

The Analysis of Occupational Health and Safety of The Ship's Crew on Board in The Enclosed Spaces

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Abstract

The research on enclosed spaces is used to identify the work accidents, availability of the Occupational Health and Safety (OHS) equipment as well as the suitability of SOPs used by the Officer to handle the occupational accidents on board. The methodology used to identify the occupational accident in enclosed spaces were quantitative analysis based on some primary data (primary analysis) and secondary data (secondary analysis), by which the author performed the direct observations, interviewed the respondents who experience the accidents and did the literature study. The results confirmed that the enclosed spaces is not used for the activities or daily work by the ship's crew since the rooms have no ventilation, thus the air inhaled is less than 21% by volume and the concentration of hydrocarbon gas is less than 1% of the LFL (Limite Flammable Lower) than the levels of other toxic gases. Based on the interview results of 175 respondents, 93% said the accident was caused by the negligence of the supervision or personal responsibility, 21% said that it was caused by the absence of carbon gas test since there were no tools for detecting the toxic gas (gas detector) and 78% claimed that they understand that the occupational accidents happened in enclosed spaces due to the negligence and procedural error (SOP). Therefore, it can be said that the limitations of knowledge and understanding of the crew, granting permits (work permit) by Officers which was not appropriate, the availability of supporting equipment and the inadequate involvement of shipping companies, the SOP that are not well socialized and the improper handling of accident victims were the causes of the work accidents on board.

Keywords: OHS, SOP, Enclosed Spaces

1. Introduction

Since the ship is a mean of goods and humans transportation, it should meet the standards of safety which refers to the regulation of SOLAS (*Safety of Life at Sea*) 1974 consolidated edition 2014 and ensure occupational health for all the ship's crew [4]. The application of the occupational health and safety (OHS) regulation is expected to optimize the work or the activities on the board, that the crew can work under the safe, healthy, and comfortable condition. Occupational Health and Safety is the fundamental demand of workers since it is closely related to their well beings. [3]. Working in enclosed spaces put a risk to the health and safety of the seafarer on board since the spaces provide some sources of danger from chemicals containing toxic, and flammable substances (gas, steam, smoke, dust and others) and other physical risks arising such as noise, wet/slippery surfaces and the fall of a hard object resulting in the death of sailors in working on board.

Working in a confined space certainly poses a risk to safety and health for sailors on board, considering that limited space contains several sources of danger from chemicals that contain toxins, and flammable substances. In addition there are other dangers in the form of oxygen deficiency or preferably excessive oxygen levels, extreme temperatures, trapped or engulfed (engulfment), as well as other physical risks that arise such as noise, wet / slippery surfaces and falling hard objects in the room. limited which resulted in work accidents resulting in the death of sailors who worked on the ship.

Table 1.1. Fakta Kecelakaan Kerja di Ruang Tertutup

No	Name of Ship	Actual Accident	Date Accident	Location Accident	Remaks
1.	MT Victoria 11	1 person	14 Jan 2019	Fuel tank	Cleaning tank ballast
2.	MT Paluh Tabuan	2 persons	30 Des 2019	Fuel tank	Cleaning tank ballast
3.	TB Aditya 55	4 persons	19 April 2019	Barge	Check for Tank Barge
4.	MT Nusantara Akbar	1 persons	14 Feb 2016	Fresh water tank	Cleaning hatch
5.	TB Alpine Marine 12	3 persons		Fresh water tank	Cleaning Tank Fresh water

Data Processing, 2020.

The potential hazards can cause occupational accidents because the physical and chemical condition cannot be identified clearly in the enclosed spaces, while the standard operating procedures and the availability of facilities used in working were not appropriate. Based on the description of facts of occupational accident in enclosed spaces that the risks resulting in accidents and even loss of lives of the crew on board, the researcher formulated notions, (1) that causing the accident on the crew in an enclosed space in the fuel tanks and fresh water tanks, (2) actions in handling work accident have met the providing procedures, (3) Standard Operating Procedures, regarding entering an enclosed space have met the occupational health and safety criteria. The purpose of this study are to identify the problem on occupational accidents, availability of safety and medical equipment as well as the suitability of the SOP used for the prevention of occupational accidents by the Officers on board in enclosed spaces.

2. Literature Review

According to the OHSAS (Occupational Health and Safety Assessment Series) 18001, 1999. in Shariff, 2007. Occupational accident is a sudden incident which is not desirable resulting in death, injuries, property damage or loss of time. Work accident is an accident that occurs on someone related to working and most likely caused by the danger in relation to workers and working duration. Supporting the implementation of occupational health and safety by performing the procedure that requires the organization consistently identify and control risks to health and safety in the workplace as well as improve the performance and company image. Work in enclosed/confined spaces is risked by potential hazard. Thus it needs the application of Occupational Safety and Health (OHS) program to ensure the safety and health for seafarers on board. *Confined Space*, according to Ir. Amri AK, is the room that has the following characters, the room construction only sufficient for a person to enter and perform work in it, in and out access

is limited and not designed as working space and to work continuously in it, because this room does not have continuous ventilation that the air in these spaces is harmful to the human due to the presence of *hydrocarbon* gas, toxic gas, as well as the lack of oxygen levels in it [2]. The procedure of entering an enclosed room is testing the quality of the atmosphere, by making sure the necessary oxygen level required is 21%, and ventilation equipment operates correctly. Have standard operating procedures and the availability of adequate infrastructure on the ship.

3. Research Method

Based on the formulation of the problem then the researcher used the quantitative research by using the *primary data* collection methods, direct observations of on board condition by witnessing the enclosed space on the ship, the process of entering an enclosed spaces based on the SOP, interviews 175 crews that have sailing experience, the vessel's situation and condition. Then *secondary analysis* was used by taking some of the ship's documents on board that was the SOP of entering the enclosed spaces, the checklist entering the enclosed space, documentation of entering the enclosed space/the readiness of equipments of entering the enclosed space, licensing documents of entering the enclosed space, the *checklist safety equipment*. From 175 respondents, the researcher selected 25 respondents and then 5 respondents to explore and get more in-depth interview results.

Table 1.2. The List of Questions

Name	:
Age	:
Position	:
Name of the Vessel	:
Questions	
1. Do you understand the enclosed spaces on the vessel?	
2. Do you know the requirements for working in an enclosed space on the vessel?	
3. Do you ever see the working procedure in an enclosed space on the vessel?	
4. Do you ever see and fill out the form of licensing of entering in an enclosed space on the vessel where you work?	
5. Do you ever do the procedure of health examination and testing of the gas atmosphere in an enclosed space on board?	
6. Do you ever do training and rescue team in entering an enclosed space on the vessel?	
7. Does your the ship have the team of rescue and emergency response when working on progress in an enclosed space?	
8. Do you have safety equipment in an enclosed space on the vessel?	
9. Do you ever do an upgrade the work safety tools and are they in accordance with the number of CREW in an enclosed space on the vessel?	
10. Do you ever follow a training work in an enclosed space on the vessel?	

Processed Data, 2020.

3.1. The data obtained then analyzed by the descriptive statistics that serve to describe the object to be examined through the sample or population data as is, without doing analysis and making general conclusions. Activity in an enclosed space already caused many deaths due to those conditions. An enclosed space on the ship such as, cargo spaces, double bottoms, fuel tanks, *ballast tanks*, *cargo pump-rooms*, *cargo compressor rooms*, *cofferdams*, *chain lockers*, *void spaces*, *duct keels*, *inter-barrier spaces*, *boilers*, *engine crankcases*, *engine scavenge air receivers*, *sewage tanks*, and the room next to or connected with the enclosed space mentioned. Some of the things

that must be considered to enter the enclosed space for the security and safety on board, as follows:

- 3.1.1. All door or *hatch cover* in the enclosed space should be close if it is not required or do other activities for the entering of a person or crew into it.
- 3.1.2. If an enclosed room is entered or doing work activities, then all the doors or *hatch cover* should be in open as a vent and must be in the guard or in pairs barrier in order to remain open.
- 3.1.3. All the supplies will be used in an enclosed space should be in *good working condition* and be checked before the room is used.

Every crew who will enter the enclosed room has to get permission to enter the room (*permit work*) from the Capten or the Officer or the *responsible person* in the form of *entry permit* and has implemented security procedures on board. The Capten and the Officer or the *responsible person* in determining that an enclosed room is safe to enter should consider several things, namely :

- 3.2.1. Potential accidents or hazards have been identified in the *assessment* and declared safe
- 3.2.2. The room ventilation should be adequate to remove toxic or flammable gases and to ensure levels of Oxygen in the enclosed room is sufficient for the number of crews that will enter the room.
- 3.2.3. The atmosphere of the room should be undergone the testing in advance with the tools that have been calibrated to ensure the oxygen level and the combustibile gas level or toxins can be accepted or inhaled by the crew at the time of work activities in an enclosed room.
- 3.2.4. The enclosed room must be secured for the entry of a person or the crew and has been equipped with the lighting.
- 3.2.5. All parties concerned should use the tools of communication according to the provisions and distance covered by the tools of such communication.
- 3.2.6. *An attendant* is instructed to stand guard at the entrance to the room closed as long as there are people or crew that entered it.
- 3.2.7. *Rescue and resuscitation* equipment (First aid box to resuscitate the victim who suffered injuries) have been positioned near the entrance in the *standby* condition for use and *rescue arrangement* has been approved.
- 3.2.8. Safety equipment and appropriate work uniform of the crew as well as the appropriate *safety equipment* has been used for related work in an enclosed room.
- 3.2.9. Having and approving the permit that has been given to the crew in the form of *entry permit* that has been acknowledged and signed by the person in charge (Officer on board).

In entering the enclosed space, the Officer responsible must make sure the oxygen levels are not passed by 21% by volume and the concentration of *hydrocarbon gas* is not more than 1% of the LFL (*Limite Flamble Lower*) than the levels of other toxic gases. *Life lines* and *harnesses* that exist around the tank and is ready for use, while the *breathing apparatus* and a respirator equipment should be ready for use. The use of the tools of test atmosphere should be approved by the classification society and must be preserved, then calibrated with the standards specified, (for Example N2 to the calibration of the O2 Analyzer and Butane 50% for the calibration of *Combustible Detector*). The results of the maintenance, as well as the results of the calibration, should be recorded in a certain period, the one doing the calibration should be the people who are trained and have the ability to

use such tools. The concentration of gas allowable are the *hydrocarbons gas* 1% < LFC %, *Benzene gas*, *Hydrogen Sulphine* and other toxic gases, Oxygen 21% by volume.

3.2. On July 20, 2020, the researcher and the team conducting the initial data collection through interviews on the crew who still work on the ship and on the crew that have the leave and continuing their education. Researchers identify 175 respondents that being the sample in this study.

Table 4.1. List of the Respondent in the Interview

NO	NAME	VESSEL	PHONE NUMBER	NOTES:
1	Andi Fauzan Ichdar	MV Andhika Kanishka	081355708715	Have
2	Rinno Reeflito M	KM Caraka Jaya III	081272504496	Have
3	Muhammad Ridwan	MV CTP Bravo	085386358368	Have
4	La Ulu	TB Buana Harbour 3210	081251416098	Have
5	Sofyan Rachim	KM Hellepont Daring	081294368913	Have
6	Iskandar Joni	MT Harmoni Selatan	085393910939	Experience
7	Yanmar	TB Bluefin 6		Have
8	Saul M.P	AHTS Over Corner	082153605834	Experience
9	Surya Angghi Saputra	TB KSA 53	082153605834	See
10	Yohanes Makkayu	MV Marina 32		Have
11	M Kamrang	SPOB Jambo V	081244794933	Experience
12	Muhammad Irfan	SPOB King Ocean		Have
13	Zainal Abidin	KM Budi Mulia 68		No
14	Zaifullah	TB Prime 4	085250966287	Have
15	Awaluddin	KM Express Bahari 98	08114875314	No
16	Kadirman	MV Ena Jade	085299209238	No
17	Nasrul	MV Linton 159	082352417231	No
18	Herianto	TB Farel 15	085295713327	Have
19	Robin Palipadang	MV AOS Energy		Have
20	Rudy Akbar	TB Masada27	08599197121	No
21	Sudarmin Baso	SPOB Ocean Mamuju	082188865331	Have
22	Ahmad Kadir	TB Capitol T2002	081342457576	Have
23	Supardi N	TB Marina 12	085298451603	No
24	Nopian Lando	TB Marina 20	081356251712	No
25	Rizaldi Razak	MV Masada 25	085240261304	No

From 175 respondents interviewed, researchers only take as many as 25 people who became the sample to ease the deep identification on in-depth interviews to get maximum results. From all the sample selected, there are 5 respondents that the researchers defined as the resource used in the technique of sampling according to Margono (2004), that is a way to determine the number of sample based on the size of the sample that will be used as the source of actual data, regarding the behaviour and the spread of the population in order to obtain a representative sample [5].

Table 4.2. The List of Questions in the Interview

NO	QUESTIONS.	NOTES:
1	Have you ever experienced or saw the accident on the ship regarding performing work on an enclosed space?	The Answer Descriptions are under the column of the Table 4.2
2	Do you understand that accidents in enclosed spaces on the ship due to the negligence of the crew and procedural error?	
3	In carrying out work in an enclosed space, do you implement the procedures in advance (for example testing the carbon gas in the tank)?	
4	Do all the death of the CREW on board in an enclosed space (fuel tank and tank fresh water) due to the negligence of supervision?	
5	If the procedure in entering the enclosed room has been filled correctly, why is there still the death of the CREW on board?	

Processed data, 2020

Based on the results of the interview on the 175 crews with the 5 material questions that researchers conclude from the indicators of the problem. Regarding the **first question (1)**, 90% of respondents said that the work activities in the enclosed room were never performed on the ship. Then 10% of them stated that they never did such activities. For the **second question (2)**, 78% of respondents said they understand that accident in enclosed spaces was due to the negligence and procedural error of the crew, while 15% of respondents said it was the negligence and only 7% of respondents said that it was due to the procedural error in the working process. For the **third question (3)**, 67% of respondents stated that the testing of carbon gas in the tank before carrying out the works in an enclosed room have been implemented according to the procedure, 21% of respondents said that they do not do testing of carbon gas because there is no toxic *gas detector* and only 11% of respondents said that they did not understand about the procedure. Regarding the **fourth question (4)**, 93% of respondents said the death of the crew in an enclosed room (for example fuel tank/freshwater tank/ballast tank) due to negligence in the supervision of the Officer or the *Responsible Personal*, and only 7% of respondents said the death because of the destiny of God. **For the fifth question (5)**, 57% of the respondents said the procedure of entering a closed room have been exercised correctly and follow the safety standards, but if there is still a death occurs in the room due to inhalation of toxic gas, 8% of respondents said that the death caused by fatigue of the crew and around 35% of respondents said that the death of the crew caused by the unfamiliarity on working procedure of entering a closed room on the vessel.

The researcher then collect more data through in-depth interview on five respondents who have experience personally and have seen the occupational accidents in the enclosed room above the ship, as follows :

Table 4.3. List of Respondents Who Experienced and Have Seen the Occupational Accident in the Enclosed Spaces.

NO	THE NAME OF THE RESPONDENT	VESSEL NAME & TYPE	POSITION	NOTES:
1	Joni Iskandar	MT Harmoni Selatan (Tanker)	C-Eng	Experience
2	Surya Anggi Saputra	TB KSA 53 (Tug Boat)	C-Eng	See
3	M Kamrang	SPOB Jambo V (Barge)	Master	See
4	Saul M.P	AHTS Over Corner (Supply)	Master	Experience
5	Andi Fauzan Y	MT ANDHIKA KANISHKA (Container)	C-OFF	See

Processed Data, 2020.

The first respondent interviewed by the researchers on 20 July 2020 at 4 p.m were the crews that have experience the occupational accident in an enclosed room, as follows:

3.3.1. **Mr Joni, Iskandar** as a Chief engineer or person in Charge in the *Engine Department*, this interview was conducted on 20 July 2020, at 10: 30 LT on MT Harmony South Vessel of PT Sinyun Karya Abadi (SKA). The MT Harmony South vessel is a tanker that loads the oil in the category of malicious payloads. In the quote of interview result between researchers and respondents, he said, "I have an occupational accident on board when vessel travelled from Gresik Port to Sorong Port, at the time when the *tank cleaning* was undergone in the enclosed room, the accident was caused by the negligence in the supervision of the Officer or Person in Charge (*the responsible person*) of the crew who do not follow safety standards and procedural error in entering the room." The negligence of Officers and crew in the form of the absence to fulfil the *check list* before entering a closed room and the lack of tools availability to measure the gas atmosphere in the container tank.

3.3.2. **Mr. Surya Anggi Saputra** as the Head of the Engine Room on board. TBA KSA 53 vessel owned by PT Kartika Samudra Adijaya (KSA) is the tug that does the *towing* (hold and drive) a barge, he said, "I have seen the occupational accidents on the ship where I worked that time, where the crew got orders from the Officers to perform checks on the ballast tank of the barge (*the Barge*) that was leaking with the 2° tilt angle and to ensure the presence of the leak then an enclosed room (*enclosed spaces*) or *ballast tank* checks was performed. The Helmsman at the moment who was still lacking sailing experience and had less understanding about the procedure of work in an enclosed room onboard, directly open *the main hold* (holes for people entering the spaces) and enter the tank without following the standard of operational safety. The helmsman died due to gas poisoning - he inhaled the toxic gases which exceeded the threshold of tolerance for 21% by volume and carbon gas exceeds 1 %. Based on the death of the crew in the official report of the incident, the Captain and Officers as the person in charge did not have any clear SOP as the guideline to perform work in an enclosed room and did not have the safety instrument (*gas detector, safety shoes, helmet, etc.*).

3.3.3. Based on observation and interview, the researcher identified that the occupational accident and the death of the crew in an enclosed room are caused by the situation that the activities carried out in an enclosed room is an *emergency situation* that should get fast corrective action in solving the worst and dangerous conditions onboard. However, regarding the activity in an enclosed room, which will be performed on the ship, the Officers and crew still have some limitations as follows :

- a. Permits for entering an enclosed room is not yet fully understood by the Officers or the *responsibility officer* because of the level of competence which reflects the knowledge and understanding
- b. The limited equipments that will be used by the crew in working in an enclosed space were greatly determined by the Shipping Company.
- c. SOP (standard operating procedure) in entering an enclosed room which is owned by each ship was not disseminated properly to the crew and the Shipping Company had no concern for these conditions.
- d. The involvement of the crew in working in an enclosed space which resulted in the accident as well as loss of the lives of the crew consists of a variety of factors, namely the supervision of Officers in performing the activities in an enclosed room is not done and can be said negligent (*Permit work* was not signed and the equipment was not appropriate). Knowledge about the toxic gases and the limits of tolerance to be inhaled in an enclosed room was not fully understood by the crew. Regarding the case of the death, which happened in an enclosed room onboard was happened to the crew that had sailing

duration or working duration onboard (sailing experience) less than 5 years, and this death frequently happened due to incompetence of the crew.

- e. The countermeasures when an accident occurs in a closed room onboard did not perform in accordance with the OHS (Occupational Health and Safety) especially when the crew was injured, e.g. broken bone, fall from a height and the inhalation of toxic gases.

4. Acknowledgement

There were many obstacles or challenge that the research team faced in collecting the data, as well as at the stage of processing data. However, by the help of various parties, this research report can be completed in timely manner. In this occasion, the research team would like to express highest appreciation to the Director of Politeknik Ilmu Pelayaran (PIP) Makassar, Capt. Sukirno, M.M.Tr.,M.Mar. , Head of Research Center Dr. Rukmini, ST.,MT. and the all crews who have become a respondent as well as the entire team of researchers who have contributed significantly in the completion of this research report.

5. Conclusion

An enclosed room which is the room on the ship which is not recommended for crew to do any daily activities or work, except on certain urgent conditions that need to be handled immediately. Based on the discussion and analysis result, the researcher can conclude the problem as follows;

1. Occupational accidents and the death of the crew that occur in an enclosed space in the vessel's tanks were caused by many factors, i.e. knowledge and the ability in understanding the dangers of working in an enclosed room, as well as operating procedures for work that is not disseminated appropriately by the Officer (*responsibility personal*) at the time of *sign on* and the absence of support from the shipping companies in meeting the *safety equipment* that will be used according to safety standard.
2. The measures in the handling of occupational accidents at work in an enclosed room have not been implemented according to the standard operating procedures, providing that there were still many accidents that occur onboard.
3. The Occupational Health and Safety (OHS) measure in entering the enclosed spaces has not meet the criteria yet.

6. Suggestions

1. The Captain and Officers as a *responsibility person* onboard are responsible in disseminating an enclosed room in detail (hazards posed) in regular basis and when having the crew's rotation.
2. The shipping company should provide support to the crew in providing the equipment as the provision to work in an enclosed room.
3. The crew must meet the conditions set forth in the SOP on the vessel.

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