WMU J Marit Affairs (2012) 11:187–209
DOI 10.1007/s13437-012-0029-y

ARTICLE

Oil pollution violations on vessels and adequacy of maritime training

Rajoo Balaji

Received: 22 October 2011 / Accepted: 21 March 2012 / Published online: 13 April 2012
© World Maritime University 2012

Abstract The paper projects the outcomes of an introspective study into the training imparted to the seafarer with respect to oil pollution matters. Typical training syllabi were compared with the prescribed lesson plans from Model Courses to verify quantitative and qualitative training. A sample has been drawn from the Malaysian and Indian seafaring officers for the study. Curriculum exposure to marine pollution regulations, and intensity and level of ship operational issues such as bypassing the separators and falsification of record books are analysed in the study. From the questionnaire survey amongst the officers, difficulties experienced in pollution prevention practices are highlighted. Statistical data analyses have been carried out to see if there is any relationship between pollution violations, training and human factors such as experience and attitude. While training appears to be sufficient, fatigue and attitude appear to be the causal factors for oil pollution violations. The paper concludes with suggestions for improving training such as simulator exercises and case study discussions, etc.

Keywords Seafarer training · Oil pollution violations · Human factors · Attitude · Fatigue

1 Introduction

Industrialisation 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 cost of 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

R. Balaji (✉)
Malaysian Maritime Academy (ALAM), P.O. Box 29, Wakaf Tengah 21030, Kuala Terengganu, Malaysia
e-mail: rajoobalaji@alam.edu.my

and penalised for pollution violations. Incidents of seafarers being criminalised are on the increase under the same purview. On the social platform, this could result in harming the seafarer and the seafaring profession.

For the year 2005, criminalising accidents top the listing of key issues and features in the listings of 2010 and 2011 by International Shipping Federation (ISF Annual Review Archives 2012). Concerned with this trend, The Baltic and International Maritime Council (BIMCO) analysed a number of cases and reported on the study conducted (2006). The noticeable feature of the report was that all the offences were oil pollution-related. If the rationale behind the seafarer committing pollution violations could be probed into, the severity of pollution and criminalisation could be mitigated. Figure 1 identifies possible factors affecting the performance of the ship board officer and leading to oil pollution violations. Each of the factors are briefly analysed and related to training.

Machines for pollution prevention measures are designed according to regulations, but there could be operational difficulties. Assessing the efficacy of machines such as Oil Water Separators (OWS), Oil Discharge Monitoring and Control System (ODMCS) will require a technical approach. Also, limitations in some methods (e.g. insufficient shore reception facilities) might be present, but other prevention measures can be taken. For such measures, Shipboard Oil Pollution Emergency Plans (SOPEP) identify material requirements such as self-absorbent pads, dispersants, etc. The modus of employing these and operation of machines are imparted during training. The approved methods for oil pollution prevention are included in training.

In the shipboard environment, acts of God (natural causes such as storms, tsunamis, etc.) are beyond normal control. The pollution regulations (MARPOL 73/78 2002) 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.

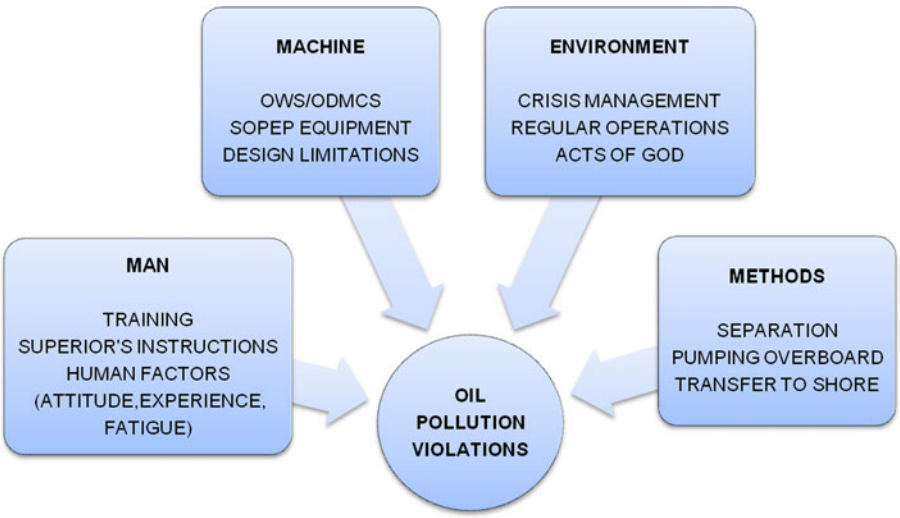

Fig. 1 Factors and reasons leading to oil pollution violations

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. In the legal purview, all concerned parties are presumed to carry the onus. For example, when an incident of oil pollution is committed, the person committing the act (seafarer), the Chief Engineer (if the incident is related to engine department), the Master (Captain) and the Company are all held responsible. Such legal aspects are made clear while the seafarer is being trained. Training is concerned with all the factors discussed above. Furthermore, 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.

Gonzalez (2000), in an analytical study of oil pollution caused by port operations, cites training of the crew as the major reason for the pollution incidents. In assessing the quality of training, the traditional measures include certification based on competency assessment and feedback from the student himself (Parsons 1997). Furthermore, 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). Proceeding from such observations, the problem statement could be if lack of training and human factors such as experience, attitude and fatigue are the causes for the oil pollution violations by the seafarer.

2 Objectives and framework 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. For the study, the seafarer referred to is the shipboard officer, and the violations are the oil pollution and falsification of records. These definitions narrow down the problem and the scope of the study. In the framework of the study, two approaches as shown in Fig. 2 were chosen to enquire if any relationship exists between training, human factors and oil pollution violations. Referring to Fig. 2, from the top, the first approach was to study the related literature and second was to survey an industry sample. Various hypotheses were also framed and tested.

3 Literature review

In the study, the grosser problem of criminalisation and the enormity of the oil pollution were established with BIMCO Report (2006) and the report by the Group of Experts on Scientific Aspects of Environmental Protection (GESAMP Report 2007), respectively. The training formats and prescribed training requirements were reviewed with reference to Standards of Training, Certification and Watch keeping (2001) (hereafter, STCW).

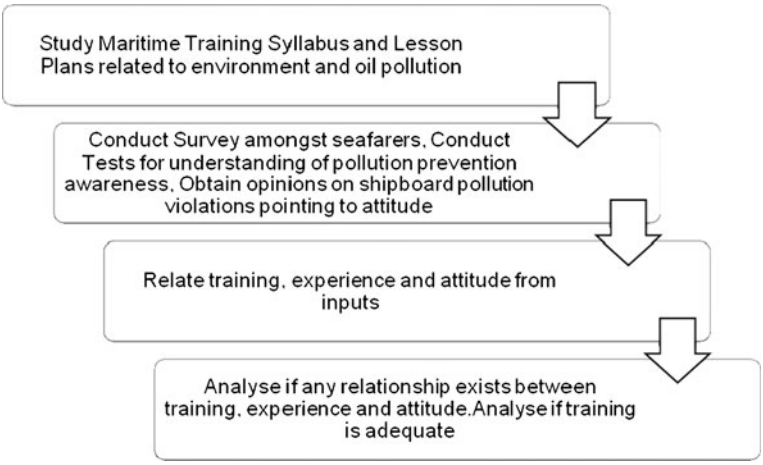

Fig. 2 Framework of the study

The BIMCO Report (2006) is the only recent study on the criminalisation issue available. The BIMCO Report observes "there is an unfortunate pattern of fair laws being applied unfairly, with seafarers being detained after an accident either on a presumption of criminal negligence, or as financial security". The BIMCO Report per se has been the inspirational point for the study but has no direct bearing on training. It establishes that criminalisation has been occurring due to pollution violations, particularly on oil pollution and falsification of records.

The GESAMP Report, on the other hand, provides a statistical database as part of the global efforts to reduce oil inputs into the marine environment from ships and other sea-based activities. The estimates regard factors such as type and age of ship, level of maintenance of ship and engines, presence of OWS and other pollution prevention equipment, practice of LOT (load-on-top), training and vigilance of the crew, level of shipping activity and adequacy of reception facilities. The estimates of operational discharges projected in the GESAMP Report emphatically indicate the fact that training has a bearing on compliance, design and operation of machinery.

As an exercise, the STCW was reviewed with reference to training on pollution matters. While structuring the syllabi for training, training institutes follow the STCW guidelines, and inputs are also drawn from the model courses validated by International Maritime Organisation (IMO). The training content, methods of evaluating the competence and criteria for the same will form part of any maritime training. Any lacuna in these areas can be a cause for non-compliance. If maritime training is to be looked at, STCW and the IMO model courses are to be taken as the reference areas.

In another review of a paper on contributory causes for oil tanker disasters (Manivannan 2004), seven major oil tanker disasters were considered. Ship's officers were seen as the major contributory cause, but training and human factors were seen as the apparent reasons for the disasters. The review of a report on manning (UK P & I Club 2005) substantiated that human factors influence ship operations in a greater way. Table 1 illustrates the listing from the report. Fatigue, training and experience were three clear factors which emerged with relevance to context.

Table 1 Human factors affecting performance of ship's staff

Human factors
Fatigue
Morale
Motivation
Loyalty
Training
Standards of certification
Experience
Conditions of service
Environment
Language
Management policies

4 Methodology

4.1 Elaboration of the conceptual framework

Training in quantity and quality is equated to awareness. To err is human, and experience, attitude and fatigue are attributed for operational errors. The idea was to explore if training and these human factors could have a significant relationship with violations limited to oil pollution and falsification of related records. With relevance to context, the officer on board is responsible for the violations.

4.2 Identification of variables and methods of approach

The initial steps were to identify the variables. The questionnaire was framed purposefully reflecting the variables to obtain measurable data. The profile validity of the general questionnaire format is shown in Appendix A. Tables 2, 3, 4 and 5 show the systematic identification of variables and the approach to the various analyses.

STCW was the reference in quantifying training imparted. Though the training schemes of the Deck and Engineering streams are based on STCW, the study has focussed on the Engineering Syllabus and modelling. For the study, the syllabi of a premier maritime institute, Malaysian Maritime Academy, were reviewed. The observations were based on the following.

1. Comparison of STCW requirements, IMO model courses and the institute's syllabi/lesson plans

Table 2 Identification of primary variables

Dependent variable	Independent variable
Crime (oil pollution and falsifying Oil Record Books)	1. Training (quantitative and qualitative: Awareness, Number of hours of Training, Learning content)
	2. Human factors (Experience, Attitude, Fatigue)

Table 3 Identification of variables with measurable attributes

Dependent variable	Independent variable
Training	1. Learning content: Syllabus. IMO model courses and STCW requirements
	2. Analyses based on test scores for groups with varying amount of training exposure
	3. Analyses based on acceptance and non-acceptance to violations for groups with varying amount of training exposure
	4. Analyses based on acceptance to involvements in pollution violations for groups with varying amount of training exposure
Human factors (Experience, Attitude, Fatigue)	1. Analyses based on test scores for groups with varying amount of experience
	2. Analyses based on acceptance and non-acceptance to violations for groups with varying amount of experience
	3. Analyses based on correlation between citing fatigue as a reason to acceptance and non-acceptance for violations

2. Hours devoted to subjects/topics related to pollution prevention
3. Methods of knowledge dissemination (lectures, practical)
4. Interview subject lecturers of the institute

STCW identifies training requirements at support, operational and management levels. Operational and management level requirements are for officers, and the Model Courses divide the course material into four functions which identify the standards of competence required for appropriate levels. While verifying syllabi content, the functions of IMO Model Courses 7.02 (1999) and 7.04 (1999) were referred to, which pertain to competencies of engineering streams at management and operational levels. The functions are as follows.

1. Marine Engineering at management/operational level
2. Electrical electronic and control engineering at management/operational level
3. Maintenance and repair at management/operational level
4. Controlling the operation of the ship and care for persons on board at management/operational level

Furthermore, awareness as a result of training was checked from scores obtained in the test included in the questionnaires. Attitude measures were obtained from the survey on issues such as bypassing the OWS amounting to oil pollution, falsification of Oil Record Books (ORB) and taking shortcuts in pollution prevention practices. Groups with varying hours of training were compared with test scores and attitude measures to verify if more training will make a difference in awareness and attitude. Next, groups with varying experience were compared with test scores and attitude measures, to verify if increased experience had any effect on attitude.

The officer population was divided into five groups based on hours of training exposure (5, 10, 20, 30 and >30 h) while considering training as a variable. The training hours included the periods during pre-sea training, modular and any other special courses relevant to marine pollution. While considering experience as a

Table 4 Training: hypotheses testing methodology

Independent variable	Measurement methodology	Criteria	Tested hypotheses
Learning content: Syllabus. IMO model courses and STCW requirements	Content analysis of STCW, IMO model courses, training hours and Syllabi	Content and training hours ≥ prescribed	H_{O1}: There is no significant difference between prescribed training and actual training content with regards to marine pollution prevention
			H_{A1}: There is a significant difference between prescribed training and actual training content with regards to marine pollution prevention
Analyses based on test scores for groups with varying amount of training exposure	ANOVA	Significance >0.05 Accept null	H_{O2}: There is no significant relationship between number of hours of training and oil pollution prevention awareness
			H_{A2}: There is significant relationship between number of hours of training and oil pollution prevention awareness
Analyses based on acceptance and non-acceptance to violations for groups with varying amount of training exposure	ANOVA	Significance >0.05 Accept null	H_{O3}: There is no significant relationship between number of hours of training and attitude towards pollution prevention practices
			H_{A3}: There is significant relationship between number of hours of training and attitude towards pollution prevention practices
Analyses based on acceptance to involvements in pollution violations for groups with varying amount of training exposure	Chi square	Significance >0.05; Spearman's ρ or Pearson's $r <$ value from tables, accept null	H_{O4}: There is no significant relationship between number of hours of training and involvement in oil pollution violation incidents
			H_{A4}: There is significant relationship between number of hours of training and involvement in oil pollution violation incidents

variable, the sample was divided into seven groups (0.5–1, 1.1–2, 2.1–3, 3.1–4, 4.1–5, 5.1–6, 6.1–40 years). Here, the actual period of engagement onboard was considered as work experience. These groups were assumed to be the different treatment

Table 5 Human factors: hypotheses testing methodology

Independent variable	Measurement methodology	Criteria	Tested hypotheses
Analyses based on test scores for groups with varying amount of experience	ANOVA	Significance >0.05 accept null	H_{O5}: There is no significant relationship between number of years of experience and oil pollution prevention awareness
			H_{A5}: There is significant relationship between number of years of experience and oil pollution prevention awareness
Analyses based on acceptance and non-acceptance to violations for groups with varying amount of experience	ANOVA	Significance >0.05 Accept null	H_{O6}: There is no significant relationship between number of years of experience and attitude towards pollution prevention practices
			H_{A6}: There is significant relationship between number of years of experience and attitude towards pollution prevention practices
Analyses based on correlation between citing fatigue as a reason to acceptance and non-acceptance for violations	Correlation analysis	Spearman's coefficient measuring strength of relationship	H_{O7}: There is no significant relationship between fatigue and pollution prevention practices
			H_{A7}: There is significant relationship between fatigue and pollution prevention practices

groups. Analysis of variance (ANOVA) tests are appropriate for such situations involving three or more treatment groups and data on variables obtained from interval/ratio levels of measurements (Caldwell 2004). Chi-square tests are appropriate where the associations between two categorical groups of variables are considered (Caldwell 2004). For example, groups with varied training are tested with groups involved in pollution violations. Similar tests were applied for testing the relationship between experience and pollution violations.

Fatigue measures were correlated to attitude measures. Correlation analyses indicate the linear relationship between two such variables. For example, it was assumed fatigue (independent variable) has a relationship to ship's officers taking shortcuts during pollution prevention operations (dependent variable), and the strength of the relationship was analysed. Spearman's ρ and Pearson's r values indicate the direction and strength of relationship between the variables. Opinions citing fatigue as reason for difficulties in following regulations were also considered to verify if fatigue has relationship with violations.

4.3 Survey: sample and scope

Assuming a global seafaring officers' population >100,000, a minimum survey sample of 360 was targeted (Uma Sekaran 1992). The population comprised of

officers from various ranks from both Deck and Engine departments who are directly responsible for the ship operations. A total of 309 respondents were considered for the first survey and 213 for the second. The scope of the sample population was extended to Indian seafaring officers. This was done considering that many Indian nationals are employed on Malaysian ships and the training formats being similar to the Malaysian format. Also, such an exercise provided a platform for a causal comparison. Table 6 shows the profile of the respondents.

5 Results and analysis

5.1 Content analysis of training syllabi

Thinking behaviour of a learner can be classified into three domains of cognitive- or knowledge-based domain, affective- or attitudinal-based domain and psychomotor- or skill-based domain. This classification is supposed to help in the learning process. The classification and associated works are referred to as Bloom's Taxonomy, named after the researcher, Benjamin Samuel Bloom (1913–1999) (Anderson and Krathwohl 2001; Forehand 2005).

In the pre-sea syllabi, the sections addressing marine pollution were identified in the subject of Engineering Knowledge General. The general learning objectives for various topics under a subject are addressed in detail as specific learning objectives. The verbs (e.g. explain, describe, sketch, name, identify, etc.) employed in these syllabi sections are related to one or more of the cognitive domains. The detailed teaching syllabi were found to be broadly based on four cognitive domains of knowledge, understanding or comprehension, application and integration. Under the structure, the topic of marine pollution addressing the

Table 6 Profile of survey respondents

Number of respondents targeted	360	Survey sample required for population >100,000
Number of respondents sought	523	Shipboard officers in active service
Valid responses	522	1 invalid respondent
Number of officers		
Deck 81 (15.5 %)	Engine 441 (84.5 %)	
Master 37	Chief engineer 21	
Chief officer 15	Second engineer 35	
Junior officer 29	Junior engineer 385	
Average age of respondents	28.5 years	
Average experience of respondents	5.83 years	
Nationality	Malaysia 341	
	India 147	
	Others 34	Bangladesh/Indonesia/ Philippines/Myanmar/USA

pollution prevention training is allocated a weightage of 10 % (knowledge 2 %+ understanding 8 %).

In the preparatory course for Chief and Second Engineer Certificate of Competency, the sections addressing marine pollution were identified in the syllabus for Engineering Knowledge General. Under the domains, referring to Bloom's Taxonomy, pollution prevention training is allocated a weightage of 8 % (knowledge 1 %+ understanding 7 %). The following are other observations.

1. The contents of IMO model courses and comprehensive syllabi match except for function 4, competence 4.2 (Model Course 7.02 1999) which was found to be covered in a modular course subsequent to pre-sea training.
2. The IMO model courses have not been updated for subsequent annexes which have come into force, whereas the syllabi have recognised the same and have been updated (e.g. air pollution).
3. Both model course and syllabi have no mention of ballast water management.
4. The lesson plans of the institute reflect the syllabus objectives and the content of IMO model courses.
5. The contents of IMO model course on MARPOL annexes are found in the modular course, "Maritime Law". The modular course is completed by the students prior to joining ships as certified watch keepers. MARPOL annexes are discussed for 4 h (recommended, 3 h)
6. Qualitatively, lectures and self-study turn out to be the main source of knowledge dissemination during the study in the institute.
7. In assessments and evaluation, questions based on marine pollution are not comprehensive (not covering all aspects).

Inferences

1. It was inferred that the quantitative training appears to be sufficient given an average of >17 h which is well above the 15 h indicated in the IMO model courses.

Accept H_{O1}
H_{O1}: There is no significant difference between prescribed training and actual training content with regards to marine pollution prevention.
H_{A1}: There is a significant difference between prescribed training and actual training content with regards to marine pollution prevention.

5.2 Training hours and test on oil pollution prevention awareness

Furthermore, the average attempts to pass pre-sea and post-sea competency examinations were ascertained from the survey respondents. The average attempts-to-pass is more at post-sea competency levels (1.05 pre-sea to 1.3 of post-sea). If taken as a measure of respondents' quality, the average shows that the officers are fairly good and well trained. Figure 3 shows the hours of exposure to pollution training of the respondents whose average was found to be 25.3. Training appears adequate.

The ANOVA was carried out on test scores obtained from responses to a section of the questionnaire. The test comprised of various questions which

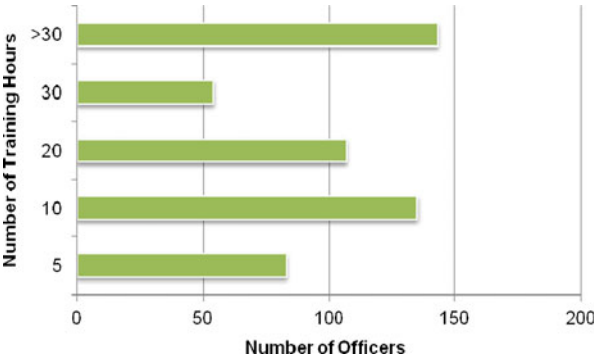

Fig. 3 Average hours of pollution prevention training of shipboard officers surveyed

were identified from regulations and practices that the officers have to be aware of before they board the ship at any level. It was assumed that the scores would show a difference between groups because of varying hours of training exposure. It was also assumed that the difference would exist between the groups as the groups comprised of various ranks of officers. Based on these assumptions, the hypotheses were framed. The significance levels and the homogeneity of variance (HOV) scores were the indicators.

Survey 1: Sig. 0.377 > 0.05, Accept H_{O2}

Survey 2: Sig. 0.780 > 0.05, HOV Sig. 0.054=0.05, Reject H_{O2}

H_{O2}: There is no significant difference between number of hours of training and oil pollution prevention awareness.

H_{A2}: There is significant difference between number of hours of training and oil pollution prevention awareness.

Inferences

1. Survey 1 indicates awareness to be even amongst officers with varied hours of training.
2. Survey 2 indicates awareness could vary with varied hours of training. This could be due to the composition of the sample population.

5.3 Training and attitude

It was assumed that training would show a variance in attitude, and since groups with varied hours of training comprised of varying ranks, ANOVA was done. Two test scores (Bad Attitude Test scores and Good Attitude Test scores) were considered separately. Bad attitude was quantified by counting the total of agreements to questions on pollution prevention practices and good attitude for non-agreement (acceptance and non-acceptance) on questions related to bypassing OWS, falsification of ORBs and tendency to take shortcuts while carrying out pollution prevention operations. For example, an agreement that shipboard laws are only on paper would count as a point scored for bad

attitude and a response that OWS is never bypassed would be a score for good attitude.

Survey 1: Sig. 0.619 > 0.05, HOV Sig. 0.043 < 0.05 (Bad attitude) Reject H_{O3}
Sig. 0.339 > 0.05 (Good Attitude)

Survey 2 : Sig. 0.169 > 0.05 (Bad Attitude)
Sig. 0.517 > 0.05 (Good Attitude) Accept H_{O3}

H_{O3}: There is no significant relationship between number of hours of training and attitude towards pollution prevention practices.

H_{A3}: There is significant relationship between number of hours of training and attitude towards pollution prevention practices.

Inferences

1. The averages for both tests being almost same (1.55 bad attitude and 1.56 good attitude), it may be assumed that bad and good attitudes prevail with almost equal intensities.
2. Further to ANOVA, post hoc test helps in ascertaining any significant difference between individual group means (Caldwell 2004). Analysing with Turkey's post hoc test, only the group with 20 h of training shows a high variation followed by groups with 10 and 5 h of training. Groups with 30 and >30 h of training show lesser variation. ANOVA results were validated as these variations were not significant.
3. Considering the independent tests indicating no significant relationship, it may be assumed that training hours have no significant relationship with attitude.
4. Considering the result of Survey 1 alone, it may be said that with increased training bad attitude diminishes.

5.4 Training hours and involvement in pollution incidents

The variables considered here are the groups with varying hours of training and those who were involved in pollution incidents in each of the groups. Here, respondents were considered only if they were involved in violations which were detected and penalties were imposed. The premise was that if training is more, involvement in pollution incidents will be less.

Survey 1 Chi-square: 1.163, Sig. 0.884 > 0.05 Accept H_{O4}

Survey 2 Chi-square: 0.244, Sig. 0.993 > 0.05 Accept H_{O4}

H_{O4}: There is no significant relationship between number of hours of training and involvement in oil pollution violation incidents.

H_{A4}: There is significant relationship between number of hours of training and involvement in oil pollution violation incidents.

Inferences

1. Involvement in pollution violation incidents has no relationship with the quantity of training imparted.

5.5 Experience and awareness

It was assumed that awareness would increase with years of experience. But, the groups with varying experience had varying ranks and varying hours of training. For example, a Chief Engineer might have had only 15 h of pollution prevention training whereas a third engineer might have undergone 25 h of training. This disparity of training exposure can be due to policies of the company one is employed with. To objectively relate experience, the population was divided into seven different treatment groups based on number of years of experience for the ANOVA tests.

Survey 1: Sig. 0.101 > 0.05, HOV Sig. 0.000 < 0.05, Reject H_{O5}

Survey 2: Sig. 0.994 > 0.05 Accept H_{O5}

H_{O5}: There is no significant relationship between number of years of experience and oil pollution prevention awareness.

H_{A5}: There is significant relationship between number of years of experience and oil pollution prevention awareness.

Inferences

1. Survey 1 shows a relationship with a low significance value and <0.05 HOV
2. Survey 2 shows no significant relationship. It may be due to the difference in sample population composition.

While analysing the results of both surveys together, Pearson's correlation values indicate experience has a weak correlation to oil pollution prevention awareness (significance, two-tailed, 0.847). Awareness increases with experience, though not significantly.

5.6 Experience and attitude

It was assumed that groups with varying experience would show a variance in attitude; ANOVA was done treating the groups differently. Two test scores (Bad Attitude Test scores and Good Attitude Test scores) were considered separately.

Survey 1: Sig. 0.02 < 0.05 (Bad Attitude) Reject H_{O6}
Sig. 0.021 < 0.05 (Good Attitude) Reject H_{O6}

Survey 2: Sig. 0.0523 > 0.05, HOV Sig. 0.055 = 0.05 (Bad Attitude) Reject H_{O6}
Sig. 0.550 > 0.05 (Good Attitude) Accept H_{O6}

H_{O6}: There is no significant relationship between number of years of experience and attitude towards pollution prevention practices.

H_{A6}: There is significant relationship between number of years of experience and attitude towards pollution prevention practices.

Inferences

1. Values from Survey 2 indicate a relationship between experience and bad attitude with the HOV for test on good attitude being just more than 0.05 (0.055). The differing results may be due to the composition of the sample population.

2. Considering three out of four tests indicating significant relationship, it may be assumed that experience has some effect on attitude.
3. While analysing both surveys together, there was no significant relationship with regards to bad attitude (significance, two-tailed, 0.965) but a very low relationship between experience and test scores for good attitude (significance, two-tailed, 0.048).
4. Operations contravening legal pollution prevention practices (bypassing OWS, pumping out oil tank washings, etc.) have a relationship with other opinions expressed in the surveys such as pollution laws are only on paper, and shortcuts are being taken.
5. Experience seems to enhance good attitude and diminish bad attitude, though not significantly.
6. There is a prevalent bad attitude towards pollution prevention practices.

Further correlation analyses were also carried out. Frequencies of illegal operations performed (violations) was correlated with acceptance to shortcuts and opining that pollution laws are only on paper. This was assumed to indicate a negative attitude. The illegal operations were OWS being bypassed (significance, two-tailed, 0.000) and oil tank washings being freely discharged from oil tankers (significance, two-tailed, 0.002). Spearman's ρ values indicate a definite correlation, but with a low intensity. At a level of 0.05, the relationship between oil prevention practices and the attitude measure is significant. The reason for a lesser value while analysing practice of pumping out tank washings can be attributed to the fact that respondents with tanker experience were less as compared with other vessel types.

5.7 Fatigue

It was assumed that fatigue can influence the behaviour in pollution prevention practices. Correlation between two responses was analysed. If there was acceptance, implying fatigue to be the cause, and also acceptance to shortcuts being taken during pollution prevention operations, it constituted to agreeing that fatigue was a cause. The framing of the survey questionnaire was on Likert scale. In the correlation analysis, Spearman's ρ=0.362 shows a moderate relationship between fatigue and pollution prevention practices. At α=0.01, the relationship between fatigue and pollution prevention practices appears significant. The coefficient shows a definite correlation but with a low intensity. It may be said that fatigue affects pollution prevention practices.

Reject H_{O7}
H_{O7}: There is no significant relationship between fatigue and pollution prevention practices.
H_{A7}: There is significant relationship between fatigue and pollution prevention practices.

5.8 Other results from surveys

Apart from data for statistical analyses, many opinions were obtained from the surveys. The survey results are highlighted and inferred.

5.8.1 Evidence of pollution violations on board: survey 1

1. 25% (76 out of 309) agreed that OWS is bypassed while pumping out engine room bilges.
2. 42% (117 out of 276 with tanker experience) agreed that oil tank washings were discharged freely in open waters.
3. 50.5 % felt shipboard pollution laws are only on paper.
4. Fifty-one percent felt that ORBs are falsified.

Inferences

1. The crimes of oil pollution violation and falsification of records are being committed on board.
2. Acceptance of ORB falsification and pollution laws being only on paper by almost 50 % of the officers indicates a prevalent negligent attitude.

5.8.2 Evidence of pollution violations on board: survey 2

1. 33.8 % (72 out of 213) have seen engine room bilges being pumped out, bypassing the OWS.
2. 32.9 % (68 out of 213) have seen ORBs being falsified.
3. 7.5 % (16) have seen other pollutions also such as garbage, inadvertent oil discharges, air pollution, etc. The number of incidents considered here were those which involved detection and penalties and not simple observations by the respondent.

5.8.3 General awareness of marine pollution: surveys 1 and 2

1. 87% (269 out of 309) said that they are usually aware of pollution incidents.
2. 92% (284 out of 309) said that they are usually aware of pollution incidents where their company's vessels are involved.
3. In survey 2, 38.5 % are usually aware, 14.1 % are aware more often than not and 35.7 % are mostly aware of sea-related oil pollution incidents.

Inferences

1. Awareness of incidents where employer–company's vessels are involved is more than the general awareness of pollution incidents.
2. An above average awareness about pollution incidents in the population may be assumed.

5.8.4 Involvement in pollution violations: surveys 1 and 2

1. 33% percent (101 out of 309) had encountered pollution incidents.
2. 20% (63 out of 309) had been involved in pollution incidents.
3. 18% (57 out of 309) said that they were treated like criminals during the incidents.

4. 81% (251 out of 309) felt that seafarers are treated like criminals when a pollution incident occurs. The details of pollution incidents referring to comments on criminalisation were not sought in the survey questionnaires.

5.8.5 Pollution violations: surveys 1 and 2

1. In Survey 1, the major pollution violations are from engine room bilges (32) followed by other pollution violations such as garbage, sewage, etc. (20) and ORB falsification (10). Figure 4 shows the number of officers who were directly involved in pollution violations.
2. Oil pollution from bilges, cargoes (10) and ORB falsification are dominant pollution violations. This corroborates with the BIMCO Report findings.
3. In 57 out of 63 cases (90.5 %), the seafarers agreed to being treated as criminals. This is close to 81 % who felt that seafarers are treated like criminals when a pollution incident occurs.
4. In Survey 2, most of the offences are oil-related (41 from oil pollution from bilges, 17 from oil cargoes and 35 from falsification of record books in conformance to BIMCO findings. Figure 5 shows the numbers.

5.8.6 Other inferences: surveys 1 and 2

1. Pollution laws and regulations appear to be enough in quantity and severity. A combined 60 % felt that the laws are enough and strict.
2. Eighty-eight percent (271 out of 309) feel that penalties for pollution violations must be severe.

5.8.7 Opinions of trainers

A survey was carried out amongst trainers with marine background (ex-seafarers) to obtain an insight into the issue of oil pollution and training. Eleven trainers were from

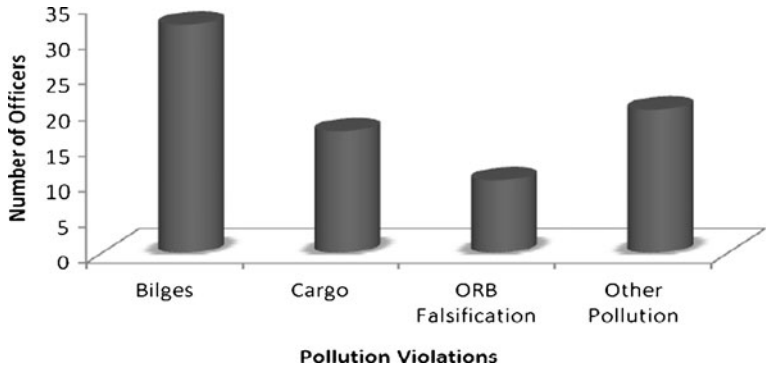

Fig. 4 Pollution violation incidents: survey 1

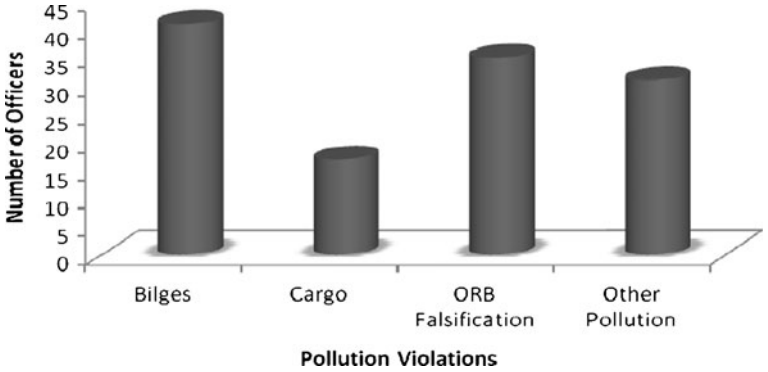

Fig. 5 Pollution violation incidents: survey 2

the Malaysian Maritime Academy and one from an Indian maritime institute. Of the trainers, six were Masters, five had been Chief Engineers and one had sailed as second engineer. All except one had seen or been involved in pollution violations. All the trainers were well aware of the oil pollution violations on board.

Inferences

1. The trainers were more inclined to agree (58 %) that the seafarers might not be aware of the severity of punishments when ORBs are falsified.
2. The trainers were divided (50 %) in accepting fatigue being the cause for pollution violations.
3. The trainers were in overwhelming agreement (91 %) that negligence might be the cause for pollution violations.
4. The trainers opined that between 10–20 h of training on pollution matters is imparted.
5. There was greater disagreement (50 %) that training hours are sufficient.
6. There was greater disagreement (58.3 %) that lecturing was the best method for imparting training on pollution matters.
7. There was strong agreement (98.3 %) on simulator training.
8. There was strong agreement (91.7 %) that a major factor affecting training on pollution prevention is that the trainer is not aware of the technological developments and changing regulations.
9. Simulator training (eight responses), case studies (eight responses) and computer-based training (eight responses) found favour amongst the trainers followed by onboard training (six responses). Lecturing (four responses) was least preferred.

5.9 Summary of inferences

1. Training is adequate.
2. Increased training hours might increase awareness.
3. Training hours has little effect on attitude towards pollution prevention practices.
4. Increased experience might increase awareness and improve good attitude.
5. Fatigue has a considerable influence on pollution prevention practices.

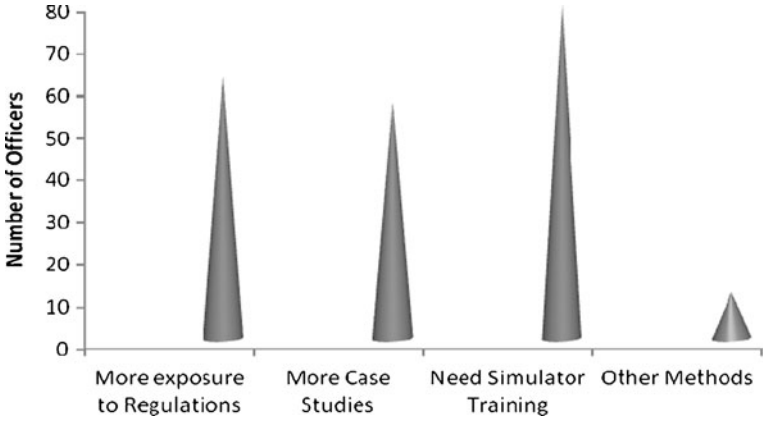

Fig. 6 Training on pollution matters—suggested methods

6 Discussions

Training hours appear to be sufficient and within the syllabi, the content of the subject matter (oil pollution) also appears to be enough while considering other modular courses. Though the substance is sustained in the training formats, the intensity of imparting the knowledge could be less. This is apparent from the survey where officers feel training could be the reason for difficulties faced in pollution prevention. A major reason for recurrence of oil pollution violations could be the attitude of the officer. Here, the attitude–behaviour is assumed to be influenced by training and experience. Whereas increased training shows no significant relationship, increased experience appears to rather enhance good attitude. Training on mindset–behaviour at early stages of an officer's career (less experience) might augur well in the long run. From survey opinions projected in Fig. 6, simulator exercises and case studies are preferred methods for enhancing present training. In the training format, discussing case studies on pollution matters might help rather than lecturing on regulations.

The element of hands-on training can be practiced with simulators. Onboard training augurs well as on-job training, and this may be strengthened with well-structured computer-based training programs (CBTs). On-board training, introduction of Marine Pollution as a separate curriculum subject, discussion forums and more tests are the other methods suggested.

Figure 7 shows the total number of responses from both surveys as reasons being cited for facing difficulties in carrying out pollution prevention operations conforming to MARPOL. The human factor of fatigue being the reason for taking shortcuts and punishable pollution offences is substantiated. Fatigue is finding a place as a causal factor for human errors in many reports and further probing will not be superfluous. Amongst other reasons, machinery design could be another factor. The capacity and efficiency of OWS have been found wanting in many old designs. The alternative of disposing oily wastes is the delivery to shore reception facilities. Here again, not all ports are equipped with such facilities. The facilities are not limited to storage and in many cases include separation systems. These are issues that have to be seen from technical and infrastructure view points.

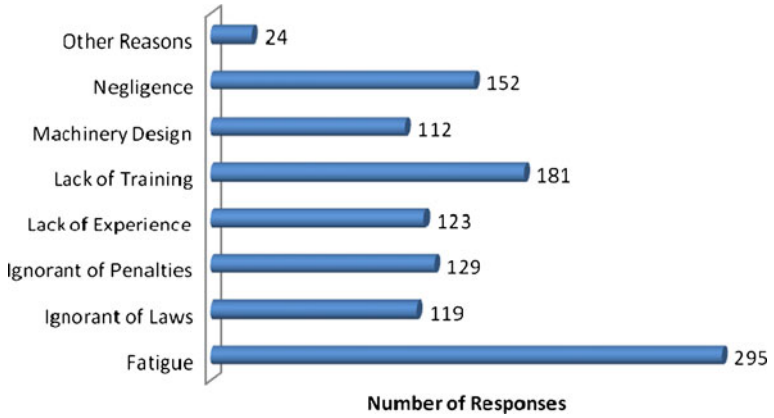

Fig. 7 Operational difficulties in conforming to MARPOL pollution prevention measures

The general feeling on pollution is that land-based pollution is more than the ship-based pollution. Also, a very high percentage of officers feel that the seafarer is easily criminalised when a pollution incident occurs. The rise in criminalising incidents on the security front could be a reason for this feeling amongst a high percentage of officers. There is enough evidence confirming occurrence of oil pollution violations. On an average, one fourth of the sample population has been involved in oil pollution violation incidents, and, comparatively, involvement in other pollution violations (garbage, air, etc.) is negligible. But, the general awareness about pollution incidents and penalties is fairly good, and it may be assumed that ignorance is not a reason for pollution violations.

7 Other issues emerging from surveys

The survey also found comments on company responsibilities with respect to delayed supply of spares and lackadaisical attitude towards ship's staff. Such comments are grouped under other reasons in Fig. 7. Pollution from garbage and plastics (non-biodegradable) is another offence where involvement is seen though considerably less as compared with oil pollution violations. Short-manning is perceived as one of the reasons for fatigue.

7.1 Recommendations on training

Maintaining the focus on training for pollution prevention, the following recommendations are proposed.

1. Simulator exercises based on pollution prevention practices must be developed.
2. Case studies on pollution matters/environmental protection must be included in both pre-sea and post-sea training lesson plans.
3. CBT programs may be used for onboard training. The packages may be ship specific rather than being generic so as to make the experience more relevant.

4. To emphasise the importance and concerns of the present times, protection of environment may be dealt with as a separate subject or a course in the pre-sea training curriculum.
5. The IMO model courses need a revision and has to be updated. It might do well that the lesson plans of institutes are updated as and when new regulations are ratified or in the process of being ratified.
6. Mindset behaviour training can be included at management levels.
7. Mechanisms for regular knowledge up-gradation for trainers must be in place. Maritime institutes may be made accountable for such provisions.

7.2 Limitations of the study

The study has limited itself to training of officers in the Malaysian and Indian contexts. The efficiencies of shipboard equipment (OWS capacity and effectiveness in separating oil) and other measures for mitigating oil pollution (e.g. shore reception facilities) have not been probed into. This will require a probe on technical lines. The question of attitude–behaviour and fatigue are issues requiring a deeper study. The complex nature of these issues requires a wider cross-section of the seafarer populace involving more nationalities which was beyond the scope of the study.

7.3 Suggestions for further research

Further studies are recommended on two platforms. On the technical side, the efficacy of shipboard equipment for oil pollution prevention may be evaluated. On the ship operations side, availability of shore reception facilities at various ports needs to be assessed as also the pollution control measures. The study must take recourse on the social front probing into attitude–behaviour of the seafarer. Shortage of manpower has greater impact on ship operations. Though minimum manning levels are regulated, at times, situations might demand extra manpower. Seafarers are prone to overwork, and the factor of fatigue needs a critical probing. Studies on human factors such as multicultural ambience, absence of mate and abnormal social life are being taken up by many researchers. These may be extended in scope and reach.

8 Conclusion

The primary aim of this study was to see the correlation between training of seafarers and the oil pollution-regulation violations. The motivating factor for the study has been the issue of the criminalisation. The outcome of the exercises may be treated as being introspective. Criminalisation for oil pollution violations is a current issue and so is the revision of STCW. It is earnestly hoped that this study benefits the maritime community including the training institutes and the shipping companies.

Acknowledgement The Author wishes to thank the Malaysian Maritime Academy for the support in carrying out the study.

Appendix A

Table 7 Profile validity of survey questionnaire

Question	Nature of data	Validity	Remarks
Deck/engine departments	Nominal	Ascertaining respondent's department	Greater percentage of engineers were targeted
Age group	Ordinal	General information on respondent's profile	All respondents in active age groups
Experience	Scale	Measure for human factor. Data for ANOVA and chi-square tests	7 groups were formed from 0.5 to >6.1–40 years of work experience
Rank/position	Ordinal	General information on respondent's profile	All officers from operational and management levels
Nationality	Nominal	General information on respondent's profile	Mostly Malaysian and Indian officers. Very few from other nationalities
Training institute	Nominal	Ascertaining training background	Malaysian and Indian training models are largely similar
Hours of training on pollution matters	Scale	Measure for varied training exposures. Data for ANOVA and chi-square tests	Training on pollution matters depends on various modular courses. However, all officers undergo the prescribed number of training hours. Five groups were formed with 5 to >30 h of training
Attempts to pass pre-sea and post-sea courses	Scale	General information on respondent's profile	If the number of attempts are within the averages, it may be assumed that the quality of sample population is fairly good
Adequacy and strictness of pollution laws	Scale	Opinion	Measures the general feeling if the regulations are enough and strict enough
Difficulties faced in following MARPOL	Scale	Measures strength of opinion. Measures for training, experience, attitude and fatigue	Data can be supportive while forming inferences
How can training be enhanced	Scale	Opinion	Data can be supportive for recommendations from the study
I feel OWS are bypassed while pumping engine room bilges	Nominal	Intensity of opinion. Measure of attitude.	Data for correlation analyses with falsification and taking shortcuts. Data can be supportive while forming inferences. Response framed on Likert scale from 'Mostly' to 'Never'
On oil tankers, in open waters, oil tank washing/cleaning disposals are freely carried out	Nominal	Intensity of opinion. Measure of attitude. Data for correlation analysis	Data for correlation analyses with falsification and taking shortcuts. Data can be supportive while forming

Table 7 (continued)

Question	Nature of data	Validity	Remarks
			inferences. Response framed on Likert Scale from 'Mostly' to 'Never'
I am usually aware of the sea related oil pollution incidents	Nominal	Intensity of awareness	Data can be supportive while forming inferences
I am usually aware of the sea related oil pollution incidents where company's vessels are involved	Nominal	Intensity of awareness	Data can be supportive while forming inferences
Punishments must be severe for pollution violations	Nominal	Opinion	Data can be supportive while forming inferences
Land-based pollution is more than pollution from ships	Nominal	Opinion	Data can be supportive while forming inferences
I feel the shipboard compliance of pollution laws are mostly on paper	Nominal	Measure of attitude	Data for correlation analyses with OWS by- passing, fatigue and oil tank washing disposals. Data can be supportive while forming inferences
I feel shipboard logs (ORB, etc.) are falsified on many occasions	Nominal	Measure of attitude. A criminal act in the present context	Data for correlation analyses with OWS by-passing, fatigue and oil tank washing disposals. Data can be supportive while forming inferences
Many a time shipboard staff may take shortcuts due to short manning etc.	Nominal	Measure of attitude and fatigue	Data can be supportive for fatigue being a causal factor
Fatigue due to long working hours causes a seafarer to take shortcuts in oil pollution prevention practices	Ordinal	Measure of fatigue	Data for correlation analyses with falsification and taking shortcuts. Data can be supportive while forming inferences. Response framed on Likert scale from 'Strongly Agree' to 'Strongly Disagree'
Reasons for ship-running becoming harder	Scale	Opinion	Data can be supportive for recommendations from the study
Seafarer is easily criminalised when a pollution incident occurs	Nominal	Measure of general feeling/ opinion	Data can be supportive for the issue of criminalisation
Encountered pollution related problems on board	Nominal	Measure of number and type of pollution violations	Data can be supportive while forming inferences
Encountered pollution related problems on board when ship's staff was treated as criminals	Nominal	Measure of general feeling/ opinion	Data can be supportive for the issue of criminalisation
Been involved in pollution violations	Nominal		Data can be supportive while forming inferences

Table 7 (continued)

Question	Nature of data	Validity	Remarks
		Measure of number and type of pollution violations	
Six questions on OWS	Scale	Test on oil pollution awareness. Questions pertain to OWS operation. Measure of awareness	Data for ANOVA with training hours and experience

References

Anderson LW, Krathwohl DR (2001) A taxonomy for learning, teaching and assessing: a revision of Bloom's taxonomy of educational objectives. Longman Publishers, New York

Caldwell S (2004) Statistics unplugged. Wadsworth/Thomson Learning, California, Pp.139, 207, 229–232, 241, 268

Forehand M (2005) Bloom's taxonomy: original and revised. In: Emerging perspectives on learning, teaching and technology, Orey M (ed). Retrieved 25 Jan 2012 from, http://projects.coe.uga.edu/epltt/

Gonzalez B (2000) Analysis of pollution incidents at sea and those caused by port operations, section 3, Maritime Engineering and Ports II

IMO Model Course 1.29 (2000) Proficiency in crisis management and human behaviour training including passenger safety, cargo safety and hull integrity training. IMO Publication, London, p 128

IMO Model Course 7.02 (1999) Chief engineer and second engineer officer. IMO Publication, London

IMO Model Course 7.04 (1999) Officer in charge of an engineering watch. IMO Publication, London

ISF annual reviews archives (2012) www.marisec.org. Last accessed 22 January 2012, 1645 LT

Manivannan Capt (2004) Influential oil tankers disasters (1967 to 2003): contributory causes, analysis, summary. IKMAL J (Institut Kelautan Malaysia) 8:25–29

MARPOL 73/78 (2002) International convention for the prevention of pollution from Ships, 1973, as modified by the Protocol of 1978 relating thereto. IMO Publication, London

UK P&I Club (2005) The human factor: a report on manning

Parsons K (1997) Preparing a company training strategy and assessing its effectiveness, maritime education and training—a practical guide, section IV, chapter 25. The Nautical Institute in conjunction with World Maritime University, London, p 183

BIMCO Report (2006) BIMCO study of recent cases involving the international practice of using criminal sanctions towards seafarers, 10 Mar 2006 (adopted by BIMCO Board of Directors on 2 Mar 2006, Rev. 10 Mar 2006) and the presentation of the study at IMO/ILO ad hoc Expert Working Group 14 Mar 2006

GESAMP Report (2007) (IMO/FAO/UNESCO-IOC/UNIDO/WMO/IAEA/UN/UNEP Joint Group of Experts on the Scientific Aspects of Environmental Protection) Estimates of oil entering the marine environment from sea-based activities. Rep Stud GESAMP No.75. Pp. 96

Sekaran U (1992) Research methods for business. John Wiley & Sons Inc, New York, p 253

STCW (2001) International convention on standards of training, certification and watch-keeping for seafarers, 1978, as amended in 1995 and 1997 (STCW Convention) and Seafarer's Training, Certification and Watchkeeping Code (STCW Code). IMO Publication, London