# Application of Technical and Non-Technical Factors Affecting Safety Management Systems on The Container Ships

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## ABSTRACT

The study aims to analyze the problems in implementing Safety Management System on container ships by implementing the international safety management conventions. The analysis is about the relationship between technical and non-technical factors of SMS that could affect the maritime safety. This study used a Qualitative method using NVivo 12 software. The respondents were the Captain, Officers, Chief Engineer, and Engineers. The study also involved the Designed Person Ashore, Marine Inspector, Shipping Entrepreneurs, and Marine Academy with a total of 32 respondents to obtain diverse and comprehensive perspectives on the phenomena that occur when the ship boarding. The sampling technique used NVivo 12 software to produce data visualization through project maps, coding, and interpretation based on node and sub-node codes. The results of this study are obtained through a comprehensive analysis of the problems of implementing safety management system on ships that should comply with the provisions of the International Safety Management Code and the Convention for the Safety of Life at Sea as well as factors such as crew training and human resource development, which are consistently integrated in the successful implementation of SMS and will later be used by stakeholders to improve the safety of container ships in the maritime sector.

**Keywords:** safety management system, international safety management code, safety of life at sea, technical and non-technical factors, container ship

## A. Introduction

Currently, sea transportation plays an important role in supporting the increase in the flow of commodities through the company and reliable sailors who are also inseparable from their persistence in carrying out work safely on board ships. Wang et al. (2022) reveal that globalization has caused the importance of maritime transportation to increase in recent decades, especially container shipping transportation, which is an important aspect of the flow of goods in supply chains around the world. Shipping companies should also ensure that the ship's crew complies with all international maritime regulations set by the IMO (International Maritime Organization). This includes crew safety regulations, marine environmental protection, and ship safety standards. In recent decades, with the rapid growth of the shipping industry, maritime accident investigation has become one of the

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hot topics. Cavusgil et al. (2020) revealed that shipping companies are considered a high-risk industry and stakeholders must take action to prevent accidents.

Meanwhile Hasanspahić et al. (2021) argue that maritime accidents are a series of extraordinary random events that have adverse effects and endanger life, property, and the marine environment. Shipping safety is also the responsibility of many parties, including operators, regulators, and users of transportation services. By identifying the responses to current and future international regulatory measures in the Shipping Industry stated by Lun et al. (2023). So safety is a very important thing that should be given serious attention by shipping companies, especially the crew who work on the ship every day.

A Guide to the Collision Avoidance Rule Edition 7 (2012) declared the Convention on Preventing Collisions at Sea 1972 (Convention on The International Regulation of Preventing Collusion at Sea, 1972) that state "the word vessel includes every description of watercraft, including non-displacement craft and seaplanes, used or capable of being used as transportation on water" Therefore, this sea transportation has been set several regulations regulated by IMO as a benchmark to ensure the safety of ships, lives and even environmental pollution at sea. Likewise with the establishment of conventions as standards related to maritime protection and safety.

Based on the International Convention for the Prevention of Pollution from Ships (1973), it is defined as follows: "Ships means a vessel of any type whatsoever operating in the marine environment and includes hydrofoil boats, air-cushion vehicles, submersibles, floating craft and fixed or floating platforms" by ANNEX 26 Resolution (2011).

According to Hasanspahić et al. (2022) An accident at sea is an unwanted and dangerous event, often with catastrophic consequences including death, injury, loss of money, equipment damage, and pollution. Because the rate of ship accidents is still high, implementing SMS on board ships must have correct and proper procedures and work procedures to minimize and reduce the number of accidents on board ships. As expressed by Péry et al. (2021) that accidents at sea are complex and result from a combination of events or processes that can ultimately result in loss of life at sea, as well as irreversible ecological, environmental, and economic damage.

Safety is often described as freedom from unacceptable risks defined by Joseph & Dalaklis. (2021). Ricardianto et al. (2021) revealed that the human factor is one of the causes of ship accidents. Amirullah et al. (2020) states regarding ship safety, the company must have an SMS that is intended for everyone working on land and at sea. The company built this system using the guidelines and model documents of the International Safety Management Code (ISM Code). Law Number 17 Concerning Shipping, (2008) explains SMS that shipping safety and security is a unified system consisting of transportation in waters, ports, safety and security, and protection of the maritime environment.

A Safety Management System (SMS) is a systematic safety management method that is widely used and researched throughout the world as stated by Guo et al. (2021). Fraitag et al. (2022) reveal that effective SMS and legal requirements for accident prevention can be implemented in the organization and if it occurs, the impact can be minimized by taking action. The ISM Code requires a safety management system to be implemented by the shipowner or shipping company. Hasanspahić et al. (2021) argue that in this regard the ISM Code regulations (section 9) require reporting of accidents and near misses to determine their causes (section 16) however, there is an inconsistent approach and analysis within the marine industry, as well as inadequate reporting and investigation of near misses. Meanwhile, Puspitawati (2019) stated that SM S must contain safety practices in the use of ships and a safe work environment, establish actions against potential risks from the use of ships and other maritime transportation activities,

permanently, improve HR management both on ships and on land in terms of safety measures and environmental protection.

In the context of international law, this SMS has also been regulated by IMO and ILO, an international organization under the auspices of the United Nations (UN) through its resolutions in the form of STCW Manila Amendment 2010, ISM Code, SOLAS 1974, MARPOL 1973/78 (Marine Pollution), LLC 1966, COLLREG 1972 (International Regulations for Preventing Collisions at Sea). IMO issues various regulations related to the safety of ships, cargo, and humans. However, its implementation has not been carried out properly.

Therefore, SMS via ISM Code is issued by SOLAS, namely the International Convention for the Safety of Life at Sea (SOLAS) which is one of the oldest conventions of its kind. Meanwhile, in the national context, safety regulations are also regulated in Regulation of the Minister of Transportation of the Republic of Indonesia No PM 45 Tahun 2012 about Ship Safety Management, (2012), which contains policies and procedures for the

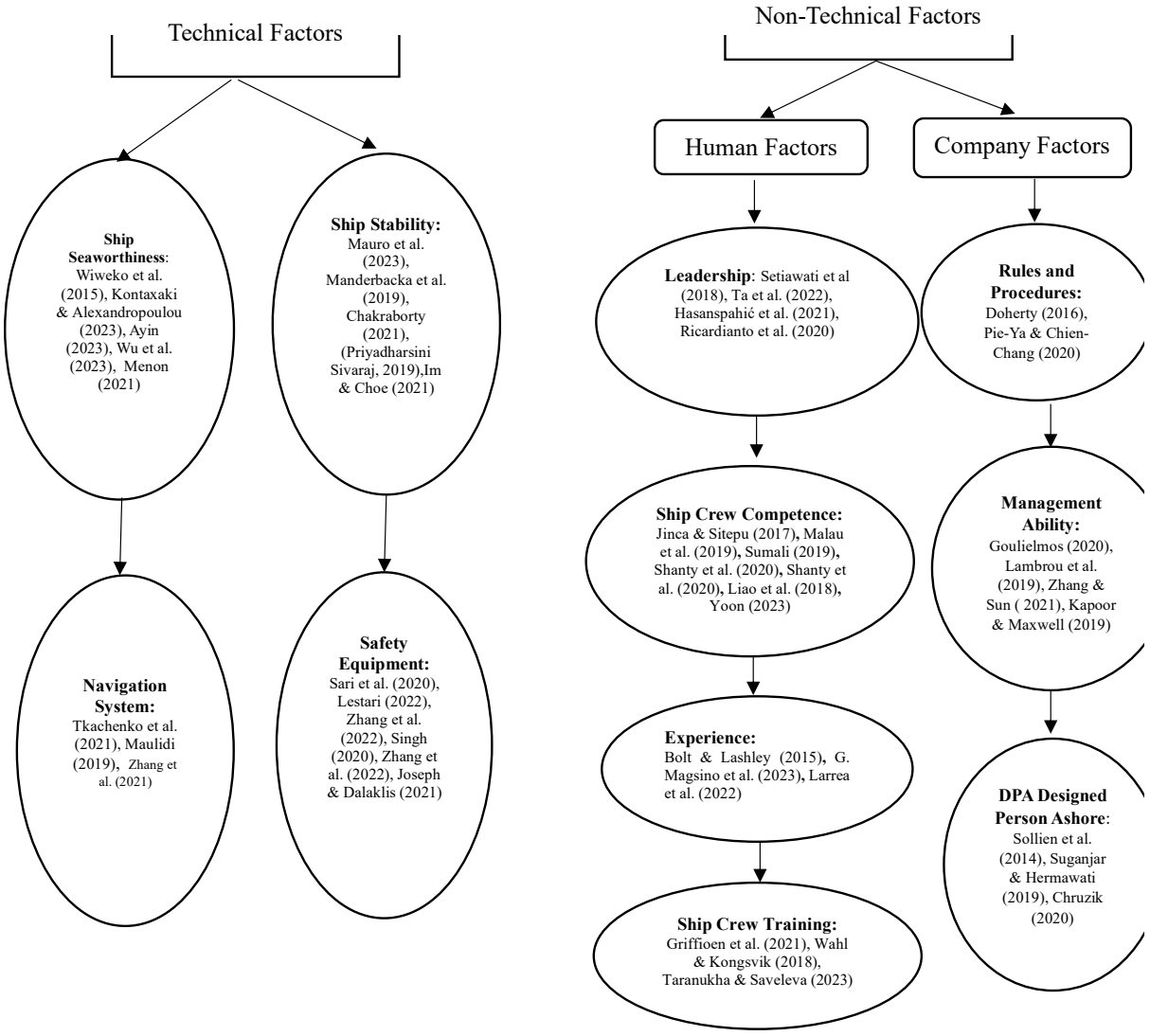


Figure 1 Factors that influence SMS

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implementation of company and ship safety management systems and Regulations of the Minister of Transportation of the Republic of Indonesia No PM 61 Tahun 2019 About the Seaworthiness of Indonesian Flagged High-Speed Passenger Vessels, (2019) which contains safety information.

To overcome this problem, research on the application of SMS aims to provide standardization both nationally and internationally maximize safety management and ship operations, and prevent pollution at sea. With systematic application in identifying evaluating and managing many risks. Several issues are often raised by several authors regarding risk Rajapakse & Emad (2023) stated that there is a strong relationship between fatigue and accidents. It is expected that the implementation of SMS can reduce the possibility of accidents such as fires, collisions, sinking and even damage to cargo caused by one of them is the risk of fatigue. Currently, fatigue management at sea has also been included in the regulations for fatigue management that have been adopted in international shipping as stated by Grech (2016). Hamidi et al. (2012) shows significant differences between various safety indices before and after implementation.

From the data above, it is concluded that many ship accidents occur due to technical and non-technical factors. Much research has been conducted on SMS, both technically including safety equipment stated by Ammad et al. (2021) ; Riantini & Subiyanto (2019) both technical and non-technical include leadership models studied by Lange & Hernandez-Bark (2020) ; & Fischer et al. (2017) as well as the competence of the ship's crew as stated by Malau et al. (2019) and risk management as stated by Rajapakse & Emad (2023)However, many ships still have not been able to implement the ISM Code (SMS) in real terms and do not yet know clearly what factors have the most influence on SMS on board ships.

## B. Methods

This research used a Qualitative method approach, which focuses on an in-depth understanding of a phenomenon, context, or setting from the perspective of the participants. The main goal was to provide a complete and holistic picture of the subject being studied Creswell (2020). In this study, a qualitative approach allowed us to understand the experiences of ship crew and DPA staff related to the implementation of the Safety Management System (SMS). Through in-depth interviews and direct observation, various technical and non-technical factors that influence the implementation of SMS could be explored. This research was conducted at PT. Tanto Intim Line, which located in Jakarta, Indonesia. In its development for ship activities, the transportation of goods is using containers. In this study, several data collection techniques were used including Interviews, Participatory Observation, Documents and Archives, and Triangulation. Respondents in this study amounted to 32 informants consisting of ship crews and related personnel in shipping companies operating in Indonesia. This included the Captain, Officer, Engineer, and personnel management at the company's headquarters, such as DPA (Designated Person Ashore) and Ship Operations Manager, Shipping Entrepreneur, Marine Academics, and Marine Inspector. In this study, Qualitative data analysis was carried out by utilizing NVivo 12 software with Thematic Network Model.

## C. Result and Discussion

### 1. Data Acquisition Research Sample Informants

From the table 1, the number of informants above is 32 informants based on their respective names, ages, and positions. Consisting of Captain, Chief Officer, Second Officer, Third Officer, Chief Engineer, Second Engineer, dan Third Engineer, and involves

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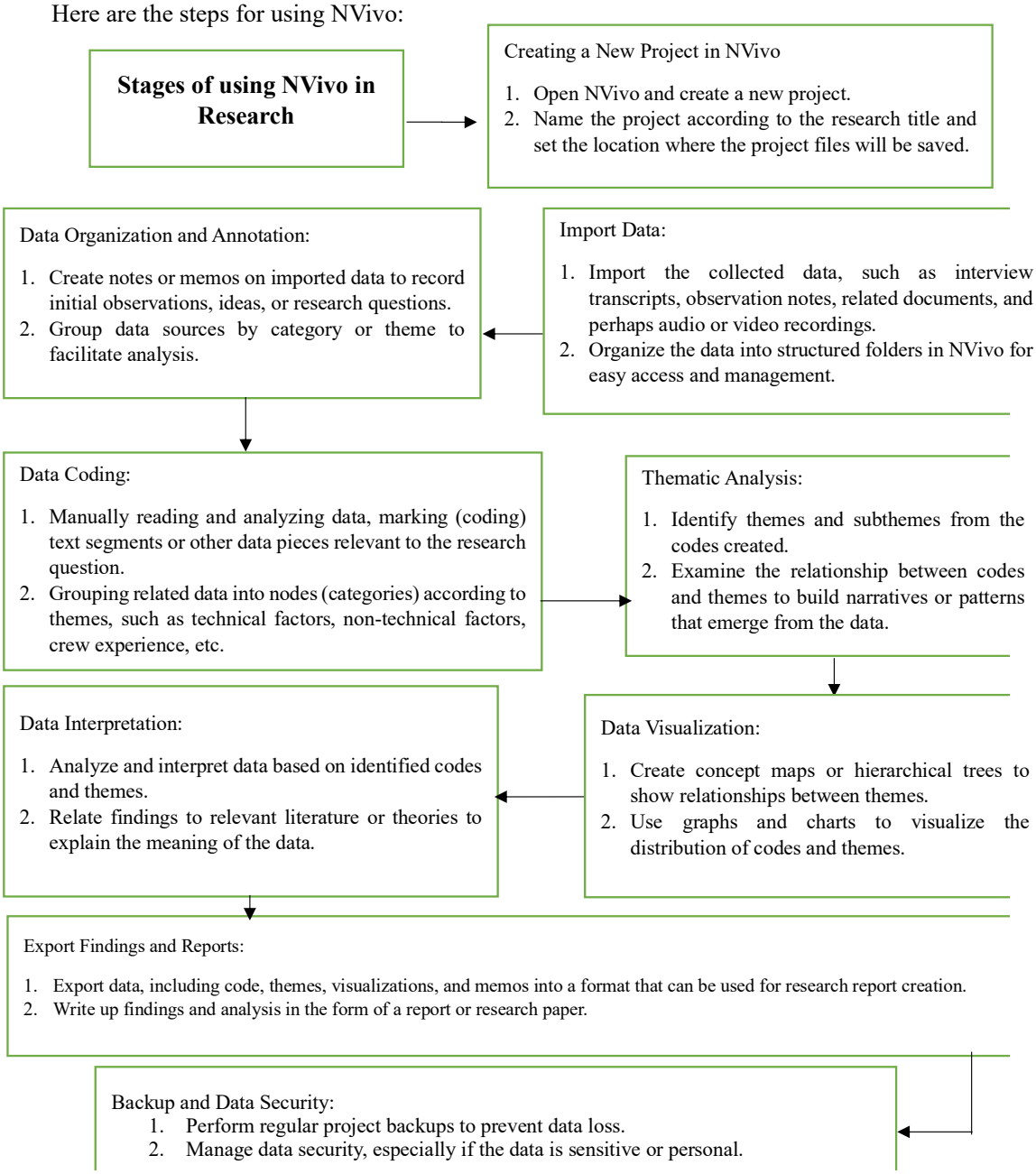


Figure 2 Stages of Using NVivo in Research

(DPA) Designed Person Ashore, Marine Inspector, Shipping Entrepreneur and Marine Academy and also positions.

2. SMS Technical Factor Considerations

The following is a general description of the results of the Technical Factor coding related to the implementation of SMS on board ships (Figure 3).

From Figure 3, the visualization of the project map data (Thematic Network Model) above, we can interpret the data based on the node code related to the SMS technical factors. From the technical factors These elements are divided into several points, namely the effectiveness of the navigation system, the seaworthiness of the ship, the quality of safety equipment and loading procedures, and the stability of the ship.

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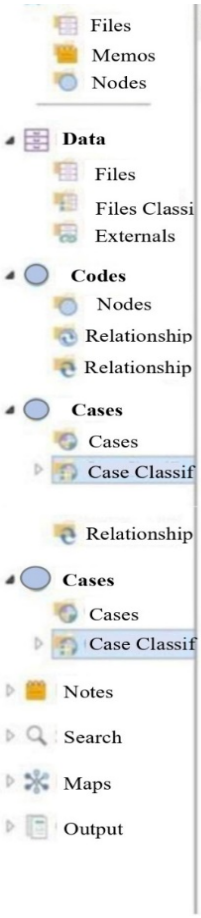
Table 1 Data Acquisition Research Sample Informants




| | A : USIA | B : JABATAN | C : NAMA |
|---|---|---|---|
| 1: Informan 01.... | 41 | Nahkoda | Nur Syamsul |
| 2: Informan 02.... | 40 | Nahkoda | Usman |
| 3: Informan 03... | 41 | Nahkoda | Alfendra |
| 4: Informan 04... | 41 | DPA | Faisal |
| 5: Informan 05... | 35 | DPA | Lucyanti |
| 6: Informan 06... | 38 | Chief Officer | Sahlan |
| 7: Informan 07.... | 28 | Chief Officer | I Putu Harimbawa |
| 8: Informan 08... | 39 | Chief Officer | Adnan Ishak |
| 9: Informan 09... | 35 | Second Officer | Ahmad Zulkarnaen |
| 10: Informan 10.. | 26 | Second Officer | Hasan Basri |
| 11: Informan 11.. | 28 | Second Officer | Rahmatullah |
| 12: Informan 12.. | 27 | Third Officer | Handers Putra Prata |
| 13: Informan 13... | 25 | Third Officer | Salinda A Rasid |
| 14: Informan 14... | 26 | Third Officer | Lorens |
| 15: Informan 15... | 41 | Chief Engineer | Taryono |
| 16: Informan 16... | 40 | Chief Engineer | Rafilo Soga |
| 17: Informan 17... | 40 | Chief Engineer | Wilson Sampe |
| 18: Informan 18... | 35 | First Engineer | Mika Rante Padang |
| 19: Informan 19... | 35 | First Engineer | Muh. Faisal |
| 20: Informan 20... | 36 | First Engineer | Sigit Putranada |
| 21: Informan 21... | 29 | Second Engineer | Agus Setiawan |
| 22: Informan 22... | 30 | Second Engineer | Nurridhatul Fikri |
| 23: Informan 23... | 27 | Second Engineer | Pallira Yaser |
| 24: Informan 24... | 29 | Third Engineer | Suraies |
| 25: Informan 25... | 27 | Third Engineer | Taufik Husain |
| 26: Informan 26... | 26 | Third Engineer | Erwin Sarnallo |
| 27: Informan 27... | 40 | Marine Inspector | Muh. Candra |
| 28: Informan 28... | 41 | Marine Inspector | Abdul Rahman |
| 29: Informan 29... | 35 | Marine Akademisi | Irwan |
| 30: Informan 30... | 41 | Marine Akademisi | Abdul Haris |
| 31: Informan 31... | 39 | Pengusaha Pelayaran | Eka Wahyudi |
| 32: Informan 32... | 44 | Pengusaha Pelayaran | Meilin Nelci Malintoy |

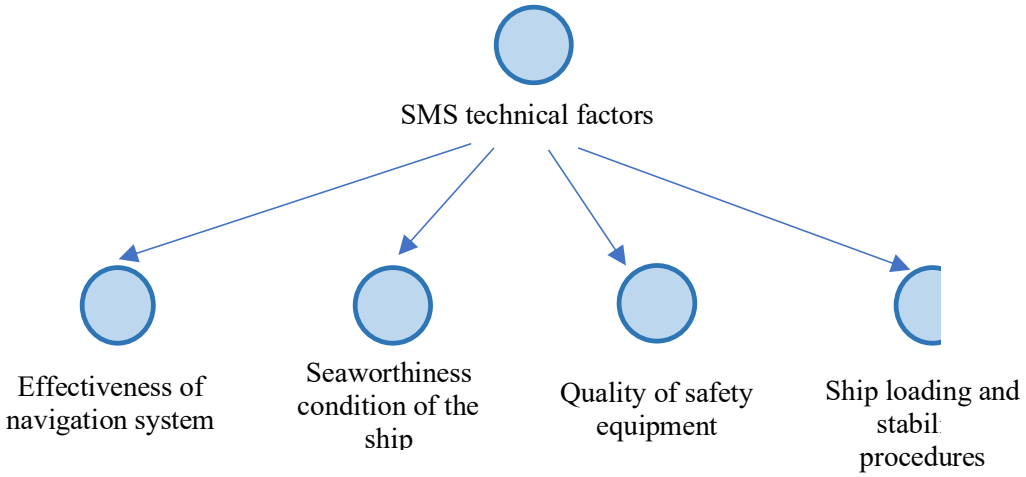



Figure 3 Project Map Data Visualization (Thematic Network Model) General Code Technical Factors

3. SMS Non-Technical Factors Considerations

The following is a general description of the results of coding Non-Technical Factors related to the implementation of SMS on board ships (Figure 4).

From the Figure 4 visualization of the project map data (Thematic Network Model) above, we can interpret the data based on the node code seen from how the elements related to non-technical factors. From these non-technical factors, the elements are divided into two, namely human factors and company factors. Where the human factor includes the competence and experience of the crew, the psychological condition of the crew, the criteria for crew experience, leadership models crew training, and HR development. While the Company factor consists of several elements, namely rules and procedures, management capabilities and the most important is the role of DPA (Designated Person Ashore). From the results of the analysis above, the factors that most influence the implementation of the Safety Management System are non-technical factors, namely crew training and human resource development.

4. Crew Training and Human Resources Development

The following table shows data analysis 2 that identifies themes and sub-themes from the coding project map image in NVivo 12 for the crew training and HR development nodes (Table 2).

From figure 5, it is explained that crew training and Human Resource Development (HRD) are important elements in effective and efficient ship operations. Some of the main aspects of crew training and human resource development (HRD) include document creation by DPA and approval by the Owner, adjusting to the needs, goals, and objectives of the SMS, conducting briefings, implementing toolbox meetings, training based on the Captain's proposal, periodic training and drill programs, and conducting monthly safety meetings. By implementing these aspects, ships can oper-

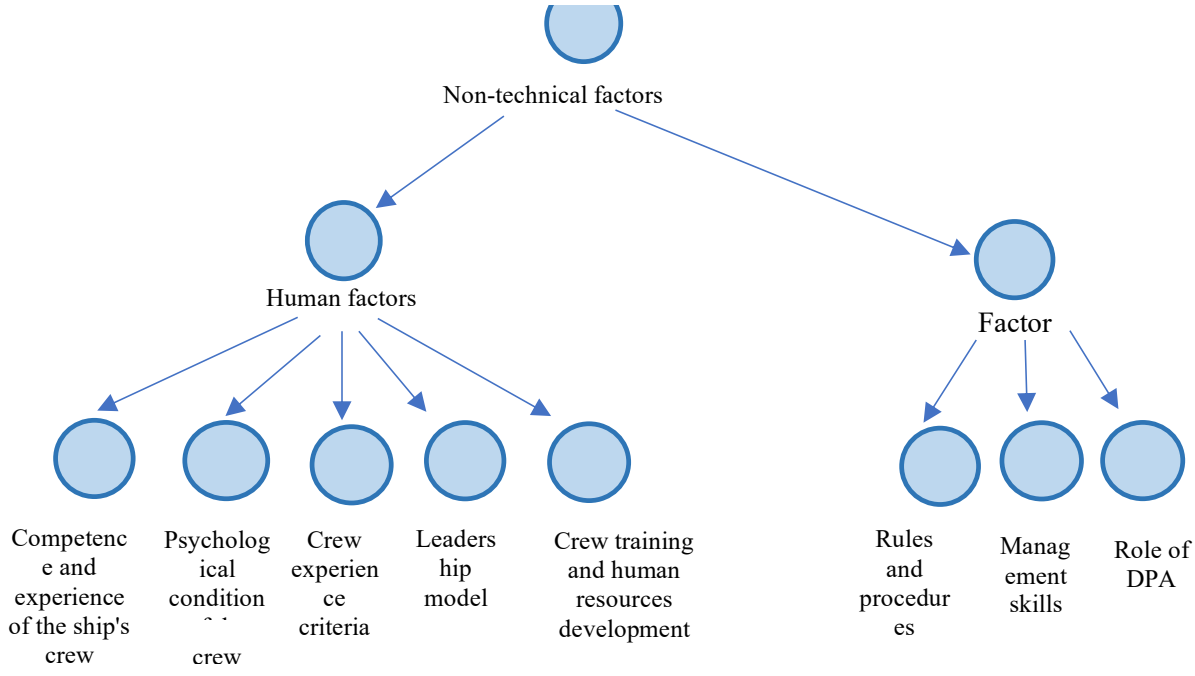



Figure 4 Visualise Data Project Map (Thematic Network Model) General Code Non-Technical Factors

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**Nodes**

| Name | Files | References | Created On |
|---|---|---|---|
| Leadership Model | 0 | 0 | 15/02/2024 14:17 |
| Crew training and human resources d | 0 | 0 | 15/02/2024 14:20 |
| Created by DPA and approved by o | 3 | 3 | 17/02/2024 14:39 |
| Tailored to the needs, goals and ob | 1 | 1 | 16/02/2024 13:37 |
| Conducting a Briefing | 1 | 1 | 15/02/2024 14:58 |
| Implementation of toolbox meeting | 1 | 1 | 15/02/2024 14:21 |
| Training on the Captain's proposal | 4 | 4 | 16/02/2024 13:59 |
| Regular training and drill programs | 21 | 21 | 15/02/2024 15:25 |
| Safety meeting every month | 3 | 3 | 15/02/2024 22:29 |

Figure 5 Crew Training and Human Resources Development

ate more safely, efficiently, and by applicable industry standards, as well as improving the overall performance and welfare of the crew.

From Figure 6, the project map data visualization (Thematic Network Model) above is interpreted data based on node code, it can be seen that crew training and Human Resources (HR) development is an essential component in improving work safety on board ships and supporting the implementation of the Safety Management System (SMS). The priority of work safety, known as the principle of "Safety First," is emphasized through the implementation of a toolbox meeting before starting work to discuss safety aspects. The training program designed must be by the standards set by the DPA and approved by the company owner.

This training is carried out routinely according to the needs, goals, and objectives of the SMS and is attended by all crew members, including drills and emergency exercises proposed by the Captain, monthly safety meetings, and briefings before carrying

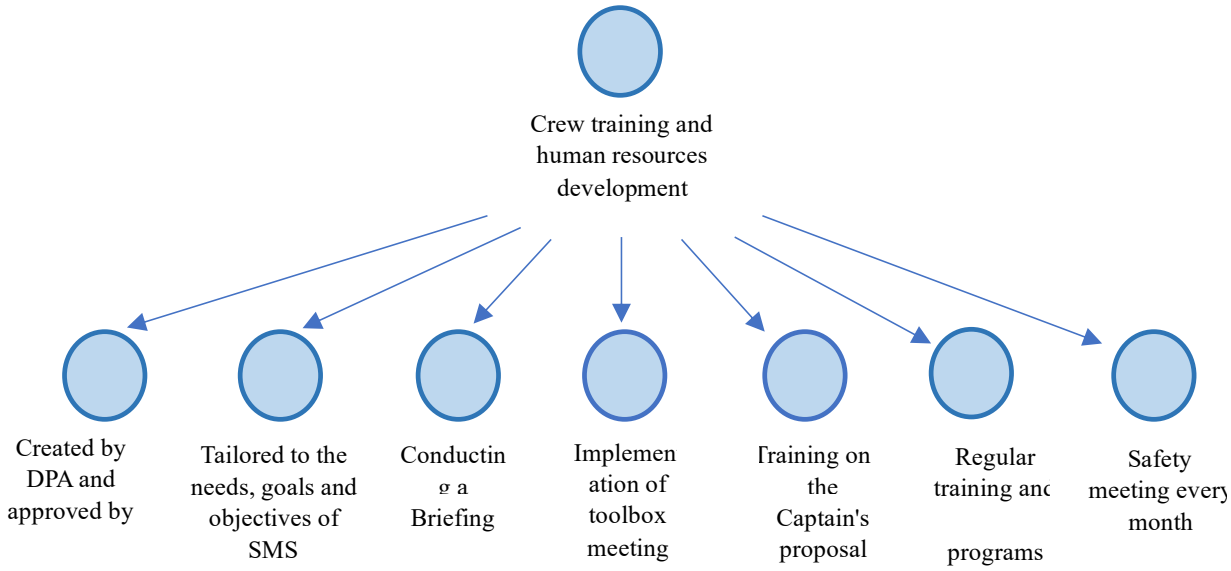


Figure 6 Project Map Node Data Visualization (Thematic Network Model) Crew Training and Human Resources Development

out work held at certain frequencies such as weekly, monthly, or annually. This training aims to ensure that every crew member understands the safety and emergency procedures by the applicable SOP. Regular safety meetings, both before and during off-duty time, as well as the implementation of drills or training for all crew, are part of the human resource development efforts on board. This helps improve the crew's readiness to face emergencies and supports the effective implementation of SMS.

There needs to be special socialization for new crew members regarding additional training from the Company, which includes emergency drills conducted by applicable regulations. Human resource development on board includes Company-standard training and briefings to equalize the skills of each crew member. This training program also includes increasing knowledge about safety and security, as well as the use of safety equipment such as Breathing Apparatus, Personal Floating Device (PFD), and Emergency Escape Breathing Device (EEBD). Training and development on board must be by the SMS created by the DPA and approved by the company owner, implemented routinely and periodically.

Thus, crew training and HR development are important initiatives that ensure work safety on board ships and support the success of SMS implementation. Through 2 considerations of technical and non-technical factors and 7 thematic analyses that have identified themes and sub-themes from the coding project map image in NVivo above, it can be seen that the Crew Training and Human Resource Development factors, namely non-technical factors (human factors), have the greatest impact on the implementation of the safety management system on board ships. The implementation of SMS and crew training and HR (Human Resources) development in the Maritime context is to improve safety and overall performance in maritime operations (Trullen et al., 2024) Includes safety policies such as formal documents that set out the company's commitment to maritime safety. Risk Control through actions taken to reduce or eliminate identified risks Thakkar (2022) ; & Chang et al. (2019). Regular Audits and Evaluations to ensure compliance with safety procedures. Incident Reporting and Learning.

SMS also regulates training on safety procedures, including fire prevention, evacuation, and first aid. Training to improve the technical skills of the ship's crew, such as navigation. Viljanen (2023) equipment operation, and machine maintenance (Poor & Basl 2020) and development of leadership and management skills. The results of the Project Map Node on Thematic Network Model data visualization on crew training and HR development, show that the approach is adjusted to SMS through the DPA as the individual responsible for implementing safety on board the ship. DPA holds monthly safety meetings where crew and personnel engage to discuss safety issues, evaluate performance, share experiences and lessons learned from incidents or exercises, and design and implement Regular drill training programs for ship crews including evacuation drills, firefighting, and other emergency actions to ensure that the ship crew is trained and ready to deal with emergencies effectively.

## D. Conclusion

Based on this research, the author found that the current implementation of SMS on ships should comply with ISM Code and the SOLAS Convention, which could affect the safety of ships, crew, and cargo. When facing the problem of SMS implementation, it is important to identify vulnerabilities and potential risks that need to be addressed. This study also aims to provide SMS solutions that could be applied to ships to improve safety, crew, and cargo. The proposed solution is expected to overcome the problems identified in the current SMS implementation and has a positive impact on improving the ship's safety system. It is very important to understand the relationship between the technical and non-

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technical aspects of a ship in the implemented SMS. Both technical factors include provisions from international codes such as SOLAS and the ISM Code

It is recommended to increase training and education for crew members in the use and implementation of new SMS solutions. This includes training on the use of new technology tools, safety procedures, and emergency response, and the implementation of an ongoing monitoring and evaluation program to ensure the effectiveness and reliability of the SMS solutions implemented. This may include regular audits, data collection, and analysis of system performance. We recommend awareness of safety culture among all crew members by developing the procedure manual by the company that is directly monitored by a data protection authority, and a commitment by the master to the implementation of SMS on board. For further researches, it is hoped that they will investigate more sources and references related to the object being studied.

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