Effects: The environmental effects vary spatially and temporally from project to project. When the effects are considered to have a significant adverse impact it is necessary to investigate means to reduce or mitigate them. The significance of the environmental effects depends on site-specific factors that govern the vulnerability and sensitivity of environmental resources in the project area. When the sediment being moved is chemically contaminated, the need for environmental protection is generally recognized by all stakeholders. Fig. 11 shows compoents of risk and decision system.
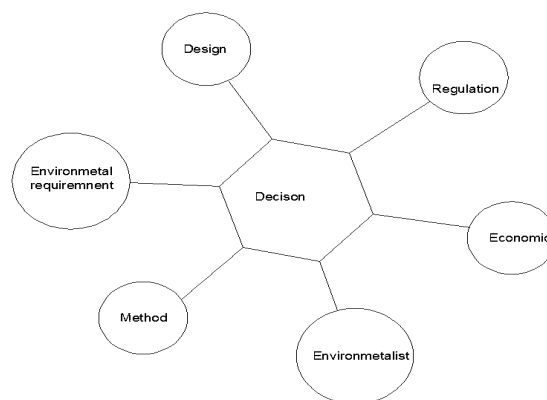
Fig. 11 Compoents of risk and decision system

Complexity with respect to uncertainty has made necessity for several efforts to find tools for the assessment and management of different types of uncertainty. As mentioned before, the word uncertainty is used in many different situations for expressing a lack of certain, clear knowledge for taking a decision. Uncertainty is any departure from the unachievable ideal of complete determinism. In the case presented here, uncertainty signifies that is not possible to provide a unique, undisputable, objective assessment of a certain action (for example an environmental risk assessment of the dredging). However, depending on the actor (e.g. the modeller, the policy-maker, or stakeholders), the perception of the nature, kind, object and meaning of uncertainty can be very different. This will be clear when presenting the perception of uncertainty of the stakeholders involved in the case. Nevertheless, the simple definition presented above gets more complicated when trying to describe the sources, or the sorts or dimensions of uncertainty.

Typology approaches adopted for characterization and assessment of uncertainty by this group focus on uncertainties encountered from the point of view of the modeler that assesses policy-makers (which they call model based decision support). Therefore, their proposal aims to be useful for expressing the uncertainty involved in the use of models, perhaps rather than expressing uncertainty from the point of view of the policy-makers or stakeholders. The typology is based in the distinction of three dimensions of uncertainty:

i the location of uncertainty (where within the model);
ii the level of uncertainty (from deterministic knowledge to total ignorance); and,
iii the nature of uncertainty (whether the uncertainty is due to the imperfection of our knowledge or is due to the inherent variability of the phenomena being described).

6.3. Risk communication and management

Parties involved in a dredging project view the process differently depending on their individual perceptions of these risks and rewards, as well as their individual tolerance of the perceived risk. In this sense there may be several types of risk in a project. For the proponent the consequences of failure of the whole project may be very severe and will usually be measured in economical terms. For an environmentalist the potential effects on the environment may be recognized as the highest priority risk. Communication is an essential component of sharing concerns and identifying means to mitigate them to the fullest extent reasonably possible. During the risk analysis, it is important to balance the identified environmental effects and risks against the economic and social consequences of the project.

Complete and transparent communications are therefore essential throughout the process from beginning to end. This refers to all parties involved. Communication should address uncertainties and natural variability in the environment. Seldom does an actual project present a clear choice between unbiased, neutral, and generally accepted options. Rather, the choice among options is frequently driven by values and perceptions. This tension can best be reduced through open lines of communication that include:

i.   A transparent process;
ii.   Outreach that begins during the earliest possible stage of the project and continues throughout all phases;
iii. An open and honest process; and
iv.   Proactive engagement of local and/or regional media, because their influence on public opinion can be large.

Risk perception is very much influenced by the social, political and historical contexts. Environmental Protection Agency's (USEPA) can be found giving some generic recommendations. Figure 12 shows expected impact in dredging project. The figure also shows the interrelation ships between physical changes above and below the water and their potential to cause environmental effects. The figure also illustrate physical changes can create multiple environmental effects.
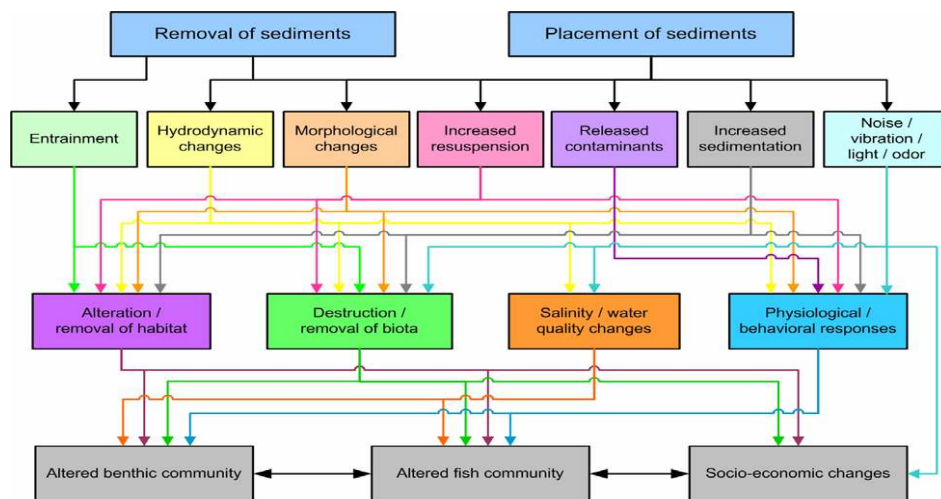
Fig. 12 Conceptual Model of Physical Changes and Ecological Effects from Dredging - Related Activities

6.4 Selecting evaluation and risk control option for dredging project

i.   Action might be taken to adjust the monitoring program itself or as a direct response to the monitoring results. Based on the monitoring data, adjustments to the monitoring program could include:
ii. Reducing the level of monitoring because no effect was observed;
iii. Continuing with the existing monitoring program to gain further clarification of the response; or
iv. Expanding the monitoring program to include additional parameters or sites.
v.   So that responding can be quick and effective, it is necessary to establish hierarchy of options to adverse monitoring results. The level of response can be targeted to the receptor and its sensitivity. Options could include:
vi. Continuing with dredging under the existing regime;
vii. Modifying the dredging regime to reduce the actual effect on a sensitive parameter;
viii. Ceasing dredging within an area until further information is gathered;
ix. Ceasing dredging within an area altogether; or
x.   Ceasing dredging and implementing recovery measures.

For a monitoring program to be fully effective, it must include a timely communication of results and related actions. Stakeholders should be involved to help build overall program credibility.

Risk control options are meant to improve the environmental performance of a dredging project. Some form of environmental evaluation or Environmental Impact Assessment (EIA) is normally required by international conventions. One example is the

London Convention, which establishes a framework for the evaluation of placement of dredged material at sea. The "Specific Guidelines for Assessment of Dredged Material" (International Maritime Organization, 2000) comprises the following steps:

  i.   Dredged material characterization;
  ii.   Waste prevention audit and evaluation of disposal options;
  iii.   Is the material acceptable for marine placement?;
  iv.   Identify and characterize the placement site;
  v.   Determine potential impacts and prepare impact hypothesis(ies);
  vi.   Issue permit;
  vii.   Implement project and monitor compliance; and
  viii. Field monitoring and assessment.
  ix.   Within the LC-DMAF guidance it is stated that

Assessment of potential effects should lead to a concise statement of the expected consequences of the sea or land disposal options, i.e., the "Impact Hypothesis". When applying these Guidelines uncertainties in relation to assessments of impacts on the marine environment will need to be considered and a precautionary approach applied in addressing these uncertainties. Figure 13 shows risk matrix for risk measure of risk based design.

Fig. 13 Risk priority matrix

All dredging and placement projects will cause some changes to the environment. It is therefore necessary to determine whether these can be considered serious and or irreversible. Because adequate information is rarely available to answer these questions with absolute certainty, an evaluation of the relative risk of permanent detriment to the environment is required. Many factors affect this assessment of the general environmental risk including the scale of the project, the natural variability of all of the elements of the system likely to be affected, possible contamination levels, and the timing of the project. Preparation of an EIA involves collaboration among environmental scientists and engineers in consultation with port authorities, dredging companies, and often a diverse assemblage of stakeholders. The amount of technical information available will be important, but should be used in tandem with the perceptions and knowledge held by the engaged stakeholders. Risk evaluation is a value judgment reached by consideration of the total body of evidence offered by all interested parties.

An overview of the selection process is shown in the presented Figures, which also shows how the process can be repeated to achieve a project that optimally conforms to acceptable environmental risks. The flow chart shows that there are multiple stages within the process that allow feedback and repetition in order to achieve a project that is in full

compliance with acceptable environmental risk. For example, if the application of certain RCO does not reduce the risk to an acceptable level then the project would need to be reevaluated to determine if other alternatives could be used or the project design modified to reduce or remove such unacceptable risks. Feedback loops also occur following the analysis of monitoring results against the required objectives. The effectiveness of the RCO is assessed against the degree of derived protection of the environmental resource and if found to be ineffective then further RCO may be necessary. Monitoring to measure the effectiveness of the selected RCO provides adaptive feedback that can be applied to future projects, and is always a prudent strategy.

These constrains are very important to bear in mind when we think of environmental management at the local or regional level with projects with are used limited time and budget of money. Therefore the lack of knowledge that can be experienced by both managers and citizens in assessing a concrete project may have more to do with limited resources than general scientific ignorance. Benefit-Cost Analysis (BCA) is a tool for organizing information on the relative value of alternative public investments like environmental restoration projects. When the value of all significant benefits and costs can be expressed in monetary terms, the net value (benefits minus costs) of the alternatives under consideration can be computed and used to identify the alternative that yields the greatest increase in public welfare. However, since environmental goods and services are not commonly bought or sold in the marketplace, it can be difficult to express the outputs of an environmental restoration project in monetary terms.

Risk monitoring

It is acknowledged that monitoring can take many forms and fulfill various objectives before, during, and after any dredging and placement project. This document does not provide an exhaustive description of monitoring technology but rather focuses on the role of monitoring as a necessary element in the context of BMP application. In particular, monitoring can be proposed as a management practice in itself or used to assess the effect of other management practices. Monitoring is the first step-in determining whether corrective actions will be necessary to ensure the required outcomes [13,14].

One of the key issues related to any environmental monitoring program is the scope for combining broad monitoring objectives for separate parameters into a single survey. Monitoring programmes can be categorized into three types:

i.   Surveillance monitoring
ii. Feedback monitoring
iii. Compliance monitoring

Formulating a suitable monitoring strategy requires the following elements:

i.   Targeted objective
ii. Beeline condition
iii. Monitoring criteria
iv. Methodology for measuring change
v.   Threshold values
vi. Timely review procedure

Requirements for monitoring are site-specific and based on the findings of the baseline surveys. For example, surveys could be necessary to record:
    a. The abundance and distribution of species, which is needed to determine

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b. the rate of species and community recovery within the study area;
c. The effect of dredging on seabed morphology;
d. The effect of dredging on the concentration of suspended sediments in the water column;
e. The type of substrate remaining following dredging;
f. Use of the area by fish; and
g. Actual effects on any sensitive species or communities within the study area.

Sometimes, model studies can be used to determine the appropriate locations for monitoring. Monitoring involves many uncertainties and difficulties that need to be considered. Models are generally not well validated or calibrated and so it is not easy to quantify the results with certainty though they are continually improving. After the monitoring criteria have been selected, the methodology for measuring change against those criteria needs to be determined.

A number of biological, physical, and chemical variables need to be considered when defining a monitoring scheme. The variety of possible effects depends on the Characteristics of the dredging and placement areas and the dredged material itself, therefore, the monitoring programmed sign must be site- and case-specific and proportional to the extent of the environmental concern. It is also important to understand the possible causes of the environmental problem to identify the source of the problem. There should be a specific hypothesis that can be tested using easily acquired data.

The monitoring could be in the water column, on the seabed, on land or in the air. It could be physical, chemical, or biological or a combination. Key considerations in establishing the monitoring methodology are summarized below:

i. The methodology used to monitor environmental effects should be the same as that used to determine the characteristics of the relevant parameter during the baseline survey, to ensure comparability.
ii. The sampling stations should be the same, although there are likely to be fewer stations (e.g., the feature of interest may require a more targeted approach than was adopted for the baseline survey).
iii. For parameters where timing is critical (e.g., benthic and fish sampling), repeat surveys should be undertaken at the same time of year as the baseline survey to ensure that seasonal changes in abundance and distribution do not affect the results.
iv. The frequency of sampling is determined based on the monitoring objectives and criteria. The expected impact is also a factor to consider when determining frequency of sampling. For some parameters (e.g., impacts on geology), changes occur over a long time scale and therefore require less frequent monitoring, possibly post project.

It is important to identify a level above or below which an effect is considered unacceptable, referred to as an environmental threshold. If the monitoring shows that the threshold level is close to being reached then remedial action is required to reduce the level of effect. In the absence of a threshold value, monitoring of many parameters is justified to improve the knowledge base of the particular effect. Timely review of monitoring results is essential to ensure the success of the program. It is recommended that the results of monitoring should be reviewed at times that will allow for meaningful adjustments to the dredging and placement activities.

7. CONCLUSIONS

Dredging provides economic and social benefits for the whole community. However dredging can and often will have an impact on the environment outside of the desired change, of say deepening a channel. To assess the significance of these effects an environmental impact study often needs to be undertaken. During such a study, cumulative and in-combination effects should be considered as it is important to place the dredging activity into context with other activities, e.g., fisheries, navigation, etc. Previous regulatory work for system design has been prescriptive by nature. Performance based standards that make use of alternative methods of assessment for safety and reliability of component design, manufacture and testing is recommended for hybrid alternative energy system installation.

System failure and carefree of environment in past project poised all field of human endeavor to adopt precautionary principle by providing tools to conduct dredging projects in an environmentally sound manner and design based on comprehensive system based scientific method discussed in this paper. Properly applied the precautionary principle provides incentives to develop better solutions. The paper present structured approach and strives for an objective means of selecting the most appropriate Risk control option for that lead to the best protection of the environment and meet sustainable development requirement. Absolute Reliability of the dredge work can be realize by using predictive statistical tools and the data collected.

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COLLISION DAMAGE CONSEQUENCE RISK RELIABILITY FOR LANGAT RIVER (MALAYSIA) SUSTAINABLE INLAND WATER TRANSPORTATION

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Accident consequences resulting from collision remain a big threat to coastal water transportation operation. The nature of the threat can be worrisome; the danger may involve instantaneous and point form release of harmful substance to water, air and water causing a long time ecological impact. That may lead to the loss of life, damage to the environment, disruption of operation, injuries. This makes scientific risk based design that analyse all components of risk including the quantification for consequences of accident very imperative for reliable design and exercise of technocrat stewardship of safety and safeguard of environmental. System risk has been widely assessed using traditional environmental impact assessment, a checklist based approach that ends up bypassing a lot of uncertainty that comes with complex and dynamic systems. Novel analysis of frequency, consequence, subsystem and uncertainty components of system risk using g hybrid of deterministic, probabilistic and stochastic process represent a modest best practice for sustainable system design. This paper discusses the result from analysis of damage components for collision accident towards generic risk mitigation option and decision support required for operational, societal and technological change for sustainable inland water transportation system for Langat River. The risk on Langat River determines by consideration the actual situation of the channel and suppressing the system parameters under pressure and determines the reliability of the trend generated from the model. The present risk consider on Langat is found to be low in the absence with ongoing improvement plan. Accident frequency is of 3.8E-5 and consequence energy of 31MJ, resulting to length of collapse of 9.3m. The damage estimation is further simulated for all channel variable parameters to determine the generic risk and reliability condition that can be used for traffic situation limit definition for safety and environmental preventive risk avoidance within inland waterways.

*Keywords*: collision, risk, marine vehicle, transportation, reliability

1. INTRODUCTION

Collision risk is a product of the probability of the physical event and the probability of occurrence as well as economic losses. Earlier risk modelling focus more on frequency estimation and leave analysis with more uncertainties to account for, incorporating consequence estimation and quantification make collision risk work more complete. Collision accident scenarios carry heavy consequence thus its occurrence is infrequent. These accidents represent a risk because they expose vessel owners and operators, as well as the public, to the possibility of losses such as vessel and cargo damage, injuries and loss of life, environmental damage, and obstruction of waterways (Eftratios, 2005). Like frequency

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analysis, damage collision data are hard to come by, however available data should be made meaningful as much as possible through hybrid use of available tools especially predictive tools for necessary mitigation decision for sustainable waterways. (Minorsky, 1959). This paper discusses the modelling of waterways collision risk and associated consequence related with other variables risk factors like vessel characteristics, channel characteristics, traffic characteristics, operator skill, topographic and environmental difficulty of the transit (Blischke et al, 2000). The paper discuss of implementation of risk and reliability model to prevent collision on Langat River. Determined accident frequencies per year are plotted against the consequence in term of damage and energy release during accident to determine collision risk in one millionth years. The paper also discuss outcome of validation analysis of the model as function of reliability for sustainable IWTS design.

2. BACKGROUND

The study area is Langat River, 220m long navigable inland waterway that has been under utilized. Personal communication and river cruise survey revealed that collision remain the main threat of the waterways despite less traffic in the waterways. This makes the case for analysis of risk and reliability for sustainable development of the waterways a necessity (Wang, 2000). Data related to historical accidents, transits, and environmental conditions were collected. Accident data are quite few, this is inherits to dynamic and complex system like most Inland water transportation system (IWTS). This equally makes probabilistic methods the best preliminary method to analysis the risk, the outcome of which can be optimized through simulation method and expert rating as required.
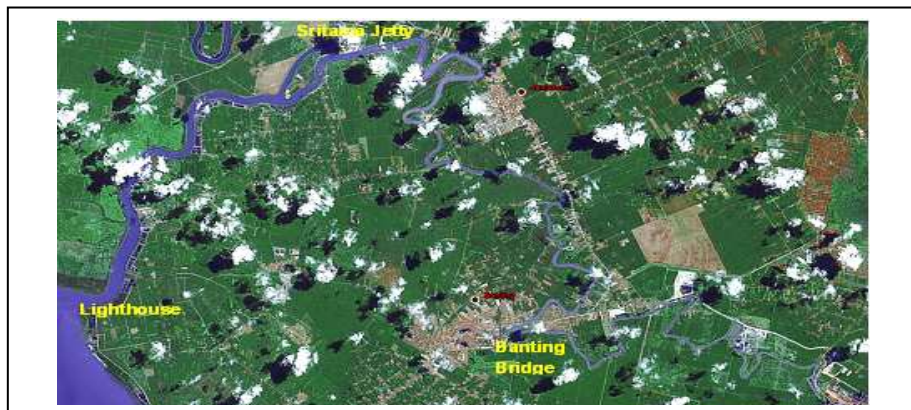

Fig. 1 Langat River map

Barge and tug of capacity 5000T and 2000T are currently plying this waterway at draft of 9 and 15 respectively. Safety associated with small craft is not taken into account. Collisions including contact between two vessels and between a vessel and a fixed structure are considered, also, causes of collision are linked to navigation system failure, mechanical failure and vessel motion failure are considered in risk based worked for use of the river for transportation (Wang, 2000). Below are other information relating to channel, vessel and environment considered employed in the risk process, lacking information about the distribution of transits during the year, or about the joint distribution of ship size and flag particular, environmental conditions are systematically derived of the probabilistic and stochastic estimation process. Figure 1 shows aerial view of Langat River.

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3. BASELINE DATA

The channel width data plays a very important role in possibility of accident and damage caused to physical structures. Therefore beside fatality and societal consequence analysis, extent of damage can be analysed to determine risk of collision in waterways (Lewiston 1978). Figure 2 shows data of channel width parameter required for damage analysis, where the channel width is one of the parameters- way traffic, straight channel is 98m, bend is 120m and depth is 8m**)**. Table 1 shows Langat River waterways parameters where Langat River length is represented by 135.7 km, estuarine data Langat in North Estuary is 44.2 km, and South Estuary is 9.9 km. The main risk contributing factors can fall under the following: (Kielland P et al 1994):

  i.   operator
 ii.   vessel characteristics
iii.   traffic characteristics
 iv.   topographic difficulty of the transit
  v.   environmental condition including water level and tide
 vi.   quality of operator's information including
vii.   uncertainty in Surveys/Charts
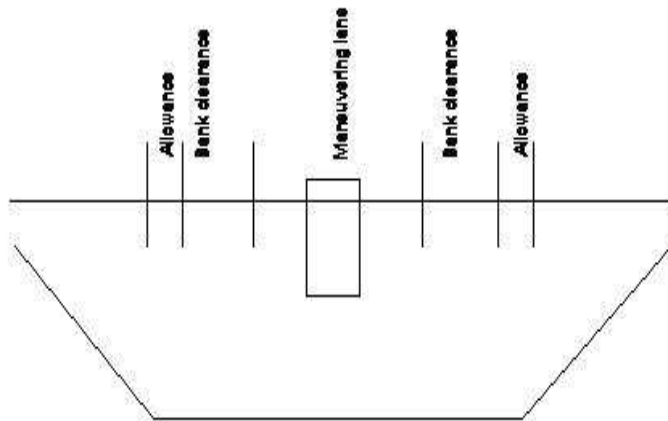
Fig. 2 Channel width parameter

Table 1 Waterway parameter

| Basic Maneuvering Lane	1.5B
Addition for cross wind (less 15 knots)	0.0B
Addition for cross current (negligible <0.2 knots)	0.0B
Addition for bank suction clearance	1.0B
Addition for aids to navigation (Excellent)	0.0B
Addition for cargo hazard (medium)	0.0B
Channel width for Inland Waterways (B= Beam of the ship)	2B=53 m
<u>At Bend</u>	
Channel width	3.0B = 64 m

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Vessel width parameter plays a very important role in collision scenario and potential damage. Vessel movement for the case under consideration currently has no vessel traffic separation system. However, there is traffic movement from both inbound and outbound navigation in the channel. The same type of barge size is considered for the estimation work (Department of Environment, 2000). Table 2 shows barge and tug parameter use for the analysis of vessel on Langat River. Figure 3 shows Langat River vessel and channel requirement.

Table 2 Vessel requirement, Barge and Tug parameter

		2000 tons	5000 tons
Barge parameter	Length (m)	67.3	76.2
	Beam (m)	18.3	21.3
	Depth (m)	3.7	4.9
	Draft (m)	2.9	4.0

Table 3 Vessel requirement, Barge and Tug parameter

		2000 tons	5000 tons
Tugs parameter	Length (m)	23.8	23.8
	Beam (m)	7.8	7.8
	Depth (m)	3.5	3.5
	Draft (m)	2.8	2.8
	Horse Power (hp)	1200	1200
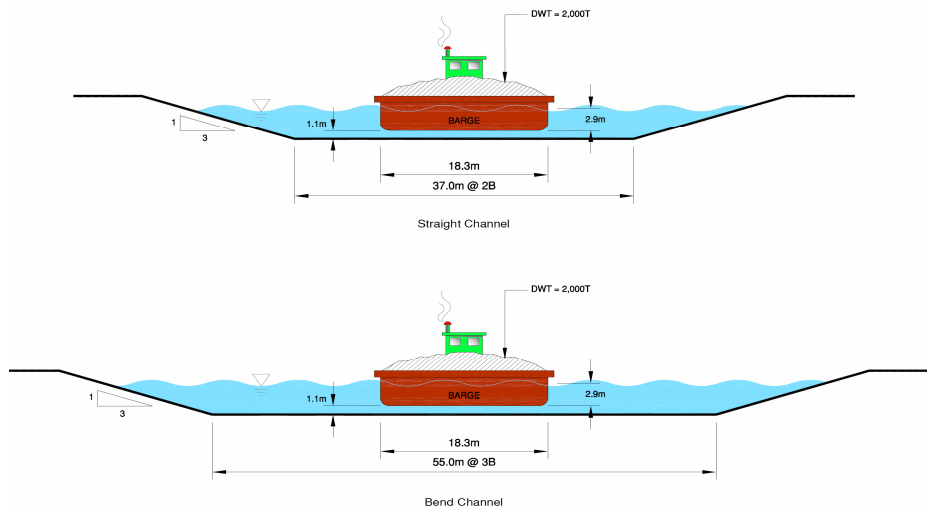
Fig. 3 Langat vessel requirement

4. RISK ANALSYS MODELLING

The reliability process involves deriving rate of accident from deterministic first principle, historical data, probability and stochastic estimation. Individual risk involve hypothetical

individual who is positioned there for 24 hours per day, 365 days per year. Average individual risk is usually qualitatively calculated from historical data (McGowan, 1993).

Individual risk = Number of fatalities/number of people at risk   (1)

Individual risk per year and fatal accident rate (FAR) for workers are commonly expressed as a fatal accident rate (FAR), which is the number of fatalities per 108 exposed hours. FARs are typically in the range 1-30, and are more convenient and readily understandable than individual risks per year, which are typically in the range 10-5 - 10-3. FAR can be expressed as:

Onshore FAR = Fatalities at work x 108 / Person hours at work   (2)

Conversion between Individual Risk and FAR when calculated in a risk analysis, the FAR is usually derived from the calculated individual risk of death per year, divided by the number of hours exposed in a year x. the conversion from individual-specific risk to FAR is:

FAR = Individual - specific risk per year x l08 / 3360 hours per year   (3)

Conversion between individual risk and group risk related using the personnel on board (POB) as follows; this conversion is only recommended as a check. It is preferable to calculate individual and group risks separately. Expectation value (EV) of group risk is the correct mathematical term, but makes the risk sounds inevitable. Potential loss of life (PLL) per year is also sometimes used for the expectation value of lifetime group risk as the lifetime fatality rate or Rate of Death (ROD).

In the fatality estimation, the consequences of each scenario can be represented by the probability of death for an individual initially at a particular location on the platform when the event occurs. In hydrocarbon events, the overall probability of death is calculated from: Probability of local fatality in the fire/explosion P_{fl}, Probability of fatality during escalation / mustering P_{fm}, Probability of fatality during evacuation P_{fe}. The total fatality probability P_F is:

$$P_F = P_{fl} + P_{fm}(1 - P_{fl}) + P_{fe}(1 - P_{fm})(1 - P_{fl})$$ (4)

The location-specific individual risk (LSIR) for a hypothetical individual continuously present in a particular area of the accident location is:

$$LSIR = \sum_{allscenarios} F_s P_F$$

Where F_s frequency of scenario, P_F is probability of death in the scenario for an individual at the location, the individual specific individual risk (ISIR) for the specific groups of workers from events on the platform is:

$$ISIR = \sum_{alllocations} LSIR * P_L$$ (5)

P_L is the proportion of time an individual spends in a location

The fatal accident rate (FAR) for each group of workers is :

$$FAR = \frac{ISIR * 10^8}{H}$$ (6)

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Where H is the hours offshore per year (3360 hours per year is a typical value)

For group risks, the total number of fatalities in the scenario is given by:

$$N_F = \sum_{Locations} P_F N_L \qquad (7)$$

N_L represents average number of people on location

Group (or societal) risk involves the risk experienced by the whole group of people exposed to the hazard. It is interchangeable with group risk. Societal risks may be expressed in the form of Frequency Number (FN) or Annual fatality rate (AFR). FN curves show the relationship between the cumulative frequency (F) and number of fatalities (N), annual fatality rates, in which the frequency and fatality data is combined into a convenient single measure of group risk. For each scenario, frequency –fatality (FN) curve can be obtained. The annual fatality rate is given by:

$$AFR = \sum_{allscenarios} F_S N_F \qquad (8)$$

Alternative damage costs estimate could be modelled using the consequence analysis, where damage fraction is estimated for each scenario. This is equal to the cost of the accident as a fraction of the total infrastructure cost. For fires and explosions, the consequences of each scenario may be represented by fractions of each module's volume damaged. The total terminal damage fraction is:

$$D_F = \sum D_m * C_m / C_t \qquad (9)$$

Where: D_M fraction of module damaged, Cm / C_t cost of module as fraction of terminal cost. The annual damage fraction is represented as:

$$ADF = \sum_{scenarios} F_S * D_F \qquad (10)$$

Oil Spills is another consequence analysis where the quantity of oil spilled, S, is estimated for each scenario.

The annual spill rate is given by:

$$ASR = \sum_{allscenarios} F_S * S \qquad (11)$$

5. DAMAGE DATA REQUIREMENT

Collision data are drawn from relevant marine administrator, previous risk work for complex system like offshore. There is expectation that most gaps will be covered by stochastic and probability estimations. The Langat River work model involve systemic risk and reliability analysis using scientific procedures for inland waterways risk to deduce the probability of failure or occurrence, consequence risk ranking, damage estimation, high risk to life safety, cost benefit analysis and sustainability and acceptability criteria (McGee. et al, 1999).

Couple with the analysis of annual frequency of occurrence, potential accident causal factor and damage consequence in term of energy of hit resulting from collision of vessel is studies. Ship barge and tugs of 5000T and 2000T having respective draft of 9 - 15m is presented in Table 4 where, magnitude of hit are described theoretically. By using probabilistic risk method, system uncertainty can be uncovered under absolutism principle of

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discrete probability. Seasonal trends and limit is estimated from result of stochastic process outcome and system behavior. Limitations of data for high risk complex and dynamic system like inland waterways demand use of hybrid use of historical and stochastic analysis. Future data collected during monitoring and simulation can open opportunity to cover deficiencies gap, validation work, improved analysis and understanding of accident risk. The general hypothesis behind assessing physical risk consequence model is to determine the probability of an accident impact and energy release on particular events and the variables that make magnitude of the consequences more meaningful for decision support input (Emi, et al 1997).

Table 4 Chronology of accident along Langat River due to inland navigation activities

Case	Hit
Hit	2 nos. of concrete pile have a scratched mark. 5 nos. of concrete pile were broken.
Hit	The protection pipe at the nearby jetty was damaged & missing. 3 nos. of welded pipe were missing.
Hit/ Tug and vessel	The protection pipe at the nearby jetty was damaged & missing. 3 nos. of welded pipe were missing/bended I- beam
Hit/ Tug and vessel	Temporary jetty at Pier 9a.
Hit/ Tug and vessel	Temporary jetty at Pier 9a.
Hit/ Tug and vessel	Temporary jetty at Pier 9a.
Hit/ Tug and vessel	I-Beam that is used for Gen-Set was bent. Workers jetty was badly damage.
Hit/ Tug and vessel	Bended I-Beam.
Hit/ Tug and vessel	Protection pipe at Pier 9a.
Hit/ Tug and vessel	Temporary jetty at Pier 9a. Welding set & crane collapsed & sank into the river.

Table 5 Tug boat & vessel activities along river for 2008

Operation parameters	Activities
Jetty	3 nos
Daily	9 times
Weekly	63 times
Montly	252 times
Annually	3024 times
Total	12 nos. of barge will used every day (24hours)
Incoming	6 nos every 4 hours
Outgoing	6 nos every 4 hours
Speed	2-3 knots
Traffic situation	Single way traffic
Layby	Four

6. DAMAGE ESTIMATION ANALYSIS

Based on available accident statistics and the results from the Hazard analysis, eight generic accident scenario umbrellas that required deep analysis are: collision, fire or

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explosion, grounding, contacts, and heavy weather/loss of intact stability, failure / leakage of the cargo containment system, incidents while loading or unloading cargo, emission of ship power sources (IMO, 1993). It is recommended that further efforts should focus on measures relating to safety function impairment like (Cockrofft and Lameijer, 1989):

i.   Risks of safety function impairment:
ii.   Damage Risks
iii.   Annual damage cost
iv.   Frequency cost (FC) curves
v.   Oil Spills, annual spill rate
vi.   Frequency damage size (FD) or Frequency energy curves
vii.   Risk Measures for Loss of Life

Initial kinetic energy of ship (E)= ½ $\frac{M}{1000} V^2 . K$ (MJ)   (12)

Where: E = impact energy (MJ) , M= vessel mass (tonnes), V= vessel speed
K= hydrodynamic added mass constant, taken as (Den 1990)

K factor assignment of 1.1 for head on collision (powered) impacts, and 1.4 for for broadside (drifting)

Absorbed collision impact Ea= 47.2.Vc+32.8 (MJ)   (Minosky, 1999)   (13)

Where, Vc = collapse material volume (m^3)

Interpolation between equation 1 and 2 could give an estimate of how much volume damage is experienced in collision case. Advantage derived from channel improvement work like channel widening, deepening and straightening could be quantified into sustainability equity for determination of cost control option required to reduce further and future risk in the channel (Goodestein, 2001) .

$$N_a = \frac{1}{2} . \mu_c . D . Pi . Nm$$ (14)

Total integrated risk is represented by:

Rt = fs (Rc, Re, Rs**) +Rw +Rh**   (15)

Where, Rc (crew) = fc (qualification, fatigue..). re (environment), fe (sensitivity, advert weather…), Rs (ship) = fs (structural and system reliability, ship layout and cargo arrangement…). Rw = Fw (waterway, channe..l), Rh=Fh (Human reliability analysis). Table 6 shows consequence of risk acceptability criteria for maritime industry.

Table 6 Consequence acceptability criteria

| 1	Limited	Consequence limited to accident area with no public impact	Impact Energy <40 MJ
2	Minor	Impact has no consequence on public health	50 MJ
3	Serious	potential for serious injury	Impact Energy >50 MJ
4	Extensive	potential for fatality	

The consequence could further be broken down into effect for ship, human safety, oil spill and ecology.

6.1. Result presentation

ALARP high risk area. Derived equation for each collision is shown in the graph. Figure 4b shows expected number of impact (Ni), accident energy at variable speed plot for head

on collision, as the number of ships in the waterway increases. Figure 4b shows that there is higher risk and potential rise in Ni as the number of ship in the channel increase, 1 to 2 number of accident is likely to occur. Interestingly, the graph also shows that the risk of accident of occurrence is possible when the speed is moving at much lower speed. For 3 number of ship in the channel navigating at 4 knot, there is likelihood of 0-1 accident occurrence. Figure 4c shows that, for overtaking collision, at 3 number of ship that Langat is currently operating there is likeliness of zero a-1 accident for overtaking collision, accident will only occur if vessel slows down less than 1 knot.

| a. | b. | c |
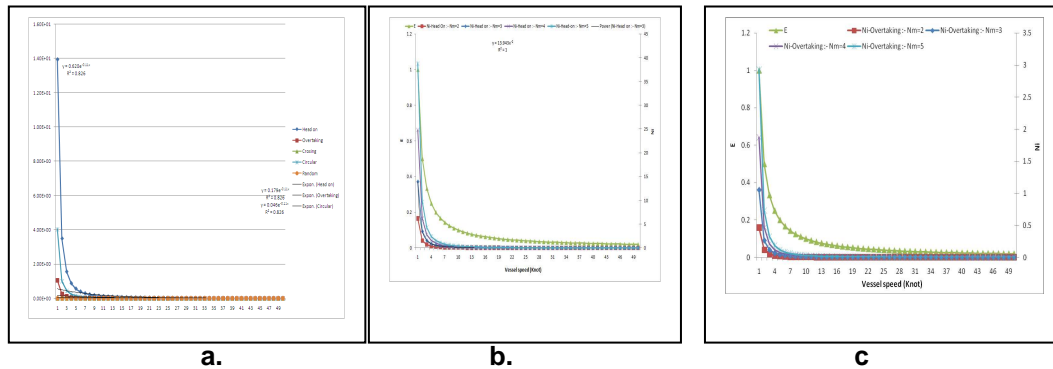
Fig. 4a Collision risk potential for different collision situation, b. Number of accident impact vs speed and number of ship traffic and accident energy for head on collision situation c. Number of accident impact vs speed and number of ship traffic and accident energy for overtaking collision situation

Figure 5a shows relationship between Ni and velocity, from the graph there is high probability for accident occurrence between 90 and 150 following precision principle, where high impact can be experienced if accident happens at that angle and at speed of about 12 knot. Figure 5b shows relationship between Ni, released energy and volume of collapse for different accident situation. Excess number of Ni up to 7- 8 with high energy release and catastrophic volume of collapse up to 14 cubic meters can occur at the point where the energy and Ni graph meet.

| a | b |
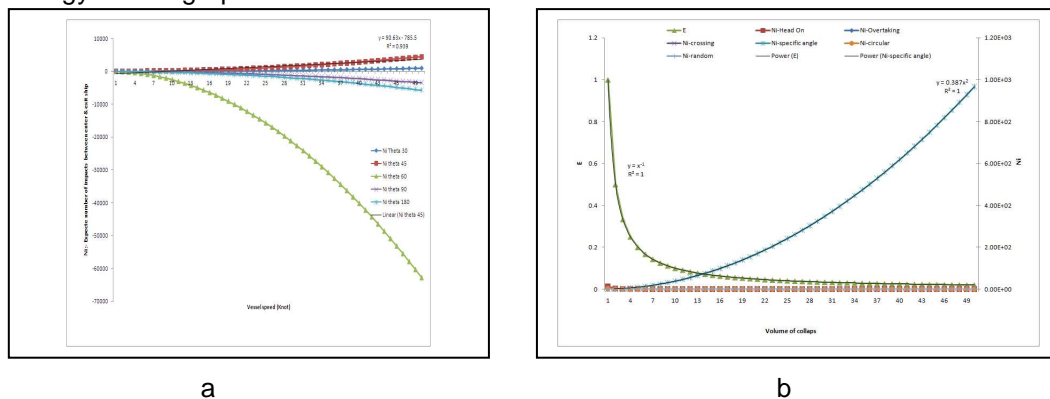
Fig. 5a. Number of accident impact vs angle of collision b. Number of accident impact, accident released energy and volume of collapse for different collision situation

Figure 6a shows the mass and energy release relation, for vessel mass of 5000t, there is 12 MJ of energy released, while for vessel mass of 2000t, there is 1.2 MJ of energy

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released. The derived equation for the trend can be used for model iteration and validation of model of similar waterway profile. Figure 6b shows relationship between impact energy, volume of collapse(Vc) and length of penetration (Lp). The gragh shows that at avaerage enegy (Ea) of 36MJ, power colision energy (Ep) of 39MJ, the lenght of collapse is about 11m.


a

b
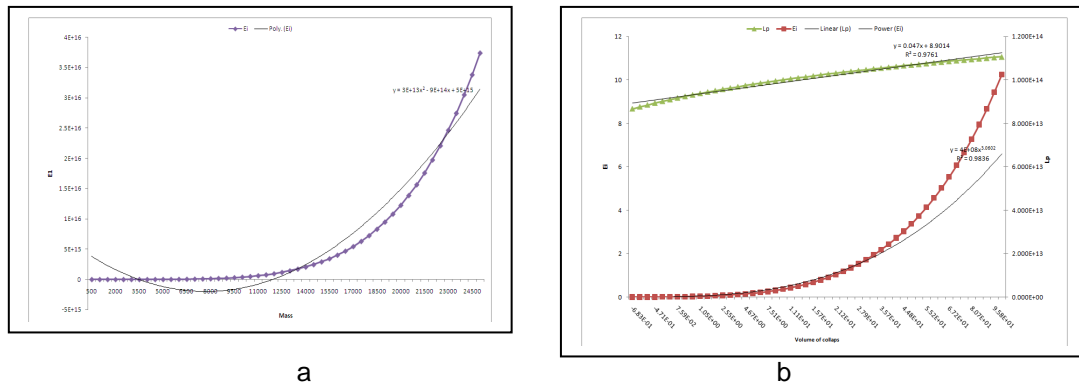
***Fig.* 6a Accident consequence energy and mass, b. Impact energy, volume of collapse and length of collapse**

Figure 7a shows the energy and volume of collapse relation for powered collision energy (Ep), drifting collision (Ed) and interpolated average collision energy (Ea). It is observed that volume of collapse of 51 cubic meter occur at 12 MJ release of energy from Ep and 27 MJ from Ea, the speed at this point is observed to be 8 -12 knot, catastrophic energy will occur at speed of 38 knot, at point where E1, Ea and VC are equal with respective value of E1= 3000MJ, Ea is 3008MJ and Vc is 60 cubic meter. Similarly result is observed for drifting collision as shown in Figure 7b. The value is a bit higher for drifting colision and the gragh of drifting colision is much more steeper than the gragh of powered collision. Driftng collision, for exemple can be due to lost of mooring function, that can consequentially leads to vessel moving at higher spped to nearby structure while powered colision can be due to loss of propulsion function. Respectively subsytem level risk analysis can be perform for cause of cause function using fault three and event tre analysis to deduce much more reliability on the system.

a

b
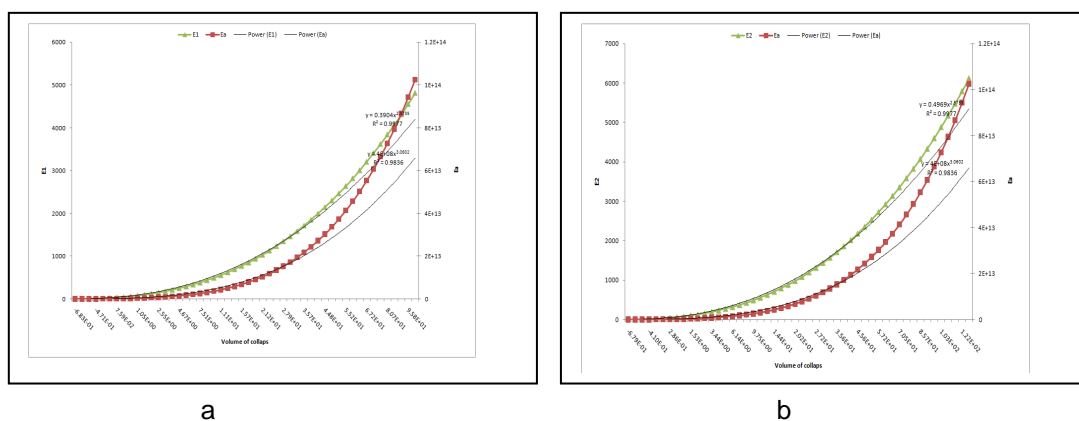
Fig. 7a Powered collision energy and volume of collapse, b. Drifting collision energy and volume of collapse

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Figure 8a and b show variation in accident consequence, mass of ship and volume of collapse, at curent speed of 3 knot the maximum mass of vessel that can give minimum volume of collapse of -0494 is 1500t and 9.45 MJ energy. The acceable energy for low impact event is below 50 MJ, which can lead to 3.1 volume of collapse at allowable speed of at speed of 5 knot. For vessel of of 2000 t mass, there is release of 224 MJ of energy and 0.22 cubic meter of volume of collapse, for vessel of 5000 t mass, there is release of 35 MJ of energy and 6.7 cubic meter of volume of colapse. The derived equation for volume of colapse is $y = 0.567x^2 - 11.68x + 51.41$ with corelation of 0.995 correlation. The equation derived for energy trend is trend is $y = 0.35x^3$ with correlation of 1, while the derived equation for mass is 500x at $R^2 = 1$. Catastrophic volume of colapse can occur at 90 cubic meter with of vessel mass up to 12300t. Also it is observed that vessel of up to 19000t could lead catastrophic relase of energy up to 19205MJ.
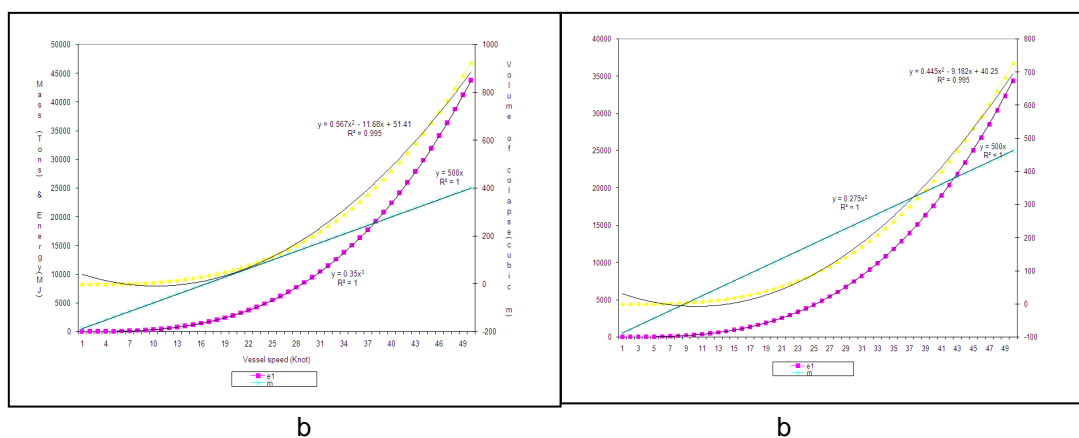

Fig. **9a Powered collision mass, energy, volume of collapse and speed, b. drifting collision**

6.2. Alarp principle, risk acceptability criteria and risk control option

The acceptability matrix is based on ALARP principle. The ALARP outcome risk influence curve can be compared with risk acceptability criteria in offshore in maritime industry. This is followed by risk control option and sustainability balancing of cost and benefit towards recommendation for efficient, reliable and effective decision. This is followed by risk acceptability criteria whose analysis is followed with cost control option using cost of averting fatality index (ICAF) and ALARP Principle. Risk acceptability criteria established in many industries and regulations to limit the risk. Risk is never acceptable, but the activity implying the risk may be acceptable due to benefits to safety, environment and economy, reduction of fatality, injury, individual and societal risk. Perception regarding acceptability is described by (Rowe, 1977, Starr 1969, and Green et al 1998). The rationality may be debated, societal risk criteria are used by increasing number of regulators. The outcome of risk and reliability work on Langat River revealed that the current situation acceptable, but, indication about increase number of accident per year for a channel of such magnitude posed lots of question to be answered before the elapse of millionth years.
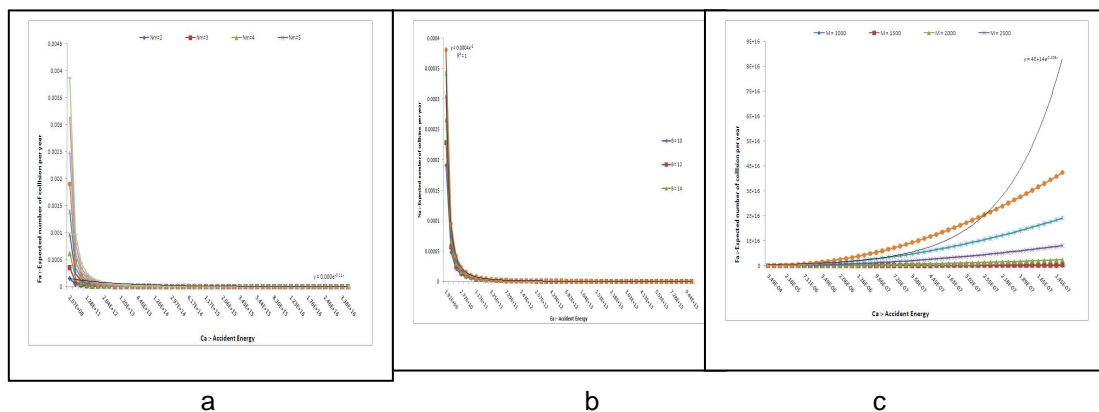
Figure 10a shows the accident frequency per annum and consequence energy graph at changing speed, the current situation on Langat River good The situation only become risky at 0.00035and corresponding volume of collapse of 2.07E+07. Similar comparative studies revealed the same trend on the length of penetration, where deep penetration into struck

structure can start to occur at 7.18m. Figure 9b shows a cross plotting for accident frequency and consequence at changing speed, the trend revealed that maximum speed for Langat is 4 knot if all safety requirements are in place. The risk at that point is 2.1786E-05 x 20 MJ.

a   b
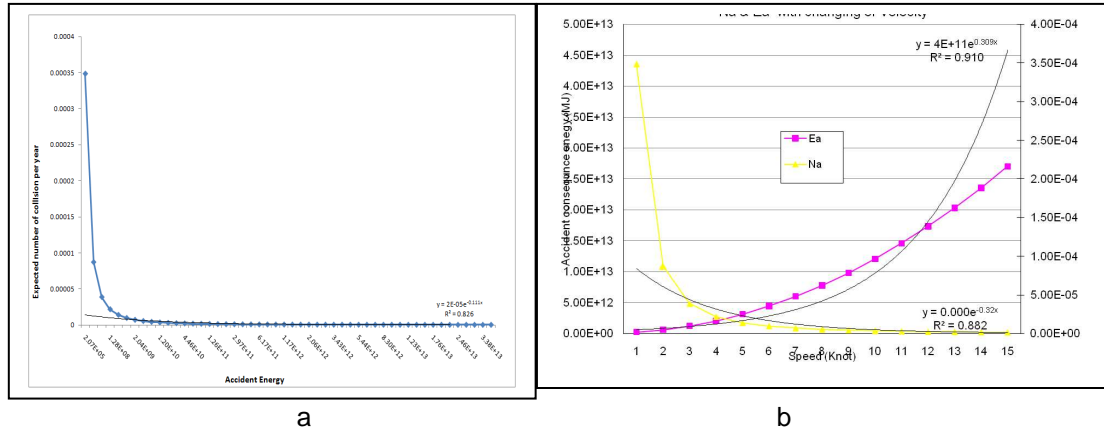
***Fig.* 9a Accident frequency and accident energy, b. Cross plot for accident frequency and consequence at changing speed**

It is shown the graph frequency and damage (volume of collapse) graph, from the graph figure, based on ALARP principle and sustainability analysis, decision can be made for waterways requirements. The ALARP influence diagram show at that a speed of up 7 knot there will be likehood of high accident for the waterways and energy of impact of about 137.5 MJ which is considered a high consequence energy. It is also observed from the figure that positive volume of collapse of 1.3 cubic meters occurs at 7.1E-5. Thus, the risk curve at maximum acceptable is value of 0.0035 is at the top ALARP high risk area; from that point interestingly accident is likely to occur at reduced speed. Similar trend is observed for accident frequency and volume of collapse for drifting collision except that, with a small difference of 0.01 cubic meters. Figure 10c shows that acceptable risk at 10e+4 is at length of penetration equivalent to 7.1m.

a   b   c

Fig. 10a Accident frequency and consequence energy at changing number of ships, b. Accident frequency and consequence energy at changing beam of ship, c. Accident frequency and consequence energy at mass of ship

Figure 10a shows accident average energy and accident occurrence frequency. The maximum speed that should not be exceed is when Fa is 2.06E-06, and Ea is72E- MJ. For the current speed of 3 knot at Langat River, Ea value is 14MJ, and Ea is 3.8e-5. Figure 11b shows the limit definition for risk when the graph of drifting and powered collision are combined. The point 64MJ, E2 is 82MJ and 2.8 E-6 represent point of limit definition against catastrophic release of energy.

a   b
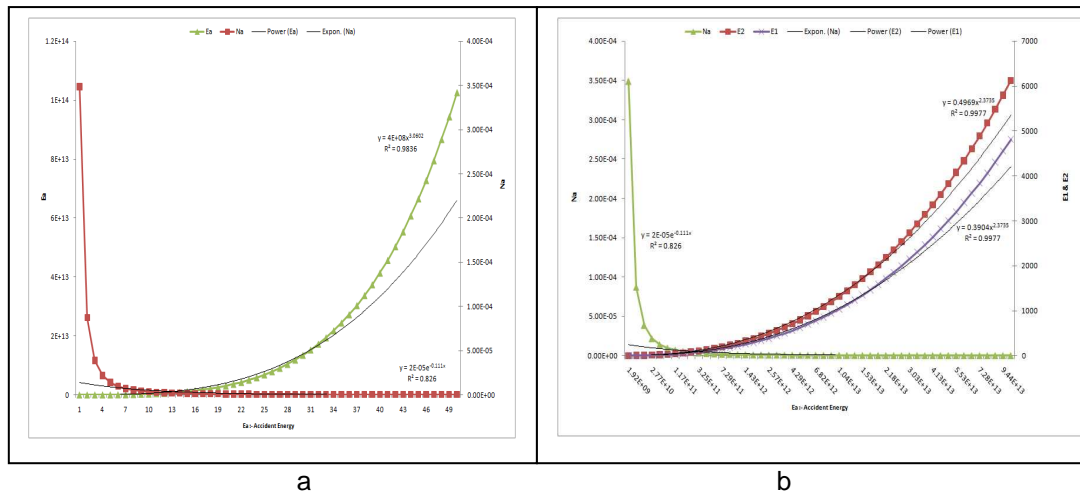
Fig. 11a Cross plotting for accident frequency and accident consequence energy Vs consequence energy at changing beam of ship

7. BETWEEN RELIABILITY AND VALIDATION

Reliability analysis is required to have assurance about the model; the purpose of reliability testing is to discover potential problems with the design as early as possible and, ultimately, provide confidence that the system meets its reliability requirements. Reliability testing may be performed at system and subsystem level. It can be conducted in the following way for a system in question (Neubeck, Ken 2004):

1. Accident mean, variance and standard deviation from normal distribution

For 10 years =>Mean (μ) = N x Fa   (16)

Variance (σ) = N x Fa x (1-Fa)   (17)

Standard deviation $= \sqrt{\sigma}$, Z = (X-μ)/ σ (18)

2. Year for system to fail from binomial, mean time to failure and poison distribution.

F_r (N/γ, T) $= e^{\gamma.T}($)γ,($\gamma.T)^N$). N!   (19)

3. Implementation of TSS is one of the remedies for collision risk observed and predicted in Langat; this can be done through integration of normal distribution along thewidth of the waterways and subsequent implementation frequency model. The differences in the result can reflect improvement derived from implementation of TSS.

$$f_{south}(x) = \frac{1}{\mu\sqrt{2\pi}} e^{-\frac{1}{2}}(x - \frac{12}{\mu}) \tag{20}$$

$$f_{north}(x) = \frac{1}{\mu\sqrt{2\pi}} e^{-\frac{1}{2}}(x - \frac{12}{\mu}) \tag{21}$$

4. Comparing the model behavior applied to other rivers of relative profile and vessel particular

5. TRIANGULATING ANALYSIS OF THE SUM OF PROBABILITY OF FAILURE FROM SUBSYSTEM LEVEL FAILURE ANALYSIS
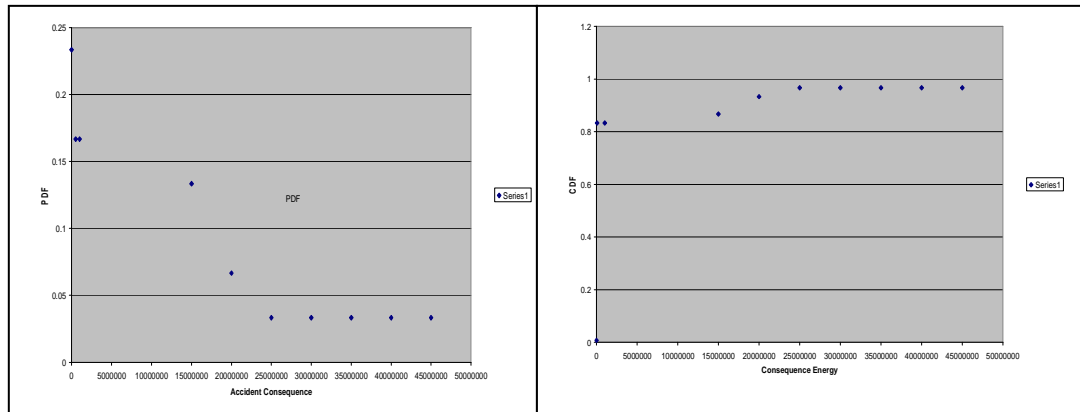
6. Probability Density function (PDF) and cumulative density function (CDF) of the model determination. Calculate the cumulative probability of each residual using the formula. PDF can be systematically represented by the histogram curve while CDF is calculated from:

$$P(i\text{-th residual}) = i/(N+1) \tag{20}$$

Table 7 shows sample consider for accident damage for PDF and CDF estimation. Figure 12a and b show theoretical PDF and CDF plots for sampled data. The CDF tailing assymptote, while the PDF has exponential droping is sign of good reliability for the data used to generate the trend.Damage distribution based on 10 ship accidents per year.

Table 7 Damage size

Damage size	Frequency of damage
100-500	7
500 – 1000	6
1000-5000	5
5000-10000	4
10000-15000	2
15000-20000	1
20000-30000	1
30000-40000	1
40000-50000	1
50000-100000	1

a. Probability density function for accident   b. Cumulative density function for accident
consequence,   consequence

Fig. 12 show theoretical PDF and CDF plot

Figure 13 show **c**ollision impact variation for powered collision energy E1, normal distribution and histogram curve fit is good. On average the damage distribution is acceptable. The overall pattern of the residual observed is similar for the plot of histogram of normally distributed data. Thus the "S" shaped curve on the normal distribution graph give indication of bimodal distribution of residuals.
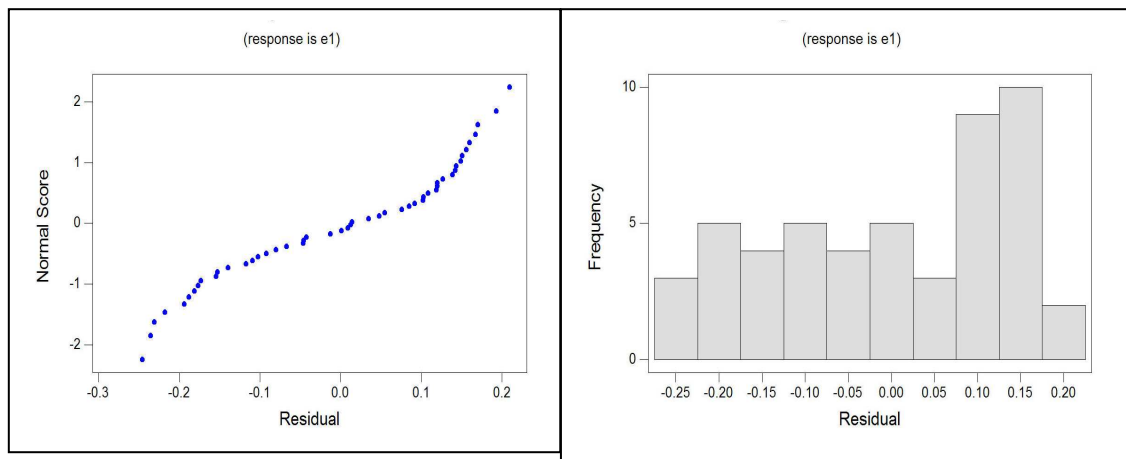

Figure 13 Collision damage impact (Powered collision)

Fig. 14a and b show collision impact variation for drift collision (anchored ship)

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a. Nomal Probability plot of the residua   b. Histogram plot of the residual
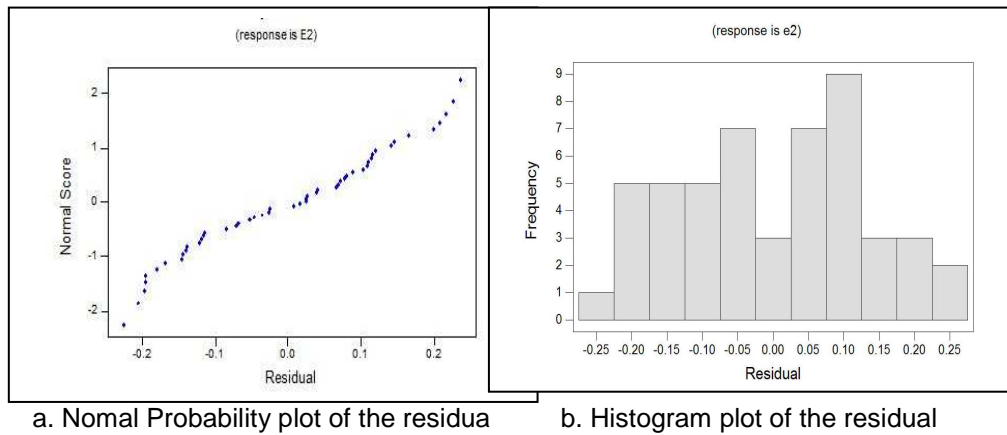
**Fig. 14 Collision damage impact (Drifting collision)**

Figure 15 shows collision impact for alternative interpolation for collision energy (Ea) with respective volume of collapse, curve fit is good, The regression work show standard deviation of 0.00115 and correlation up to 86.

a.   Normal probability plots if the residual   b.Regression for the risk curve
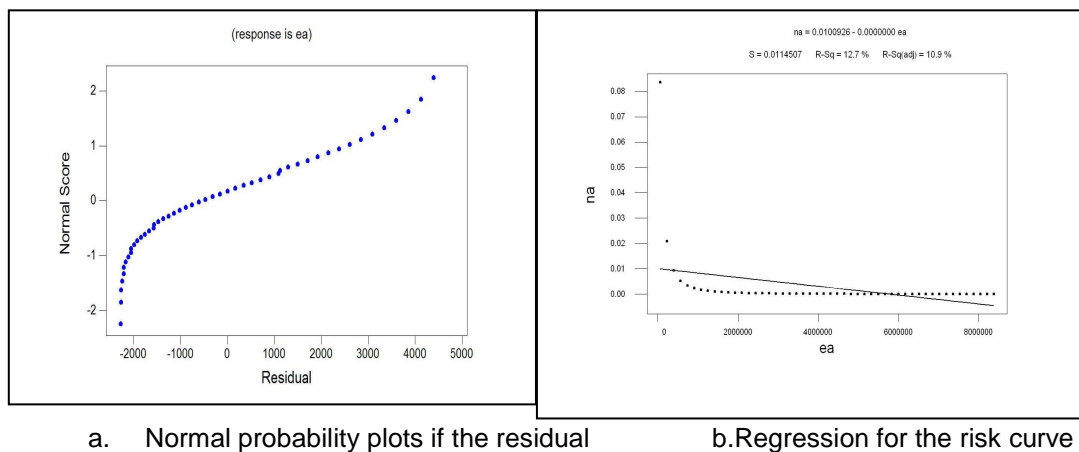
Fig. 15 Collision impact and volume of collapse for alternative interpolation

Figure 16 shows curve fit and residual analysis for frequency and consequence risk model on Langat River. Figure 17 shows matrix plot for accident frequency and consequence, the graphs shows scatter plot of response with good pattern of inter relationships among the predictor variables. It shows that there is no much gaps and outlying in the data points. From the, matrix curve it is observe that risk is totally unacceptable for reckless increase in number of ship and also high speed. The matrix observation also show that B AND w parameter risk are tolerable for long-term.

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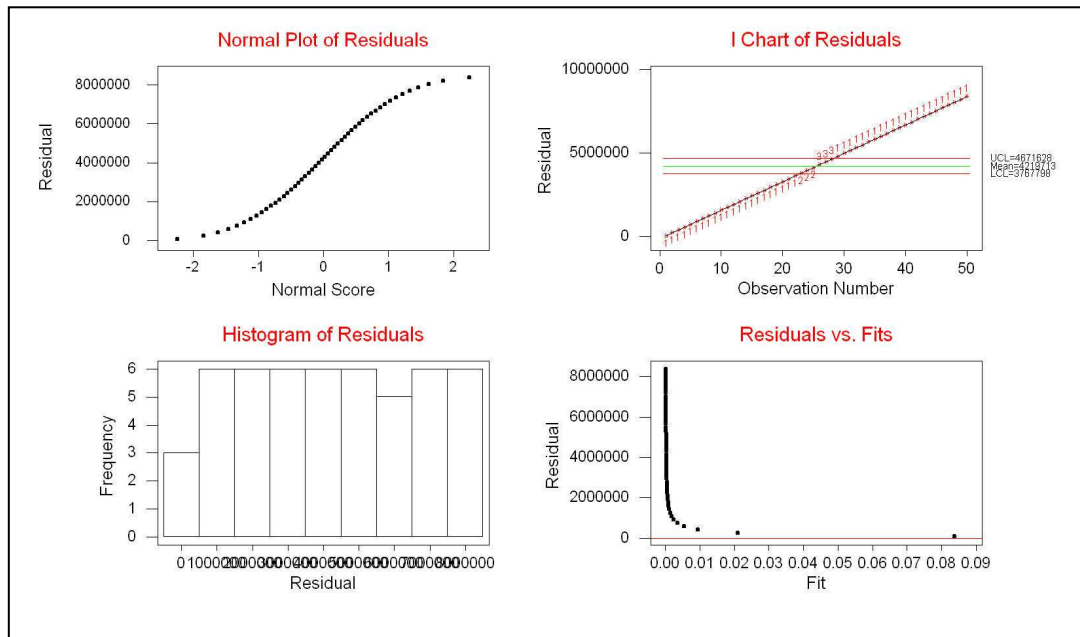
Fig. 16 Curve fit and residual analysis for frequency and consequence risk model on river Langat.
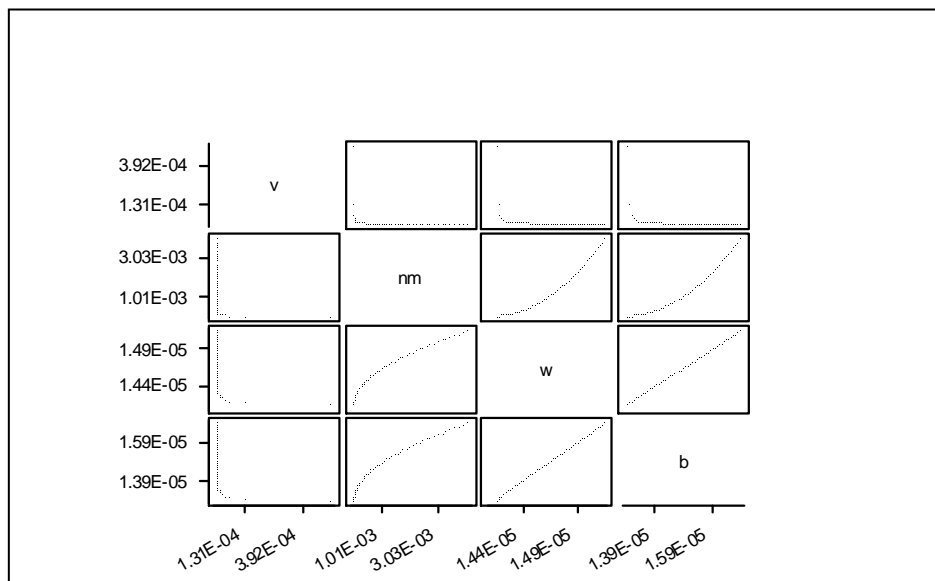
***Fig. 17 Matrix plot for accident frequency and consequence***

7. CHANNEL COMPLEXITY ANALYSIS

Various channel components enter channel complexity components, these can be visibility weather, squat, bridge, river bent, human reliability. It is important to Account for

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each of them in channel design work. Figure 18 show channel complexity for Langat. Poor visibility might be expected to increase the risk of groundings and collisions (Parry, 1996). The increase in accident risk due to poor visibility is more consistent and more significant than the change associated with high wind. A model extracted from Dover waterway studies concluded with the following:

Fog Collision Risk Index (FCRI) = $(P_1 + VI_1 + P_2 + VI_2 + P_3 \cdot VI_3)$ (22)

Where: P_k = Probability of collision per million encounters, VI_k = Fraction of time that the visibility is in the range k, K = Visibility range: clear (>4km), Mist/Fog (200m- 4km), tick/dense (less than 200m).
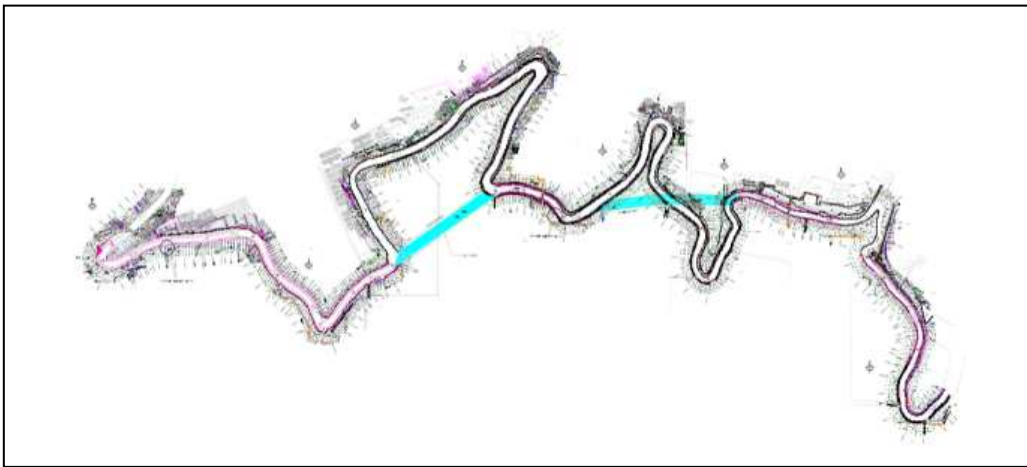
Fig.18 Langat channel complexity

Empirically derived means to determine the relationship between accident risk, channel complexity parameters and VTS is:

$$R = -0.37231 - 3.5297C + 16.3277N + 0.2285L - 0.0004W + 0.01212H + 0.0004M$$
(23)

Where, predicted VTS- consequence 100000 transit, C = 1 for an open approach area and 0 otherwise, N = 1 for a constricted waterway and 0 otherwise, L = length of the traffic route in statute miles, W = average waterway/channel width in yards, H = sum of total degrees of course changes along the traffic route, M = number of vessels in the waterway divided by L.

Barge movement creates very low wave height and thus will have insignificant impact on river bank erosion. Speed limit can be imposed by authorities for wave height and loading complexity (Jonh R. Dudley, 1994). Other important analysis is reliability analysis for uncertainty estimation. It is important for this to be carried out separately. Reliability work could include projection for accident rate for certain number of year, using poison distribution or determination of exact period of next accident using binomial function. Ship collisions are rare and independent random event in time,(C.A Brebbia et al, 2000). The event can be considered as poison events where time to first occurrence is exponentially distributed.

Another critical reliability stochastic estimation is human reliability assessment which can be done using questionnaire analysis or the technique of human error rate prediction THERP probabilistic relation.

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$$P_{EA} = HEP_{EA} \sum_{k=1}^{m} FPS_k . W_k . + C \tag{24}$$

Where, P_{EA} = Probability of error for specific action, HEP_{EA} = Nominal operator error probability for specific error, PSF_k = numerical value of kth performance sapping factor, W_k = weight of PSF_k (constant), m=number of PSF, C= Constant.

Navigation of vessel in shallow water at a hull displacement cause vertical sink age, or "squat," as a result of a pressure drop beneath its hull to avoid ship groundings with possible severe economic and environmental consequences, the relevant governmental, port, and maritime agencies and organizations need a reliable method of predicting ship squat. (DnV, BV, SSPA, 2002). Squat analysis of squat and channel clearance based on the physical characteristics of a channel and the ships that travel through it can be used to issue appropriate regulations regarding vessel size and speed and to plan channel dredging operations. Model on weather and human reliability assessment, and expert judgment as well as simulation could help perfect the reliability on safety and environmental risk study for inland water ways, (Moderras 1993).

8. CONCLUSIONS

i. System level damage estimation modeling of consequence in risk analysis is important. Hybrid use of use deterministic using first principle characteristics of the system with stochastic process give better reliability for the system design. Associated risks relating to system level consequence has been modeled for Langat River from River physical system behavior and stochastic process. The validated result is useful for limit definition for preventive safety and environmental risk has been presented. Generated risk graph have been used to simulate real time risk in the waterways for relevant decision support the respective result has been validated statistically.

ii. Implications of quantifying cost on benefit attached to waterways as part of decision support. Damage estimation does have some degree of linear relationship with the risks to people and the environment, getting their actual data about damage is hard on this case, thus interpolation of has been employed to generate resulting damage. Risk measurement can further be reliable by determining risk control option through sustainability balance between environmental, economic and safety aspect of IWTS. Thus, it is important to use caution when comparing accident rates across ports and over time because of the differences in reporting criteria.

ALARP comparison show that Langat River is risk is not appalling yet; risk graph is at the lower portion of ALARP. Accident frequency is of 3.8E-5 and consequence energy of 31MJ, resulting to length of collapse of 9.3m. For a River with such a low traffic, the risk is could conservatively consider high. Incorporation of advantage from traffic improvement like implementation of Traffic separation scheme (TSS), Vessel traffic system (VTS), Automatic identification system (AIS), better training, International safety management (ISM) in the risk process could achieve reduction in risk of the channel, real-time environmental information about environmental conditions, including currents, tide levels, winds, transit parameters and improvement against other channel complexity, are useful in sustainability balance work for waterways developments.

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VANILLIN BASED BIO - PROTECTION AGAINST MARINE CORROSION OF AA7619

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Marine corrosion and striking balance for efficient inhibitor remain a big challenge for maintainace of marine system and stucture. Bio material is reliable inhibitor for marine corrosion maintenance. Aluminum and its alloys exhibit corrosion resistance in many environments. This feature made them important materials with wide ranges of industrial and marine applications. Thus, with corrosion resistance, it still need some protection when introduced to the marine environment. It is because the marine environment is a very corrosive environment due to the presences of Natrium Chloride. Several methods have being introduced to overcome this problem. Among the methods introduced, the usages of corrosion inhibitor are very popular. This paper studies the use of vanillin as an inhibitor for aluminium alloy AA7619 in marine environment. This study determine the suitability and the inhibition efficiency of vanillin on aluminium AA7619 corrosion. There are two types of solution prepared which is seawater and seawater with vanillin added. The concentration of vanillin used was 20 mg/litre. These solutions were used as corrosion medium for the aluminium AA7619 immersion test. The immersion period was 42 days and the specimens characterization test were performed every seven days. The corrosion rate of the aluminium alloy and the corrosion inhibition of vanillin were determined by using weight loss method, potentiodynamic polarization scan and electrochemical impedance spectroscopy (EIS). The results shows that the presence of vanillin retards the rate of dissolution and thus the corrosion rate was decreased.

Keywords: Aluminium alloy AA7619, Seawater, Vanillin

1. INTRODUCTION

Aluminium alloys are mixtures of aluminium with other metals (called an alloy), often with copper, zinc, manganese, silicon, or magnesium. They are much lighter and more corrosion resistant than plain carbon steel, but not as corrosion resistant as pure aluminium. Aluminium and its alloys exhibit corrosion resistance in many environments. This feature made them important materials with wide ranges of industrial and marine applications. The most popular aluminium alloys for use in corrosive environments such as seawater are the 5xxx and 6xxx series alloys. Marine includes the immersion of components in seawater, equipment and piping that use seawater or brackish water. Exposure of components can be continuous or intermittent (Bochris et al., 2000; Davis, 2000; Immarigeon et al., 1995). The corrosion problems in these systems have been well studied over many years; despite several published information on materials behaviour in seawater, failures still occur.

Therefore, more investigations need to be carried out to obtain better understanding on material corrosion behaviour. The use of inhibitors for the control of corrosion of metals and alloys which are in contact with aggressive environment is an accepted practice. Large numbers of organic compounds were studied and are being studied to investigate their corrosion inhibition potential. The growing needs for the corrosion inhibitor becomes increasingly necessary to delay or stop the attack of metal in an aggressive solution. Considerable efforts made to search suitable natural source to be used as corrosion inhibitor in various corrosive media.

This paper presents the report on study of improvement of corrosion resistance of AA7619 alloy by natural vanillin in seawater using electrochemical measurements; and clarify its inhibition mechanism. The study examines the suitability of the inhibitors, the effect of vanillin on corrosion rate of aluminium AA7619 and deduces the inhibition efficiency of vanillin. The study considered several particular issues when applying selected aluminum alloy to its application which would be suitable with our natural environment. This organic inhibitor can be applied in some practical areas.

Current problems associated with corrosion and inhibitor are (Abdel–Rehim et al., 2006; Ajit and Balasubramaniam, 2006):

   i.   Inefficiency of machineries: The corrosion will cause the machineries to become not efficient and it also will affect the work done by the machineries.
   ii. The suitability of the inhibitors: The inhibitors used are effectives on the marine environment and the cost benefit factor also must be considered. The inhibitors chosen also must not harm the environment.
   iii. Effects of the corrosion: The corrosion will affect the strength of the alloy and it will cause harm to the machineries and plate of maritime structure. The cost to repair the damage is very high.

According to Rosliza et al. (2007, 2010) and Chee (2008), the tapioca starch was used as the inhibitor for aluminium AA6061. In the studies, the inhibition efficiency of the tapioca starch on aluminium AA6061 was determined by using weight loss method, polarization scan and EIS measurement. The result from the study shows that the corrosion rate of mild steel and aluminium decreased with the addition of tapioca starch. Moreover, the inhibition efficiency of tapioca starch also increased with the concentration (Li et al. 2007; Nicholas et al. 2003).

Besides that, the studies done by El – Etre (1999a, 2000b) also shows that corrosion rate of the aluminium was reduced with the addition of vanillin. As the concentration of vanillin increased, the inhibition efficiency also increases.Thus, from the studies reviews, it shows that the corrosion rate of aluminium alloy can be reduced with the addition of suitable inhibitor. Moreover the inhibition efficiency of inhibitor on aluminium alloy will increase with the addition of suitable inhibitor (Fang et al., 2009; Hosni, 2007).

2. MATERIALS AND METHODS

In this research project, the corrosion inhibition of vanillin on aluminium alloy AA7619 in seawater was examined. The corrosion resistant of the aluminium alloy in seawater with and without inhibitors was investigated by weight loss method, electrochemical impedance spectroscopy (EIS) and potentiodynamic polarization scan. The immersion period of the aluminium alloy was 42 days. Every seven days, 6 samples were taken out to be tested using the three methods mentioned. Figure 1 shows the research procedure.

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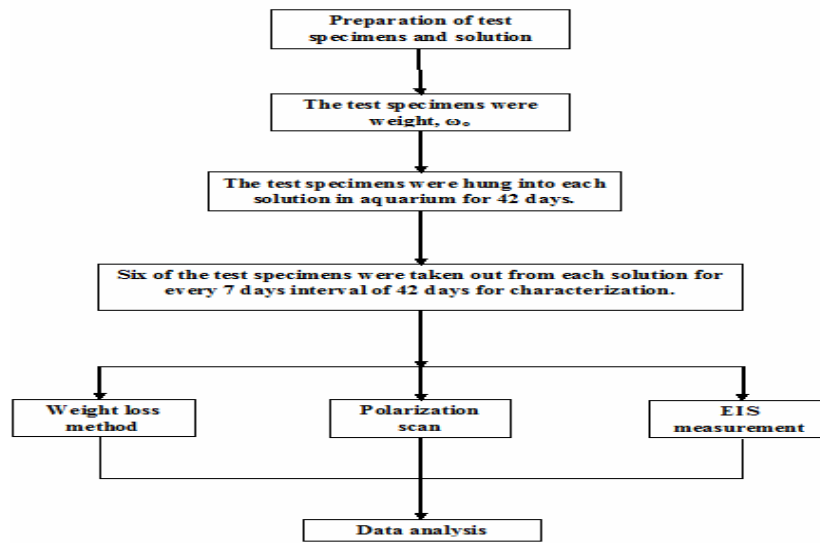
Fig. 1: Research Process

3. RESULT AND DISCUSSION

3.1. Weight loss study

From the graph shown in Figure 2, the percentages of weight loss of the aluminium alloy for the entire test specimen are increased with immersion time. The percentage for the aluminium alloy immersed in the seawater is greater compared with the specimen that being immersed in the solutions with inhibitor. From the graph, the weight loss of the specimen decreases when vanillin was added into the seawater. It shows that the vanillin gives a good inhibitive action towards the corrosion of aluminium alloy in seawater and lowers the corrosion rate.
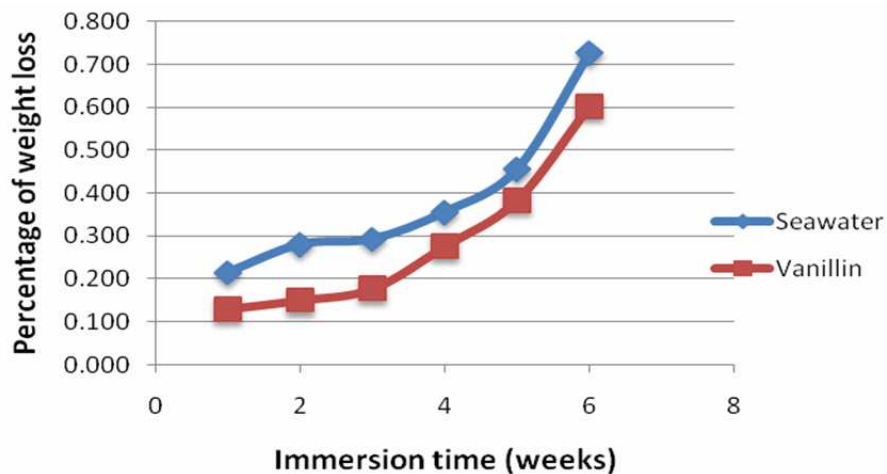
Fig. 2: The percentage of weight loss versus time for solution with and without vanillin

3.2. Potentiodynamic polarization scan

By using potentiodynamic polarization scan, the electrochemical parameters such as corrosion current density (i_{corr}), corrosion potential (E_{corr}), anodic Tafel slope (b_a) and cathodic Tafel slope (b_c) of aluminium alloy in each solution were obtained.

From Table 1, the anodic Tafel slope (b_a) and the corrosion potential (E_{corr}) shows the different values with the increasing of immersion time for both of the solutions of seawater and seawater with vanillin. By comparing both of the solution, which is the seawater and the solution of seawater with vanillin, it shows that the cathodic Tafel slope (b_c) value of the seawater is the highest compare to the other solutions. It shows that the addition of the vanillin will induce the cathodic current. From the result obtained, the corrosion current density (i_{corr}) for all the test specimens increase with immersion time. The specimen immersed in the seawater recorded the highest value compared to the solution of seawater with inhibitor. When vanillin was introduced into the solution, the value of corrosion current decreased. Table 2 shows The electrochemical parameters of aluminium alloy in seawater and seawater with vanillin.

**Table 1: The electrochemical parameters of aluminium alloy in seawater and seawater with vanillin**

Solutions	Days	Potentiodynamic Polarization			
		E_{corr} (mV)	i_{corr} (μAcm^{-2})	b_a (mVdec^{-1})	b_c (mVdec^{-1})
Seawater	7	-705	3.23	125	144
	14	-738	4.21	142	144
	21	-643	2.97	192	201
	28	-658	0.22	168	190
	35	-759	3.29	146	178
	42	-672	1.53	115	128
Vanillin + Seawater	7	-758	1.06	66	83
	14	-743	1.62	97	95
	21	-704	5.43	94	89
	28	-648	4.58	57	145
	35	-703	5.18	98	94
	42	-758	1.36	69	80

According to Rosliza and Wan Nik (2008), both of the cathodic current (b_c) and the corrosion current density (i_{corr}) are relatively related to the corrosion rate. They stated that the rate of cathodic reaction controls the rate of corrosion process where the higher the cathodic current increase with corrosion rate. Moreover the corrosion current density was increase with corrosion rate.

Figure 3 shows the corrosion rate of the aluminium alloy when it is immersed in both of the solution. From the figure, the corrosion rate of the aluminum alloy increased as the immersion time increased. The sample that was immersed in the seawater shows the

highest corrosion rate compared to sample in another solution of seawater with vanillin. The corrosion rate decreases after vanillin was added in the seawater, it reveals that the addition of vanillin in seawater will decrease the corrosion rate.
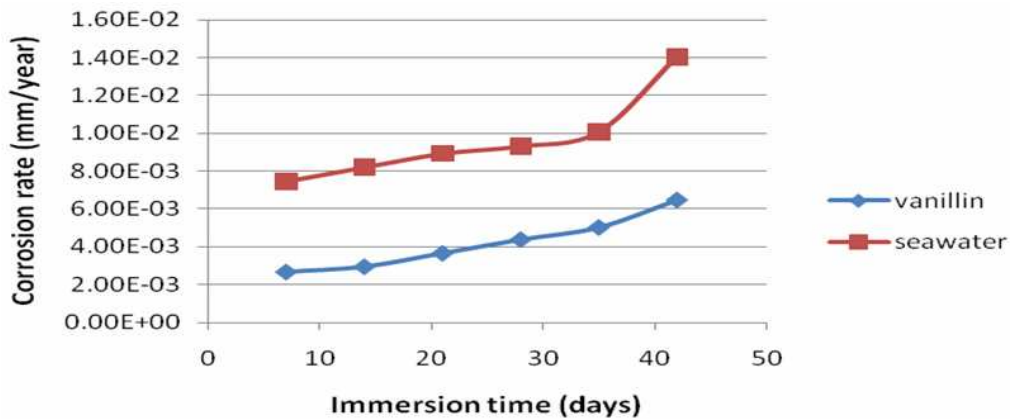

Fig. 3: The corrosion rate of aluminium alloy versus immersion time for solution of seawater and solution of seawater with inhibitor

3.3. Electrochemical Impedance Spectroscopy (EIS)

By analyzing the shape of the obtained Nyquist plots as shown in Figure 4, it is found that the curves approximated by a single capacitive semicircles, which is showing that the corrosion process was mainly charged-transfer controlled. The general shape of the curves is very similar for the entire sample where the shape was maintained throughout the whole test period. According to Rosliza and Wan Nik (2008), this indicates that almost no change in the corrosion mechanism occurred either due to the immersion time or the inhibitor addition.

From the graph obtained, the seawater has the smallest plot compared to the solutions of the seawater with vanillin. It shows that the smaller the plot, the greater the corrosion rate. It also shows the inhibition effect of the vanillin when added to the seawater.
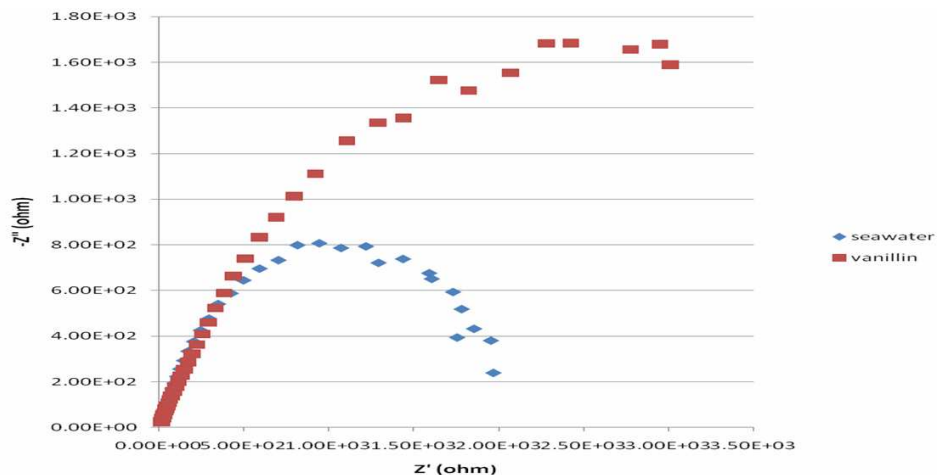
Fig. 4: Nyquist plots for aluminium AA7619 in both of the solution

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From the EIS measurement, the impedance parameters such as polarization resistance (R_p) and capacitance (CPE) of the aluminium AA7619 in both of the solution were obtained. Table 2 shows impedance parameters of aluminium AA7619 in seawater and seawater with vanillin which obtained by the EIS measurement. According to Rosliza and Wan Nik (2008), the polarization resistance R_p is usually decreases with immersion time. Moreover, a higher value of R_p indicates lower corrosion rate.

Table 2: The impedance parameters of aluminium AA7619 in solution of seawater and seawater with vanillin

Solutions	Days	EIS	
		R_p (kΩ cm^2)	CPE (nF cm^{-2})
Seawater	7	4.221	16.116
	14	3.567	19.483
	21	3.196	23.304
	28	2.665	31.501
	35	2.171	39.143
	42	1.048	43.714
Vanillin + Seawater	7	47.254	11.785
	14	43.758	14.729
	21	36.413	18.153
	28	28.121	23.305
	35	22.427	30.373
	42	15.721	31.069

3.4. Inhibition Efficiency

From Tables 3 and 4, the value of R_p for all the test specimens were decreases as the immersion time increases, while the value of CPE for all the samples increases with the immersion time. By comparing the data from both of the solution, it is found that the value of R_p in solution of seawater is lower. It is found that the value of R_p was increased with the addition of vanillin as inhibitor. It shows that the addition of vanillin into seawater will induced the R_p value. Moreover, the vanillin can reduce the corrosion rate of the specimens.

Table 3: Inhibition efficiency for vanillin obtained from various methods

Solutions	Days	Inhibition efficiency (%)		
		Weight loss	**Polarization**	**EIS**
Seawater + Vanillin				
	7	39.40	61.11	91.1
	14	46.45	63.53	91.8
	21	39.60	79.15	91.2
	28	22.51	77.39	90.5
	35	16.60	76.78	90.3
	42	17.25	77.99	93.3

Table 4: The average of inhibition efficiency of vanillin obtained

Solutions	Average inhibition efficiency (%)			
	Weight loss	**Polarization**	**EIS**	**Average**
Seawater + Vanillin	30.30	72.66	91.37	64.77

4. CONCLUSIONS

This paper presents the investigation of the characterization for vanillin as corrosion inhibitor for aluminium alloy. From the results of the weight loss method and EIS measurement, the inhibitor characterization of vanillin were found and observed. Thus the objectives of this research are achieved at the end of the stage. The corrosion studies of the AA7619 alloy were carried out at room temperature using seawater and the results indicate that vanillin improved the corrosion resistance of AA7619 alloy in marine environment by reducing the corrosion attack on the aluminium AA7619 and thus the corrosion decrease with the addition of vanillin. From the result, the corrosion rate of aluminium AA7619 increase as the immersion time increase, but when the vanillin is added into the seawater, the corrosion rate decrease. From the research conducted, the inhibition efficiency of vanillin gained is 64.77%. The results showed that the introduction of vanillin obviously minimizes the weight loss and reduced aluminum dissolution in seawater. Linear polarization curves suggested a cathodic character for the inhibition process. EIS measurements clarified that the corrosion process was mainly charge transfer controlled and no change in the corrosion mechanism occurred either due to the immersion time or to the inhibitor addition to seawater. The followings are recommendations based on the outcome of the experiment. Further analysis can be performed by using:

i. Variation of temperature and pH in order to observe the inhibition characterization of vanillin in other corrosive media.
ii. Different concentration of vanillin.
iii. Other types of inhibitor.
iv. Other metal and alloys which is normally used in marine industry.

ACKNOWLEDGEMENTS

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