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The Significance of Accidents Onboard Ships by Human Elements

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Abstract: ***Safety, and health is a dynamic component need to be practiced in daily actions. The purpose of this research is to analyze the seafarer's insight of the human element factors such as Fatigue, Attitude of Seafarers, Workplace Culture and Technical and Internal Factor contributes to the accidents while on board. The objectives of this research are to determine the main human element factor that leads to the accidents onboard and to analyze the perception of seafarers toward human element factor that contributes to accident on-board. A quantitative questionnaire survey was conducted to 300 respondents among the Malaysian seafarers which covered two sections. The Section A was for respondents' demographic and the Section B for the accident on a board's background. The collected data was analyzed using SPSS of Descriptive Analysis for mean and percentage, Multiple Correlations and Multiple Reliability Test. The results showed that the seafarer's perception indicated as the main human element factor leads to an accidents onboard. The total variation of the dependent variable on the accident on-board is explained by the independent variable at 14.8%. Some recommendations are pointed out in minimizing the accidents onboard ship among the seafarers such as Refreshing Team Culture Training, Safety Weakness Monitoring and Psych Technique Test Administration.***

Keywords: ***Human Elements, Accidents Onboard Ship, Shipping Activities, Safety, Seafarers.***

I. INTRODUCTION

The growing of worldwide trade and economics is reliant on shipping facilities. The shipping is a massively worldwide and varied trade which has directed to an extensive disparity in the engagement market of seafarers which has becoming international. Safety and health is an energetic fragment to be measured in all regular procedures whether at home, office, workshops, construction sites, sea, air, and other places. Employees who are unconscious of the safety and health fundamentals simply bestow to an accident. The accidents regularly encompass employees who are employed in varied workplaces.

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The term of the human element or human factor plays a decisive role especially in maritime safety (Berg, N., Storgård, J., & Lappalainen, J., 2013). This research was carried out among the employees who are working at a cargo ship under the Malaysia flag registration.

It is a responsibility among the shipping companies to preserve all seafarers and goods while onboard with succeeding the safety and security standard. The research objectives are as follows: a) to determine the main factor of the human element which leads to an accident on board and b) to analyze the perception of seafarers toward human element factors that contribute to an accident onboard. From the finding of this research, it could assist the relevant parties in recognizing an appropriate components for better safety among the seafarers and ships, assists management to consider and recognizing the main element and revising the problem directly, supports to provide a safer with a comfortable working environment onboard, add on additional benefits efficiently and decrease fatigue and improve morale among seafarers. The scope of the research was conducted among the onboard seafarers or has been on the onboard tanker, general cargo, and bulk carrier and container vessels. The research expounded certain seafarers from a cargo ship which is under the registration of the Malaysia flag and it was limited among Malaysian seafarers only. 300 respondents were participated in this research.

II. LITERATURE REVIEW

Shipping and Safety

Safety is contingent on the reliability of the technical and human elements of the ship system in the shipping activities. The value of enforced principles towards the promotion of safety policy in shipping is evaluated and emphasis. Mercantile shipping is alleged to be a profession with an excessive degree of mortal damages triggered by structural mishaps and seafaring catastrophes (Hansen, H. L., Nielsen, D., & Frydenberg, M. 2002). The safety and health philosophy have identified and eliminated job site hazards throughout the lifecycle of work and discouraged work practice which individual places are at risk of injury and the integration of safety and health with the daily working environment (Collins, A., Matthews, V., & McNamara, R., 2000).

The Related Safety Onboard Conventions

Ism Code (International Safety Management Code)

The ISM Code contains all shipping corporation operative certain forms of vessels to install security organization structures.

To explore human and managerial influences tousled in the fatalities and incidents, the Human Factor Analysis and Classification System (HFACS) is functional to code the identical statistics. The relative weight of casualties and incidents is reflected to deliberate the consequences of the ISM Code and HFACS assessments (Batalden, B. M., & Sydnes, A. K., 2014).

SOLAS (Safety of Life at Sea)

An International Convention has set a least safety standard for the operation of the merchant's vessels including construction, and equipment. SOLAS 1974 which came into force on 25 May 1980. March 2016 (SOLAS, 2004). Its objective is to establish the minimum standards for the equipment, operation, and construction of the vessel and is compatible with safety (Churchill, R., 2016). 90% of all impermanence cases were created by the particular mishaps on board ship. A higher primacy should be prearranged on the anticipation of personal accidents (Li, K. X., & Wenham, J., 2001).

STCW (Standards of Training, Certification, and Watchkeeping)

It is a recognized convention for Standards of Training, Certification and Watchkeeping for Seafarers (STCW) which was implemented on 7 July 1978 and came into legal on 28 April 1984 (IMO, 2004). The main purpose is to sanction the fortification of lifetime and stuff at sea and fortification of the marine setting, by crafting an agreement international principle of preparation, certification and watchkeeping for seafarers. By engaging in a prominence on quality control and competency training as a set a standard baseline for seafarers training and education through the world it assisted to establish a standard structure (Ali, A., 2006), (Kandemir, C., Soner, O., & Celik, M.,2018). The human error was the cause of utmost maritime fatalities as anxious by STCW, which might be prevented by concentrating directly on the capability of the individuals for ship operations (Young, C., 1995).

Effects of Fatigue on Seafarers

An exhausted effect on alertness among seafarers has donated from fatigue as the seafarer always strives to discover an easy technique to the determination of serious situations and positions less effort to complete tasks afterward leading to wrong decisions made. The apathy rank and reduction of inspiration at work and effect towards seafarer's poor performance at work is inspired by fatigue (Xhelilaj, E., & Lapa, K., 2010). The seafarers who reported high psychological demands and perceived the organizational-level safety climate negatively were significantly more mental fatigue, physical fatigue, and lack of energy. The aspects of the psychosocial work environment and safety climate are vibrant to be considered and potential impact on fatigue and safety in the maritime organizations amongst seafarers (Hystad, S. W., Saus, E. R., Sætrevik, B., & Eid, J., 2013).

Attitude of Seafarers

The attitude of seafarers are as follows: *Self-awareness*: has contained emotive self-awareness, accurate self-assessment and self –confidence, *Self-management*: covered self-control, honesty, conscientiousness, adaptability, accomplishment alignment and initiative, *Other awareness*: has encompassed compassion, administrative consciousness and facility alignment and *Social skills:* included teamwork and association, emerging others, effect, communication leadership, and conflict management (Goleman, D.,1998). The magnitudes such as control expanse, indecision escaping, collectivism, and long-term alignment had an expressively constructive effect on safety behavior. The safety attitude and safety behavior of seafarers has unconditionally inclined by the transformational leadership (Lu, C. S., Hsu, C. N., & Lee, C. H., 2016).

Workplace culture

Culture is defined as ideas, customs and social behavior of precise people or society (Oxford dictionary, 2012). An overall feature of crews in the present ship operations was multiculturalism and has covered 70-80 % crew of the world's mercantile armada (Hanzu-Pazara, R., Arsenie, P., & Hanzu-Pazara, L. 2010). The multiculturalism forces on board with an absenteeism of a mutual language or cultural discrepancy could consequence in a high risk of work setting on ships. The confusions and result in mishaps was lead by the changes in language among the international crew (Lu, C. S., Lai, K. H., Lun, Y. V., & Cheng, T. C. E., 2012). It is significant to recognize culture and safety culture within ship crew as it has influence maritime safety (Håvold, J. I., & Oltedal, H. A., 2018). The national culture has a substantial reputation in explaining the occurrence of human errors on ships, and it has been highlighted that the national culture dimension was related to human failures in ship operations (Lu et al, 2012).

Technical and Internal Factor

The technical faults and lack of appropriate maintenance could origin an accident. The result of an inappropriate maintenance lead to several consequences (Reason, J., & Hobbs, A., 2017). The cause of the incidents of cruise ship mishaps and disasters was as from an unfortunate maintenance in a long plan leads to defective equipment such as pipes or incidents appeared cracks (Hobbs, A., & Williamson, A., 2003). The absence of accuracy in ship design, ship maintenance, and relinquishment subsequent in harm to parts of the vessel caused the vessel to crash, burning the ship (Mileski, J. P., Wang, G., & Beacham IV, L. L., 2014). The other internal factor comprised a psychological or mental illnesses of seafarers, loneliness, short ship reversal times, absence of shore leave, parting from spouses and families, job withholding, and extensive working hours (Iverson, G. L., & Lange, R. T., 2011), (Iversen, R. T., 2012). Most of the accidents cases were due to human errors, deprived crew competence, absence of communication, non-existence of appropriate preservation, privation of application of safety or other measures, insufficient exercise and deprived discovery of the condition (Psaraftis, H. N., et al, 1998), (Hollnagel, E. ,2016), (Antao, P., & Soares, C. G., 2008), (Kim, D. J., & Kwak, S. Y., 2011),

(Corovic, B. M., & Djurovic, P., 2013), Weng, J., & Li, G.,2019).

III. METHODOLOGY

Questionnaire Survey

A quantitative method of a questionnaire survey was applied in this research. This research used a cross-sectional survey involved the process of collecting data at one point in time and based on close-ended questions. The Likert Scale of 5 points questionnaire was used as an instrument to be accomplished by the respondents. Figure 1 shown the Likert Scale of 1 strongly disagrees and point 5 indicated strongly agreed.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1	2	3	4	5

Fig. 1 Likert Scale

The following sections of the questionnaires comprised of: *Section A:* Consists of personal detail of respondents, which embrace gender, age, department and working experience. *Section B:* Concentrate on seafarer's obligation and participation of safety on-board. The distribution of the questionnaires consumed two months for the data gathering amongst the Malaysian seafarers.

Population, Samples and Respondents

These research emphases on the seafarers who have occupied experienced or still working on-board cargo ships as a population. The sample size refers to the number of subjects in a sample population (Sekaran, U., & Bougie, R., 2016). 300 respondents have contributed as the respondents from different port in the Peninsular Malaysia which covered Lumut Port, Port Klang, Penang Port and Port of Tanjung Pelepas.

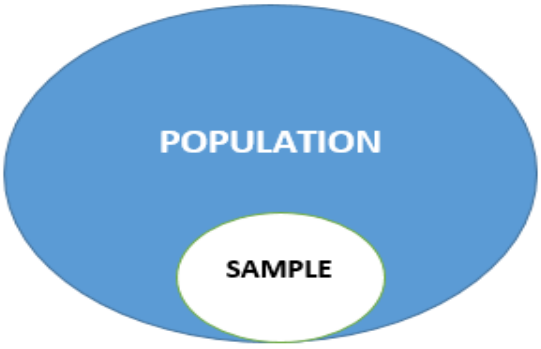

Fig. 2 Population and sample

IV. ANALYSING DATA

The collected data were analyzed by using Statistical package for Social Science (SPSS) version 25 analysis by using Descriptive Statistics, Reliability Test of Cronbach's Alpha, Multiple Correlations and Multiple Regression.

Descriptive Statistics

The descriptive statistics were applied for percentage and frequency to define and elaborate on the data attained from the respondents.

Table. 1 Level of Agreement and Mean Range

Mean Range	Level of Agreement
1.00-2.33	Low
2.34-3.67	Medium
3.68-5.00	High

Reliability Test (Cronbach's Alpha)

Reliability test was used to extend the stability of the instrument in fabricating good data by using the value of Cronbach's Alpha (George, D., & Mallery, P., 2010). If the Cronbach's alpha values are above 0.7, the items are reliable. The Cronbach's Alpha coefficient arrays between 0-1. The closer the Cronbach's Alpha coefficient to 1, the superior the internal uniformity of the items in the scale (Tavakol, M., & Dennick, R., 2011). Table III demonstrates the Cronbach Alpha value range.

Table. 2 Cronbach's Alpha Value Range

Cronbach's Alpha Value	Description
More than 0.9	Excellent
0.8	Good
0.7	Acceptable
0.6	Quotable
0.5	Poor
Less than 0.5	Unacceptable

Pilot Test

A pilot test was steered to verify the validity of the questionnaire, time replying to the questions, shared understanding and clarification of the questions. A face to face interview was applied among 20 respondents which comprised of 4 females and 16 males as shown in Table III. The majority of the respondents were male as it's a common condition in the engineering profession has been conquered by the male.

Table. 3 Descriptive statistics

Gender	Pilot Test
Male	16
Female	4
Total	20

Respondents

300 respondents were participated in this research. The respondents were among the seafarers onboard or have been on the onboard tanker, general cargo, and bulk carrier and container vessels. The research tangled among the seafarers from a cargo ship of the Malaysia flag.

Respondents Demographic

Table IV shows the demographic of 300 respondents on several contextual such as gender, age, working experiences, rank, education, types of previous vessels attached.

Gender: 240 respondents (80%) were male and 60 (20%) were female. Majority of the respondents were male and it's a common situation in the engineering profession dominated by male. Age: The highest respondent's age range was between 25 to

30 years old which was 76%, while the lowest was at 10% responded by 31 years old and above respondents. The rate of 14% was the second-highest respondents between 20 to 24 years old. It is shown that every respondent has their own experiences and dissimilar discerning from various age categories. Working experiences: The highest was within a range of 1 year to 5 years are 166 (55%) respondents. The respondents with 6 - 10 years working experiences with 93 respondents or 31%. Below 1-year working experience is 27 or 9% and 14 respondents or 15% had working experienced more than 11 years and it has created a huge impact on this study. Different levels of practices produce different types of perspective and information. Respondents rank: Majority of 224 respondents or 74% were at the rating, Secondly; at 25% was rank as an officer. Education Level: 217 respondent with a qualification in Diploma was the highest which 217 or 72%. 62 respondents or 21% with Sijil Pelajaran Malaysia (SPM). 21 respondents or 7% had Degree. Types of a vessel: 101 respondents or 34% were attached to Tanker vessel. 88 respondents or 29% attached to General Cargo, 66 at Bulk Carrier or 22% and 45 respondents at Container Vessel or 15%.

Table. 4 Descriptive statistics frequency

Background Respondent	Items	Frequency	Percent
Gender	**Male**	**240**	**80.0**
	Female	60	20.0
Age	20 – 24 years old	42	14.0
	25 – 30 years old	**229**	**76.3**
	31 and above	29	9.7
Working Experience	Below 1 year	27	9.0
	1 – 5 years	**166**	**55.3**
	6 – 10 years	93	31.0
	11 and above	14	4.7
Rank	Officer	76	25.3
	Rating	**224**	**74.7**
Education	SPM	62	20.7
	Diploma	**217**	**72.3**
	Degree	21	7.0
Type of vessels attached	Bulk Carrier	66	22.0
	Tanker	**101**	**33.7**
	General Cargo	88	29.3
	Container Vessel	45	15.0

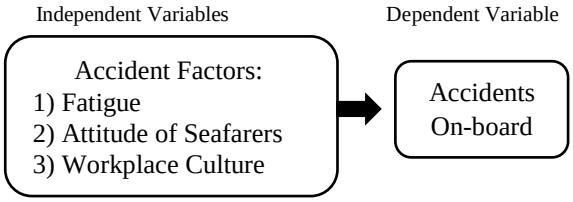

Fig 2. Correlation theoretical framework

Section B: Accidents Background

In Section B, the respondents were invited to rate the frequency of the accidents. The data were congregated and examined using the Reliability Test, Normality Test, Multiple Correlation Analysis and Multiple Regressions analysis from SPSS.

Reliability Test Cronbach's Alpha

The reliability of the data using Cronbach's Alpha was tested to quantify the consistency and accuracy of the answer to the question. The result of the reliability test of Section B is shown as follows:

Table. 5 Reliability of Case Processing Summary

Reliability Statics	
Cronbach's Alpha	**N of Items**
.905	29

Table. 6 Summaries of Reliability Statistics

		N	Percent (%)
Cases	Valid	300	100.0
	Excluded[a]	0	.0
	Total	300	100.0

Table V exemplified the value for Cronbach alpha for Section B as an Acceptable at the Alpha value of 0.905. The values have indicated that the data was reliable to be analyzed. The Cronbach's Alpha coefficient arrays between 0-1 and the closer the Cronbach's Alpha coefficient to 1 as the greater the internal consistency of the items in the scale (Tavakol, 2011).

Normality Test

The normality test was conducted during performing a statistical progression in order to accomplish a sample or any group of data matches the standard of the normal circulation (Yap, B. W., & Sim, C. H., 2011). It has presented the normality test for the Independent Variables was higher valued at 0.540 and the significant value is at 0.000. The Independent Variables element was normal as it was above 0.05.

Correlation Analysis

Correlation analysis is a technique precisely used for examining the relationship between two quantitative and continuous variables. The correlation analysis provides an assessment concerning the association between two measurements variables. Pearson's correlation coefficient (r) is a strong dimension of the association between the two variables. The degree and the direction of such relationships of both variables can be determined by correlation analysis (Puth, M. T., Neuhäuser, M., & Ruxton, G. D., 2014).

Correlation Coefficient Interpretation Guideline Rule of thumb

- $0.0 = |r|$: no correlation
- $0.0 < |r| < 0.2$: very weak correlation
- $0.2 \leq |r| < 0.4$: weak correlation
- $0.4 \leq |r| < 0.6$: moderately strong correlation
- $0.6 \leq |r| \leq 0.8$: strong correlation
- $0.8 \leq |r| < 1.0$: very strong correlation
- $1.0 = |r|$: perfect correlation

Fig. 3 Correlation Coefficient Guideline: (Montgomery, D. C., & Runger, G. C., 2014)

Figure 3 presented the range of value for the correlation coefficient strength in order to determine the relationship value strength of the variables. The correlation value that is near to the value of 1.0 has a strong significant relationship between the variables. It shows that the correlation value that is close to 0 or -1 has a relationship among the variables but a negative relationship correlation coefficient significant in which the relationship between variables is weak.

Correlation Analysis between Accident Factors and Accident Onboard

Table. 7 Correlations between Accident Factors and Accident On-board

Correlations			
		Accident Factors	**Accident On-board**
Accident Factors	Pearson Correlation	1	**.893****
	Sig. (2-tailed)		.000
	N	50	50
Accident Onboard	Pearson Correlation	**.893****	1
	Sig. (2-tailed)	.000	
	N	300	300

**Correlation is significant at the 0.01 level (2-tailed).

Table VII showed the Pearson correlation coefficient between accident factors and accident on-board is at 0.893 which designates that the value of correlation is positive. The relationship between Accident factors and accident on-board is strong r=0.893 (Montgomery, D. C., & Runger, G. C., 2014). The consequence of the correlation analysis has proved that the accident factors and accident on-board are influenced by steps and provision measurements (Puth, M. T., Neuhäuser, M., & Ruxton, G. D., 2014). The two variables Independent Variables (IV) and the Dependent Variable (DV) have a strong relationship because the independent variable of the accident factors and the dependent variable as the accident on-board is closely related and requires a corresponding relationship.

Multi Regression

The overall fit of variance enlightened of the model and the relative influence of each of the predictors to the total variance explained is permitted by the usage of a multi-regression. Table VIII shows the result of the regression model that standardized coefficients. B indicates how much the dependent variable varies with the independent variables when all other independent variables are held constant at 5.209. The result impacts the value of the dependent variable. The multiple regressions are analyzed to predict the rate of accidents triggered by fatigue, the attitude of seafarers, workplace culture and technical and internal factors. These elements statistically and expressively predicted the rate of accidents onboard Adj R^2=14.8%. All these three variables added statistically and significantly to the prediction $p < 0.05$.

Table. 8 Dependent variable Accidents On-board

Model		Standardized Coefficients			
		B	**Beta**	**t (value)**	**Sig.**
Adjusted R Square				.148	
F				14.939	.000
Constant		5.209			
1	Fatigue	.278	.1.98	3.525	.000
2	Attitude of Seafarers	0.22	.011	.192	.848
3	Workplace Culture	.202	.090	1.651	.100
4	Technical and Internal Factors	.365	.386	6.730	.000

V. DISCUSSION, RECOMMENDATION, AND CONCLUSION

Discussion

Objective 1: To determine the main factor of the human element that leads to accident on-board.

The four main elements such as *Fatigue, Attitude of Seafarers, Workplace Culture and Technical and Internal Factors* have been analyzed. Firstly, *Fatigue*: showed that this factor was donated to the accidents at 3.525 values. STCW has amended in 2010 to cope with the issue of human fatigue by reducing the working hour and upsurge the rest hour of the seafarers and has revealed the decrease of fatigue rate amongst the seafarers but, the accidents still happened on-board. Secondly, *Attitude of Seafarers:* specified that this dimension was the least significant factor at 0.192 caused an accident on-board. Most of the seafarers stated by using an enough and proper of the Personal Protective Equipment (PPE) help in the cumulative percentage of accidents on-board. Thirdly, *Workplace Culture:* this mixture seems to be a big encounter to the top management in order to lessen the accident frequency on board of the significant factor at 1.651. Even if the rule is well developed, the question remains whether these rules are properly enforced and complied by the seafarers. Racist occurred on board and leads to the stress among the seafarers and exaggerated their emotional and physical stress which leads to an onboard accident. It has shown that all the seafarers could express and comprehend English but the accents or slang could cause misunderstanding of instruction which leads to an accident. The slang or accents and the noise could lead to misunderstanding of command and communication which triggered an accident on boards. Finally, *Technical and Internal factors:* it showed that this factor was the factor donated to the accident rates at 6.730 values. By having all the vessels in a good condition such as the machinery and air conditioning, the light inside the vessels are bright enough and this could lessen the accidents to happen on-board. Some of the respondents were exposed to heat, dust or solvents.

Objective 2: To analyze the perception of seafarers toward human element factor that contributes to accident on-board

This objective was attained by using the descriptive analysis in representative the seafarer's perception of the human element factor that donated to the accident on-board by calculating the mean and rank it in ascending order. The lowest mean indicated the least factor and the highest mean indicated the most perception of the accidents factor. Most of the seafarers have experienced an accident while on-board, particularly through the night shift, was at mean = 4.200. Meanwhile, the accident during the day shift was at Mean = 3.670.

Recommendation

The recommendations are as follows:

Refreshing Team Culture Training: Positions out as the highest-precedence approach to evade the repetition of such an accident. The inspiring team culture training of seafarers is believed to be one approach to be executed pre-requisitely. Via stimulating safety philosophy on the vessel, it is proposed to improve seafarer's consciousness on the matter of safety. Additionally, via execution risk assessment and organization drill, it is projected to provision the seafarers in the judgment-creation phase.

Safety Weakness Monitoring: The alternative substantial tactic is to monitor occasionally and to form the safety responsibilities and extent they performed modifications via paying regular engagements to the vessel. This method distributes a chance for the company to converse seafarers about safety matters while on-board.

Psych Technique Test Administering: Dealing a psych procedure test to quantity insight skills of the seafarers and electing workplace employees from folks through nautical engagement to endorse initial encounter of existing dangers and defensive intercession.

This could sustenance the company to distinguish the weakness of certain seafarers and the company can organize appropriate training among the seafarers.

Cross Checking before Doing Job: To condense the accidents, the workers essential to upsurge their alertness of this risk by cross-checking previous job done. By making good ventilation at the workplace is desirable particularly in the closed zone such as connecting exhaust fan blower. Lastly, an instant declaration for the hazardous conditions arose at the workplace necessity is conveyed to supervisors correspondingly and instantly.

Hang More Warning Signs: The seafarers must hang on additional warning signs such as danger-keep off and lockout tag out (LOTO) while accomplishment every task at the workplace so that all the employees can realize the signboard obviously and the employees are conscious and might bear in mind about safety consciousness.

VI. CONCLUSION

The safety level is substantial to sustain a moral reputation for the company. The STCW has been amended in 2010 to cope with the issue of human fatigue by dropping the working hour and upsurge the rest hour of the seafarer nonetheless the accident still happens on-board. The technical and internal factor of the seafarers was occupied as the main contributed factor caused accidents on-board. However, a main anxiety from the employer is desirable to minimize the risk and work-related accidents as well as to hold a decent rank of the company by discomforting hazardous occurrence and injury while on-board. In contract with IMO requirements, all maritime incidences and accidents should to be completely supported in a timely routine and should to be analyzed on an appropriate origin in order to prevent a recurrence and all this progression must remain performed therefore to the shipping corporations' dealings. Nevertheless, the maritime companies exercise assorted approaches on ship accident spirit basis analysis and there is no ordinary practice applied in the maritime domain.

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