

Review of Occupational Health and Safety in the World Maritime Industry faced with the Ship Repair Industry of the Republic of Indonesia at the National Shipyard

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Abstract – The development of Occupational Health and Safety is very rapid, especially in developed countries. The era of 1970 was a milestone in the history of Occupational Health and Safety marked by the concern of world organizations in the International Maritime Organization (IMO) forum, which was subsequently adopted by countries in the world to enforce their national laws.

This review of Occupational Health and Safety in the World Maritime Industry is intended to find out the achievements that have been carried out in developed countries to be applied to work in the Indonesian Maritime Industry so that workers in addition to getting Occupational Health and Safety can also enjoy the welfare of their work.

As an overview, the application of international regulations on Occupational Health and Safety in the maritime industry in Indonesia has not been able to protect workers, and this can be seen from the many reports of ship accidents that occur in the Indonesian Territory so that it is necessary to adjust the rules of Occupational Health and Safety rules that must be applied according to the culture. Culture in Indonesia

Keywords – Maritim, Occupational Health and Safety.

I. INTRODUCTION

Gunningham and Johnstone, 1999, there has been a development in occupational health and safety management for the maritime industry starting from the 1970s in developed countries.

Regulations in the maritime industry are an agreement at the International Maritime Organization Forum (IMO). Subsequently, before being ratified, a country can submit a proposal on regulations applied explicitly in their country for further debate to understand the regulations set internationally.

The problems of marine accidents that occur in the maritime industry in Indonesia show the gloomy conditions of occupational health and safety as demonstrated from the realist data reports from the national transportation safety committee, including:

1. KNKT Number.17.08.24.03 concerning Report on Investigation of the Accident of the Indonesian Srikandi Cruise with Maestro Diamond and Angel No.1 Suralaya Waters, Banten August 29, 2017
2. KNKT.19.01.02.03 concerning Marine Casualty Investigation Report Main Engine Failure of Ocean Princess (IMO 8601496) at Alor Island, East Nusa Tenggara Republic of Indonesia December 29 2018

3. NTSC. 18.11.35.03 concerning Reports on Investigation of the Submerged Multi Prima I Shipping Accident IMO 8824402 Kapoposang Waters Bali Mataram-NTT Republic of Indonesia November 22 2018
4. Number KNKT.19.06.14.03 concerning Reports of Investigation of a Fire Sailing Accident in the Mentari Selaras Engine Room in Waingapu Waters, the East Nusa Tenggara Republic of Indonesia, dated June 8, 2019.
5. KNKT.19.11.23.03 concerning Report on the Investigation of the Sailing Accident of the Burning Tanto Ceria Pavilion (IMO 8910328) West Shipping Route Surabaya, East Java Republic of Indonesia November 26, 2019

Research conducted by Roberts and Marlow (2005) has not shown that sophisticated equipment has not reduced the number of accidents and occupational deaths are not significant.

The discrepancy between existing regulations and the occurrence of sea transport accidents in Indonesia is the focus of discussion in this article

II. LITERATURE REVIEW

Factors related to Occupational Health and Safety (K3) that should receive attention are:

A. Planned Monitoring and Scheduling.

To increase productivity and ensure workers' quality of life, efforts are needed to carry out planned supervision to maximize occupational health and safety.

The planned supervision model that is very practical to implement is the supervision program with the help of the General Algebraic Modeling System (GAMS) program so that it gets optimal results in the planned monitoring and scheduling process by considering other indicators when providing solutions in the final report on the implementation of supervision. Show in fig 1.

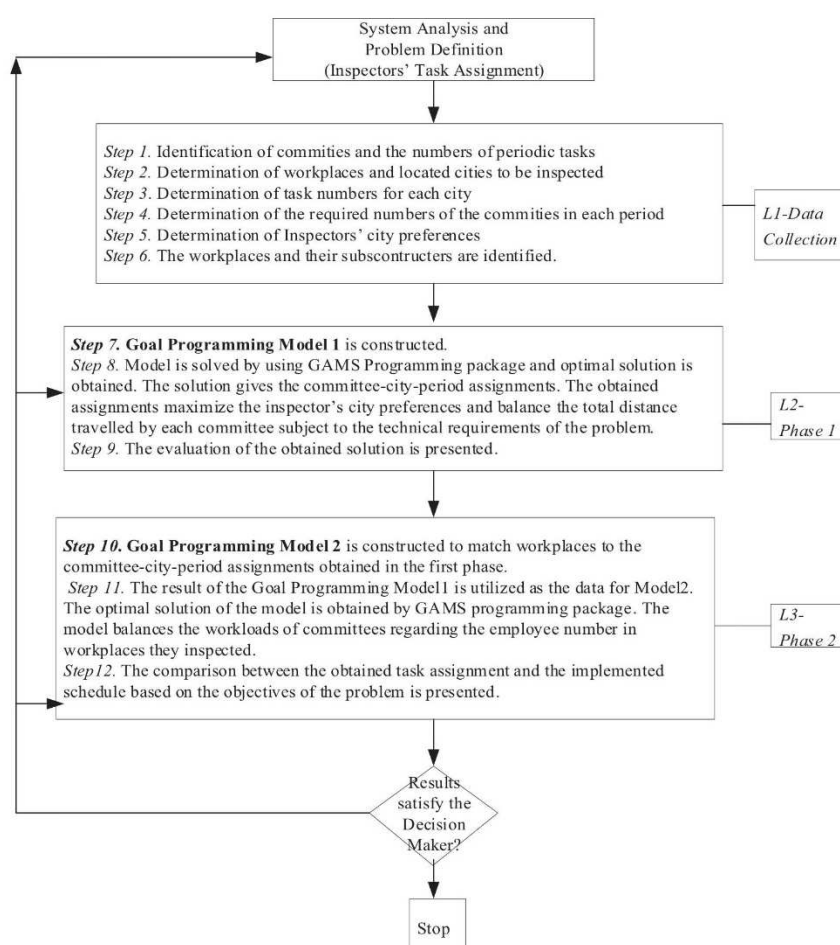


Fig. 1. Flow chart of the steps of the proposed hierarchical solution approach. L1. Data collection constitutes the six steps. The data obtained by the first five steps are used in the Phase 1. The collected data in Step 6 is kept for Phase 2. L2. The phase 1. Goal Programming Model 1 is constructed to obtain optimal committee-city-period assignments. L3. The phase 2. Goal Programming Model 2 is constructed to match workplaces to the committee-city-period assignments obtained in the first phase. The last step (Step 12) is valid for the current study. In the future, it is performed as "the presentation of the obtain solution to the decision maker."

B. Individual and Social Psychology

Problems caused by work accidents, as reported by Lawton and Parker research in 1998, are unsafe behaviours at work, including:

1. Errors

a. Slips and Lapses.

Slips are workers running equipment that is not following their skills, body position when doing wrong work, etc.

Lopes, for example, is not using work safety equipment while working, not turning off the equipment after using it

b. Mistakes are divided into two, namely:

1) Error due to lack of knowledge

2) Errors due to understanding work procedure instructions

2. Violations

Violation is an act that is done not according to the rules set because of a belief that what he did is still within the limits of tolerance—for example, workers who do not use PPE.

Based on research conducted at the Esfahan Steel Company in Iran, it shows that of the 450 respondents surveyed, generally, accidents occur due to work stress caused by worker health, work conflicts, the balance between workers' salaries and workload, internal control of the workplace, external control of the workplace.

C. Development of Key Indicators for Occupational Health and Safety

Vision Zero (VZ) integrates health, safety and welfare by developing self-confidence, competence and workability.

IOSH_UK has developed a culture of accident prevention for a long time, which consists of 10 indicators, including (Show in fig 2):

1. Commitment and Feasibility Management
2. Communication on feedback
3. Analysis of Productivity versus Security
4. Information, Instruction and Training
5. Security resources
6. Participation
7. Shared perception of safety and risk
8. Personal trust
9. Incentives
10. Accident reporting, investigation and control

The segments that need attention to improve occupational health and safety are:

1. Leadership Competencies in organizations
2. Procurement
3. Culture of direction before work

4. Evaluation of risk management and targeted programs
5. Analysis of unplanned events
6. Innovation and change
7. Work Organization
8. Orientation and Refresher Training

D. Mapping of Companies Implementing Occupational Health and Safety.

One of the efforts to establish a culture of occupational health and safety is by mapping companies involved in the maritime industry committed to implementing a culture of occupational health and safety.

The purpose of the mapping is to find out whether the actual conditions are:

1. The company feels that the implementation of the occupational health and safety management system (SMK3) is a cost that must be incurred and only allocates a small number of funds and places SMK3 only as a legal requirement. Or
2. The company feels that implementing an occupational health and safety management system is advantageous because it can increase productivity, reduce losses due to personnel accidents and incur costs due to accidents.

Planning, Doing, Checking, and Action steps are very relevant to be used for mapping so that preventive measures can be made against possible accidents, including:

1. Planning, Mapping potential and evaluating K3 receipts, opportunities, and mitigating risks that occur.
2. Execute, Implement the planned implementation procedures
3. Checking, conducting periodic checks related to activities carried out and reporting.
4. Take action, improve and improve the implementation of OHS as planned.

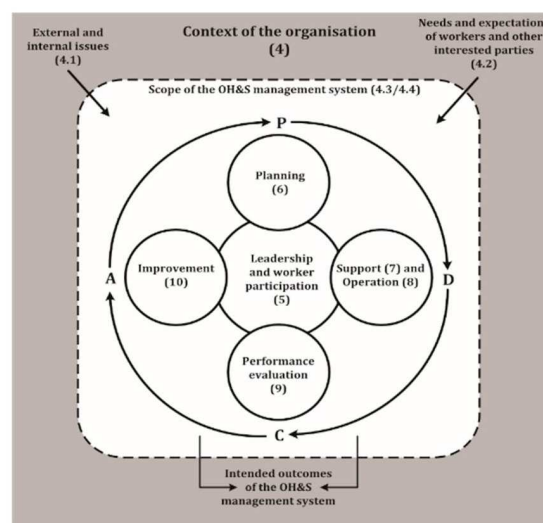


Fig. 2 The productive flow of the production line.

E. Ship's crew as agents of occupational safety and health

The ship is a very complex organization and an authority when carrying out a voyage, so that synergy is needed for every member in it, including the crew. The organization commanded by the ship's commander gives top-down orders that must be obeyed by the entire organization based on existing functions.

Every existing personnel should be equipped with Occupational Health and Safety knowledge. In every second observation of the ship's environment, they are responsible for conducting an occupational health and safety analysis of all activities on the ship. This is in line with what has been conveyed by Ljung and Oudhuis (2016) regarding changes to the international regulatory framework for improvement and recognition of the central role of crew members in ship safety.

The factors that need to be considered by each crew member and immediately reported to the ship commander in stages are:

1. Heavy Physical Load and Work Posture
2. Unsafe working conditions
3. Long working hours
4. Limited recovery time
5. The mental and emotional burden felt
6. Recreation

In the fatal accident of Costa Concordia in 2012, thanks to his courage and professionalism, finally a manager and a waiter received The Seafarer of the Year Award 2012 by Lloyds Register of Ships.

Several indicators that need attention regarding the involvement of crew members into occupational health and safety agents include:

1. Changes in ship safety concerns regularly reported by the crew from time to time are increasing.
2. Diagnose the sick leave of the reported crew members.
3. Physical, organizational and social work environment factors
 - a. Physical Work Environment
 - b. Work Organization
 - c. Social work environment
4. Health Factor

F. Safety Climate and Work Stress

Zohar (1980-1996) defines a work safety climate as a psychological perception of work safety embedded in the minds of all people involved in the work environment. Eight factors affect the safety climate and work stress, including:

1. Work safety training program that is constantly updated for workers to overcome work stress
2. Management commitment to work safety and work stress programs
3. Socialization of work safety behaviour that is carried out continuously has an impact on job promotion
4. Knowledge of the risk of accidents that may occur in the workplace
5. Effect of work speed on safety
6. Responsibilities and authorities of work safety manager
7. Awareness of social impact on work safety behaviour
8. Presence of a Work Safety Team

Then Griffin and Neal (2002) describe the work safety climate as an organizational climate experienced by individuals consisting of 5 factors:

1. Value management
2. Communication
3. Safety practices
4. Education/training
5. Safety equipment

Within the same working organization, there are two types of climate categories, namely:

1. Workplace climate for permanent workers
2. Workplace climate for sub-contractor workers

This difference is caused, among other things, because the sub-contractor workers emphasize the economic aspect rather than the safety factor. The unstable attitude of sub-contractor workers will be exacerbated when they experience work stress, congenital diseases, and relatively low wages

G. Conceptual development and measurement of Occupational Health and Safety vulnerability levels

The dimensions associated with an increased risk of work injury are:

1. Exposure to danger,
2. Occupational health and safety policies and procedures,
3. OHS Awareness,
4. Empowerment to participate in injury prevention.

Conceptual development to distinguish a condition called accident-prone is very useful to find the characteristics of increasing the risk of work accidents and safe actions taken in the workplace so that we get:

1. More contextually understand what causes the risk of work accidents, including identifying the types of workers who are more prone to injury
2. Placing workers in an environment that increases the risk of accidents
3. Provide insight into sociodemographic and contextual factors and vulnerabilities

The conceptual framework developed as the main features are:

1. Level of the potential hazard
2. Workplace/organizational level protection and policies
3. Awareness of workers about occupational hazards
4. Empowering workers to participate in injury prevention

The detection strategy is based on the framework and measurement filter strategy developed by the consensus-based standards for health measurement instrument cluster selection (COSMIN) Terwee et al. 2009

H. Occupational Safety and Health in the 4th Industrial Revolution Era

The development of Industry 4.0 is spectacular in science, carrying the trend of automation and data exchange by combining cyber-physical, internet of things (IoT), cloud computing and cognitive computing.

The most considerable use of robots is currently used in the automotive, electronics and raw materials industries which replace human labour.

With these conditions, routine jobs, namely safe and repetitive types of work, will be taken over by robots, and what remains are non-standard jobs such as delivery jobs and freelance work. The need for an economy that causes the neglect of occupational health and safety factors according to data from the Occupation Safety & Health Research Institute in the Republic of Korea in 2015, the number of workers who died was 0.39 for every 10,000 workers.

III. I. WORK SAFETY CULTURE

Work safety culture first emerged after the Chernobyl nuclear reactor explosion in 1986 by the International Atomic Energy Agency (IAEA, 1986). The Work Safety Culture is a value that is starting to be embedded in every human being involved in the organization. Even though no one is monitoring the work safety behaviour, it is still implemented.

Based on how to react to safety, Taylor et al. (2011) divide work safety culture into five levels, including:

- Pathological: workers' reactions to safety problems by not being too strict in complying with regulations.
- Reactive: workers' reactions to the importance of safety after an accident caused by ignoring basic safety instructions.
- Calculation: the reaction of company management to find data that is used to make standard work procedures without any attempt to analyze existing data to improve security.
- Proactive: the reaction of management and workers to the possibility of an accident occurring in the work environment.
- Generative: reaction to work safety by constantly analyzing incoming reports from workers and employees so that they can anticipate the development of factors related to work security on an ongoing basis

According to the International Chamber of Shipping ICS (2013), to be able to make safety culture effective, efforts should be made, including:

- The company controls the implementation of standard operating procedures to reduce unsafe acts.
- Suggestions for all organizational components, including supervisors, crew members, coast guards, to consider the safety aspect.
- Companies should target a zero accident policy and continuous improvement.

The methodology used to foster a Work Culture is as follows fig 3:

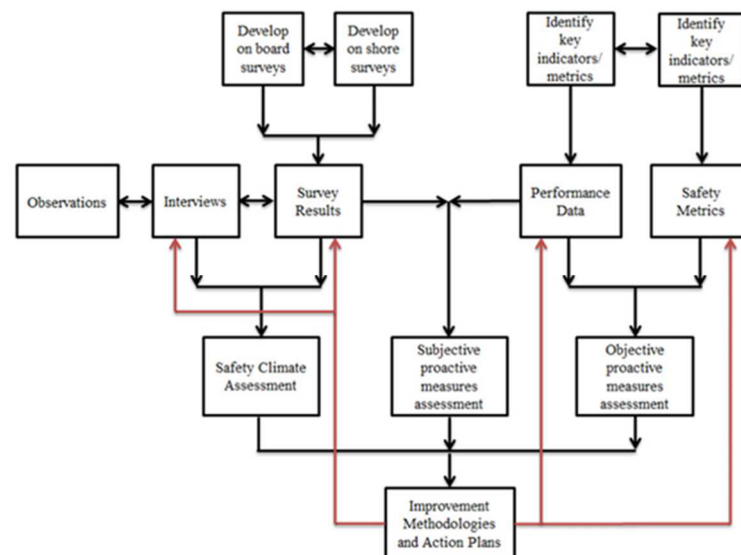


Fig. 3. The proposed safety culture assessment and implementation framework.

IV. DISCUSSION

In the discussion conducted by several journals reviewed, there are similarities in objectives; however, to implement OHS, it is necessary to have a guide and assessment to evaluate the implementation. One of the methods that need to be applied in the maintenance and repair of warships in the Indonesian Navy is the preparation of the right HIRARC ((Hazard Identification Risk Assessment & Control) because it involves many stakeholders, in this case, starting from the initial implementation of project procurement to its actualization in stages. As follows:

1. Hazard identification is an awareness of the danger, the risk of danger and the possibility of a hazard already owned by all stakeholders involved in one goal.
2. Risk assessment is more about an introduction to the workplace, including the existing situation and ongoing processes that may cause harm, especially to humans.
3. Risk control emphasizes mitigation of the impact of hazards.

In identifying hazards, it is necessary to identify the components that cause or cause trouble. Among others:

1. Humans are stakeholders involved in the process of maintaining and repairing warships of the Republic of Indonesia, including:
 - a. Planning staff has a professional attitude. And knowing the level of difficulty and risk factors faced when carrying out activities.
 - b. The Procurement Staff includes components of occupational health and safety in the procurement document that must be met by the provider when bidding.
 - c. Supervisory staff, staff checks eligibility documents and work health and safety equipment is used as long as workers carry out their activities and record work progress reports.
 - d. The crew of the ship actively monitor workers at work.

By referring to the definition above, employees/workers have a considerable role in achieving zero accidents. Some things that need to be done to realize these conditions include:

- a. Employees/workers have the appropriate competence
- b. Employees/workers carry out work procedures
- c. Employees/workers attend training
- d. Employees/workers Understand the correct work procedures (Using PPE)

2. Method, Method

To achieve zero accident, a standard method is needed that is applied in an organization, company or agency, including:

- a. Proper work procedures (Updating work procedures)
- b. Clear work instructions
- c. Implementing occupational safety and health (K3) procedures
- d. Communication about work safety that is constantly maintained

3. Material, The existence of material can guarantee the achievement of a zero accident, namely by:

- a. Using materials that have quality according to specifications
- b. Using material dimensions that do not exceed the capacity of the equipment used

4. Machine, Machine is equipment driven by a force/power used to assist humans in working on specific products or product parts. Several things need to be done to achieve zero accident, among others:

- a. Placing danger signs
- b. Carry out regular machine maintenance (Rejuvenation of machines and equipment)
- c. Using the suitable machine

5. Environment, the work environment is a unity of various backgrounds in the workplace, which includes physical, chemical, biological, physiological and psychological factors whose presence in the workplace can affect the safety and health of the workforce.

a. Physical factors are factors in the workplace that are physical which consist of:

- 1) Working climate
- 2) Noise
- 3) Vibration
- 4) Microwave,
- 5) Ultraviolet light
- 6) Magnetic Field

b. Chemical factors are factors in the workplace that are chemical, namely in the form of solids (particles), liquids, gases, mists, aerosols, and vapours originating from chemicals consisting of:

- 1) Dust in the air of the working environment
- 2) Gas in the working environment

c. Biological factors can lead to occupational diseases, including germs, viruses, fungi/fungus, insect worms, and plant growth originating from the production process of the work environment.

d. Ergonomic factors, diseases caused by ergonomic factors (work physiology), namely diseases due to the wrong way of working or the use of work tools that are not under physical conditions

e. Psychological factors occupational diseases caused by psychological factors.

The risk assessment for work carried out on ships has been regulated by the International Maritime Organization (IMO), which the International Convention subsequently adopted for the Safety of Life at Sea (SOLAS).

Job Safety & Environmental Analysis (JSEA)

No. Form : ; Rev. : ; Tgl :

Nama Dept. / Bagian	:		No. JSEA	:	
Pekerjaan/ Kegiatan	:		Tanggal	:	
Dibuat Oleh	:		No. Revisi	:	
Disetujui Oleh	:		Halaman	:	1 dari 10

No.	Area/Peralatan/Kegiatan Pekerjaan/Proses	Potensi Bahaya (Hazard) / Aspek Lingkungan	Akibat yang ditimbulkan / Dampak Lingkungan	K3/L*	Tindakan Pengendalian yang telah dilakukan	Nilai Resiko			Prosedur atau Peraturan Perundangan terkait	Rekomendasi pengendalian tambahan
						KT	TK	TR		

Kemungkinan terjadi (Likelihood of occurrence)
 1. Sangat jarang (nyaris tidak mungkin terjadi)
 2. Mungkin tapi kecil (kadang-kadang mungkin terjadi)
 3. Mungkin (dapat terjadi)
 4. Kemungkinan besar (besar kemungkinan terjadi)
 5. Pasti (terjadi berulang)

Tingkat kerugian (Saverity Risk)
Dampak pada personal / Dampak pada Lingkungan
 1. Tidak signifikan (tidak perlu perawatan / tidak terjadi kerusakan)
 2. Minor (pertolongan pertama / terjadi kontaminasi)
 3. Moderata (butuh pertolongan dokter / kerusakan terjadi di lingkungan yang terbatas)
 4. Major (lumpuh permanen, mati / kerusakan lingkungan besar)
 5. Bencana (gangguan banyak orang / kerusakan lingkungan sangat besar)

K3* = Kesehatan & Keselamatan Kerja
 L* = Lingkungan

Tabel Nilai Resiko

Kemungkinan terjadi	Tingkat kerugian				
	1	2	3	4	5
1	L	L	M	H	H
2	L	L	M	H	E
3	L	M	H	E	E
4	M	H	H	E	E
5	H	H	E	E	E

Fig. 4. Job Safety & Environmental Analysis (JSEA)

The author tries to map out what is needed in carrying out the HIRACH so that it can be a driving force for the implementation of K3, including:

1. Work Area

- a. Hull
- b. Ship Skin
- c. Keel Ship
- d. Pavilion
- e. Ship Deck
- f. Ship Ivory

2. Equipment

- a. Overhead Crane
- b. Forklift
- c. Chain Block
- d. Welding Transformer
- e. Elphiji Tube

3. Work Activities

- a. Welding
- b. Painting
- c. Weapon Repair
- d. Engine Repair and Control
- , e. Cleaning

V. CONCLUSION

The journals reviewed are from outside the country of Indonesia, so for the repair of the Republic of Indonesia Ship at the Shipyard, both at PT PAL Surabaya and the National Private Shipyard, it is necessary to adjust the K3 items that are the focus of attention according to the culture in Indonesia.

The 4.0 industrial revolution for repairs in existing shipyards is not too influential because the existing infrastructure has not adopted much robotic technology. However, almost 90% of the current jobs still use human power.

VI. DECLARATION

The authors declare that they have no financial or other interest in influencing the writing of this paper.

VII. THANK-YOU NOTE

We are grateful for the support of data from satharmattim, satlaikmattim for data supporting the repair of the Republic of Indonesia Ship, which is the responsibility of supervision and control.

We want to thank the Pelindo III Surabaya staff, who have provided reference readings to enrich the repertoire in analyzing problems and providing conclusions.

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REFERENCES

- [1] Amir Barkhordari, Behnam Malmir, Mahdi Malakoutikhah, An Analysis of Individual and Social Factors Affecting Occupational Accidents
- [2] Feyzan Arikan, Songul K. Sozen, A Hierarchical Solution Approach for Occupational Health and Safety Inspectors' Task Assignment Problem
- [3] Gerard Zwetsloot, Stavroula Leka, Pete Kines, Aditya Jain, Vision zero: Developing proactive leading indicators for safety, health and wellbeing at work
- [4] Jeehee Min, Yangwoo Kim, Sujin Lee, Tae-Won Jang, Inah Kim, Jaechul Song, The Fourth Industrial Revolution and Its Impact on Occupational Health and Safety, Worker's Compensation and Labor Conditions
- [5] Kyung Woo Kim, Sung-Jin Park, Hae Sun Lim, Hm Hak Cho, Safety Climate and Occupational Stress According to Occupational Accidents Experience and Employment Type in Shipbuilding Industry of Korea
- [6] L. Morgado, F. J. G. Silva, L. M. Fonseca, Mapping Occupational Health and Safety Management Systems in Portugal: outlook for ISO 45001:2018 adoption
- [7] Maria Grazia Gnonia, Paolo Angelo Bragattob, Maria Francesca Milazzoc, Roberto Setolad, Integrating IoT technologies for "intelligent" safety management in the process industry
- [8] Mohana Krishnan G. and Manu Menon, Risk Assessment For Entering Enclosedspaces On Board Ships
- [9] Peter Holland, Reforming and restructuring the Australian workplace: a study of the Williamstown Naval Dockyard 1983–1993
- [10] Peter M. Smith, Ron Saundersa, Marni Lifshena, Ollie Black, Morgan Laya, F. Curtis Breslina, Anthony D. LaMontagne, Emile Tompa, The development of a conceptual model and self-reported measure of occupational health and safety vulnerability
- [11] Volkan Arslan, Rafet Emek Kurt, Osman Turan, Louis De Wolff, Safety culture assessment and implementation framework to enhance maritime safety