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# Ship Bridge Nonconformity and Fire Hazard Mitigation

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**Abstract**

This study investigates how ship bridge nonconformities contribute to the occurrence and escalation of fire hazards. It aims to identify nonconformities in ship bridges and effective bridge fire hazard mitigation measures.

A mixed-methods approach was adopted for this study using both a case study and a survey questionnaire to collect qualitative and quantitative data. For the case study, two bridge fire incidents were analysed based on the National Transportation Safety Board (NTSB) reports. A semi-structured questionnaire was used to collect data from experienced seafarers or seamen and maritime safety officers. Thematic analysis was conducted on previous ship fire incidents that started on the bridge to identify the nonconformities that contributed to the incidents. Survey data were collected and analysed to capture different bridge nonconformities and the effectiveness of current bridge fire mitigation practices.

The findings of this study revealed that inadequate maintenance of equipment, poorly functioning fire detection systems, faulty electrical wiring, lack of proper communication systems, obstructed emergency exits and inadequate training of bridge personnel were major nonconformities that increase the risk of ship bridge fire. Additionally, regular fire drills, routine maintenance and inspections, proper training of bridge personnel, use of updated fire detection systems and regular review and update of fire safety protocols are very effective bridge fire hazard mitigation strategies. It was concluded that ship bridge nonconformities significantly contribute to the occurrence and escalation of ship fire.

Language: English

Keywords: ship bridge, bridge nonconformity, ship bridge fire, fire hazard mitigation

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# 1.0 Introduction

This chapter discusses the research background, problem statement and significance of the study. This is followed by the study's aim and objectives, methodology and study limitations.

## 1.1 Background of the Study

In the maritime industry, safety is highly important as minor incidents could result in environmental damage, loss of life and financial losses (Baalisampang, Abbassi, Garaniya, Khan & Dadashzadeh, 2018). The ship bridge, a central command centre, plays a significant role in communication, navigation, accident prevention and general ship management (Menon, 2020). There are industry standards and regulations outlined by the International Maritime Organisation (IMO), the International Safety Management (ISM) Code, which mandates the implementation of a Safety Management System (SMS) on board ships, and the International Convention for the Safety of Life at Sea (SOLAS) that govern the design and functionality of the ship bridge. These standards and regulations ensure that a ship bridge is well-equipped to handle various operational and emergencies such as fires.

According to Serra, Gianfranco, Marco, Mariangela and Andrea (2022), shipboard fires pose grave dangers, jeopardising crew safety and vessel integrity. In other words, when a fire incident occurs on a ship, the situation can escalate quickly, causing structural damage to the ship, endangering the life of crew members and sometimes loss of vessel. Ships experience fire incidents occasionally due to human error, equipment failure or inadequacy in ship design even though strict security measures are in place (Serra et al., 2022).

Ship nonconformity refers to any deviation from established safety, operational, or regulatory standards that could potentially compromise the safety of a vessel, its crew, or the environment. Nonconformities may arise from inadequate maintenance, faulty equipment, poor safety management practices, or failure to comply with international maritime regulations. These deviations are critical issues in the maritime industry, as they can lead to accidents, incidents or regulatory penalties. Addressing nonconformities effectively is central to ensuring the safety and efficiency of maritime operations.

Nonconformity is identified during routine inspections, audits, or post-incident investigations. Audits conducted by regulatory bodies, classification societies or third-party auditors play a significant role in detecting nonconformities. These audits involve examining the vessel's compliance with safety procedures, equipment maintenance, and crew training requirements.

## 1.2 Problem Statement

As the primary centre of vessel operations, ship bridge needs to comply with safety standards and regulations to reduce the risk of fire accidents (Kudryavtsev, Yanchenko & Androsenko, 2020). However, nonconformities in bridge design, equipment or operational procedures are believed to significantly compromise the safety of both the vessels and crews. Improper layout of navigation instruments, inadequate access to emergency exits, inadequate fire detection and suppression systems, and design flaws are some bridge nonconformities (Olsen, 2024; Danielsen, Lützhöft, Haavik, Johnsen & Porathe, 2022; Kaptan, Uğurlu & Wang, 2021). For instance, the crew's response to fire outbreaks could be delayed due to an improper bridge layout or other design flaws. Conversely, inadequate fire suppression systems could fail to contain or extinguish a fire in its early stages, allowing it to spread rapidly and causing more damage.

While the importance of addressing bridge nonconformity has been established in previous studies, there remains a significant gap in the empirical research that directly links these nonconformities to increased fire hazards. Existing studies (Danielsen *et al*, 2022; Kaptan *et al.*, 2021) have revealed ways bridge nonconformities can undermine safety or cause safety issues, but few studies have investigated how ship bridge nonconformities contribute to the occurrence and escalation of fire incidents on ships. Moreover, current fire hazard mitigation practices are often based on general safety standards that may not fully account for the unique risks posed by nonconforming ship bridges. Filling these research gaps is essential to developing more effective preparation and response strategies, ultimately reducing the vulnerability of ships to fire incidents. Therefore, this research aims to fill these gaps by investigating how ship bridge nonconformities contribute to the occurrence of fire hazards and proposing effective strategies for mitigating these risks.

## 1.3 Significance of the study

This study and its findings are expected to contribute to research, practice and industry regulations significantly. Specifically, it will add to the body of knowledge on maritime safety by providing valuable insights on how ship bridge nonconformity could contribute to fire hazards and how these risks can be mitigated. In addition, the research will help ship operators, designers and regulatory bodies to better understand the relationship between ship bridge nonconformity and fire safety, allowing proactive steps to be taken in addressing the problem. Findings from this study could inform maritime industry regulators to review or update existing maritime safety standards and regulations in order to address the risks linked with ship bridge nonconformities, thereby reducing the incidents of fire on ships.

## 1.4 Aim and objectives of the study

This study aims to answer the research question which is, how do ship bridge nonconformities contribute to the occurrence and escalation of fire hazards on vessels? The objectives of this research are:

- To identify common ship bridge nonconformities that can contribute to or increase fire hazards
- To determine the impact of identified ship bridge nonconformities
- To evaluate the effectiveness of current fire hazard mitigation practices on ship bridges
- To propose ways or strategies to mitigate ship bridge fire incidents

## 1.5 Research method

According to Bell, Bryman and Harley (2022), research methodology describes the steps taken in conducting particular research or techniques followed by the researcher to accomplish the research objectives, ensuring that the research is repeatable and its findings and results remain valid and reliable. The research method adopted for this study is a mixed-method study approach, combining both qualitative and quantitative data collection methods. A case-study and survey methods were both used for this research. This research approach was used because it allows a thorough examination of bridge fire incidents that occurred in the past as well as an analysis of the circumstances that led to their occurrence. This includes analysing the nonconformities involved and how they directly impact the occurrence of the fire incidents. Through the mixed-methods research approach, the researcher was able to analyse and understand the direct relationship between bridge nonconformities and fire hazards.

### 1.5.1 Case selection

Two cases were selected for this study and the case selection was based on two major criteria. Firstly, a detailed post-incident investigation report on the fire incidents was publicly available. Secondly, the fire started on the ship's bridge. The selected cases also involve different types of vessels to capture a range of possible nonconformities and their effects on fire safety.

### 1.5.2 Data collection method and instrument

Data used for this study was collected from investigation reports retrieved from the National Transportation Safety Board (NTSB) website and a semi-structured survey questionnaire. Searches were made on the website of NTSB (www.ntsb.gov) for relevant investigation reports on recent maritime vessel fires. Each report was screened to ensure that the incident was fire-related and that it occurred on the bridge. Data to be retrieved from the reports include the possible causes of the fire, the geographical location of where it occurred, nonconformities observed and the degree of destruction.

A semi-structured survey questionnaire was also designed and distributed using Microsoft Forms to gather supplementary data from experienced seafarers or seamen and maritime safety officers. This survey was designed to capture their perceptions regarding bridge nonconformities and the fire hazards associated with them, the effectiveness of fire hazard mitigation practices and suggested areas for improvements. The link to the survey questionnaire on Microsoft Forms was share with members of Marine Office Forum of Nigeria via their official WhatsApp group. The group has 950 members with various CoCs with different flag ships and experience. In addition, the link was shared with personnel of the Marine Department of Saudi Aramco's Industrial Services with different nationalities. Before the link was shared, all prospective respondents were brief about the purpose of the research and why their responses are important. The survey questionnaire page was kept opened for 14 days to receive responses and was closed afterward to start data analysis.

### 1.5.3 Data analysis

Data analysis in this study combined qualitative and quantitative approaches to thoroughly examine the impact of ship bridge nonconformities on fire hazards. Thematic analysis was applied to the NTSB investigation reports to identify common nonconformities such as design flaws and equipment failu\res. A cross-case comparison highlighted patterns and differences between the two incidents, providing context within maritime safety standards. Survey responses were analysed using descriptive statistics to summarize perceptions of fire risks and the effectiveness of mitigation practices. Correlation analysis explored relationships between specific nonconformities and perceived fire hazards. Findings from both analyses were compared and integrated to validate results and form a comprehensive understanding of how bridge nonconformities contribute to fire risks. This synthesis supports the development of targeted fire hazard mitigation strategies.

### 1.5.4 Ethical considerations

The survey participants were provided with informed consent before completing the questionnaire. They were also briefed on the research purpose. The researcher also ensured that participation was entirely voluntary and that their responses would remain anonymous. Hence, no personal or identifying information such as names was collected. The data collected was used solely for this research.

## 1.6 Limitations of the study

Despite providing insights into how ship bridge nonconformities contribute to fire hazards, this study is faced with some limitations. Firstly, there is a lack of adequate empirical studies on ship bridge nonconformities and shipboard fire hazards. Due to this gap in the literature, the study relied heavily on case studies and qualitative data but may not fully capture the broader implications of bridge nonconformities.

Another limitation is the low number of ship bridge-fire incident records in the public domain. Many investigation reports were either not publicly available or lacked the necessary details. Thus, reducing the data robustness and potentially affecting the generalisability of the findings. Moreover, this current study focused solely on bridge nonconformities. By concentrating exclusively on ship bridges, other important areas may have been overlooked in the study. This limits the applicability of the findings or results to broader fire safety practices within the maritime industry.

Lastly, the reliance on a limited number of case studies and self-reported data from surveys introduces the possibility of subjective or biased interpretation, affecting the overall reliability of the study. Additionally, the small sample size in the survey could limit the strength of the conclusions drawn.

# 2.0 Theoretical background

This chapter discusses the theoretical background of the study. This includes nonconformity in maritime safety, fire hazard and risk mitigation, ISM Code and SMS nonconformity and SOLAS and fire hazard mitigation.

## 2.1 Nonconformity in maritime safety

According to the IMO (n.d.), nonconformity (NC) or non-conformity is an “*observed situation where objective evidence indicates the non-fulfilment of a specified requirement*” of the ISM Code. They further define major non-conformity as “*identifiable deviation that poses a serious threat to the safety of personnel or the ship or a serious risk to the environment that requires immediate corrective action or the lack of effective and systematic implementation of a requirement of the”* ISM Code. Major nonconformity includes failures or errors in the implementation of the Safety Management System (SMS), critical ship design errors and equipment failures that could lead to accidents or damage (Chaudhari, 2021).

Standard NC and major NC have dissimilarities. Firstly, standard NC is an observed deviation from established procedures or regulations that do not pose an immediate threat but requires corrective action to prevent future issues while major NC is a more severe deviation that poses a serious threat and requires immediate corrective action to address the underlying issues and prevent recurrence (IMO, 2020). Standard NC could be a minor procedural lapse in equipment maintenance or a minor issue with the ship’s fire safety equipment (Kverndal, 2020). On the other hand, a significant failure in the ship’s fire detection and suppression system can be classified as a major NC (Kverndal, 2020).

Nonconformities are considered important in the maritime industry for continuous improvement. Hence, they need to be identified and addressed not only to ensure compliance with international safety standards but also to improve overall safety. Identifying nonconformity during routine inspections of vessels, audits or post-incident investigations is not uncommon. Conducting routine inspections such as checks on equipment on the ship, safety procedures and overall compliance with the ISM Code enables early detection of potential nonconformities and allows corrective actions to be taken immediately (Kantharia, 2020). Similarly, audits involve a thorough review of the ship's records, operational procedures and crew competencies. These audits are essential to verify that the practices on board align with the documented safety management system. Furthermore, post-incident investigations provide critical insights into the root causes of any accidents or incidents, thereby identifying possible nonconformities.

## 2.2 Fire hazard and risk mitigation

Wang, Wang, Shi, Fu & Zhu (2021) describe a fire hazard as a process, practice, operation or condition that increases the likelihood or probability of the occurrence of a fire or escalates the potential impact of the fire it occurs. Like ship nonconformity, fire hazards represent a threat to the safety of vessels, crews and the environment. This justifies it is important to always identify and address sources of fire hazards and address them on time. Besides, the confined spaces, machinery, equipment and presence of inflammable or combustible materials increase the risk of fire hazards on maritime vessels.

Kwiecinska (2015) identified some causes and factors contributing to the risk of fire and explosion in marine operations. They include damage to electrical equipment and cables, damage to mechanical equipment, structural damage to the ship's hull or its associated components, damage resulting from external factors, damage incurred during maintenance or repair activities, and the spontaneous ignition of cargo. However, Baalisampang *et al.* (2018) categorise these causes into four groups as illustrated in Figure 1.

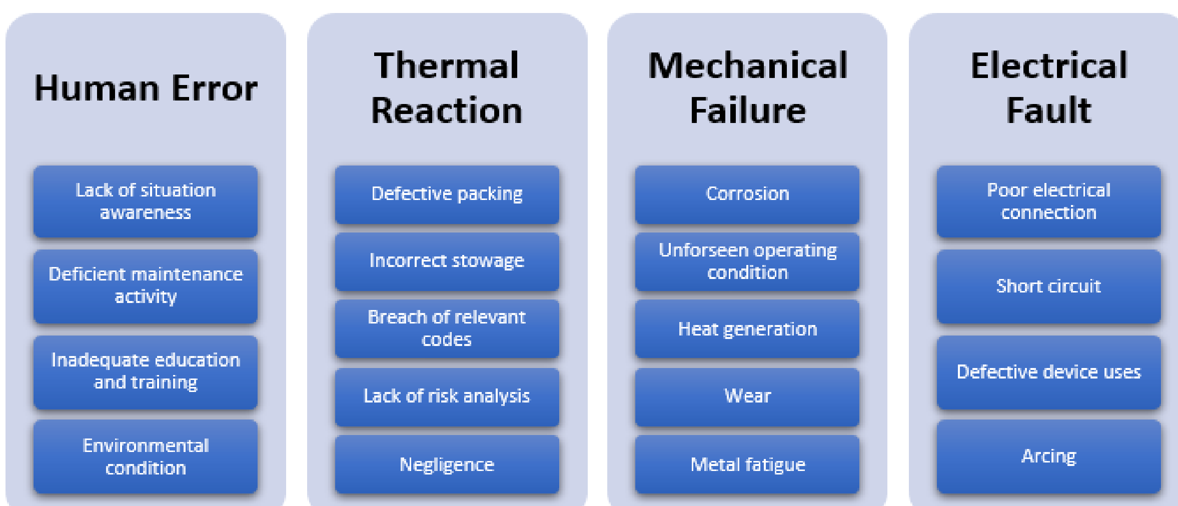


Figure 1. Causes of ship fires or explosions (Baalisampang *et al.*, 2018)

### 2.2.1 Human error as a cause of ship fires

Rothblum (2000) describes the maritime system as inherently people-centric, characterised by constant interaction between individuals, the environment, technology, and organizational factors. Hence, the potential for human error is significant in such a complex system, where human actions and decisions can directly influence the safety and operational integrity of a vessel. However, Shappell and Wiegmann (1997) opine while humans may not be solely responsible for the occurrence of ship accidents, their interactions with factors such as hardware, software, environmental conditions and actions of other individuals often lead to most accidents. Lack of situation awareness, deficient maintenance activity, inadequate education and training and environmental conditions are some causes of human error.

Lack of situational awareness can result in the misinterpretation of critical information or delayed responses to emerging fire hazards, thereby increasing the likelihood of fire and explosion. Similarly, deficient maintenance activities such as inadequate or poor hazard analysis, violations of hot work procedures, and non-compliance with confined space entry permit guidelines can contribute to fire accidents (Okoh & Haugen, 2014). Inadequate education and training further exacerbate these risks, as crew members may lack the necessary skills and knowledge to manage complex situations or respond to emergencies effectively (Baalisampang *et al.*, 2018). Another cause of human error is the environmental conditions in which crew members operate. Unfavourable environmental conditions can impair the effective performance of duties, leading to increased stress and fatigue. For instance, physical exhaustion resulting from high temperatures, exposure to high sea states, excessive vibration, noise and unsuitable temperature levels, can diminish a person's capacity to work efficiently and safely (Baalisampang *et al.*, 2018). The environment in this context also extends beyond weather and physical work conditions to include the broader regulatory and economic climates (Rothblum, 2000).

### 2.2.2 Thermal reaction as a cause of ship fires

In the shipping industry, the auto-ignition or reaction of loaded Hazardous and Noxious Substances (HNS) contributes to some fires and explosions (Baalisampang *et al.*, 2018). Defective packaging and improper stowage practices can lead to leaks, spills or the unintended mixing of incompatible chemicals, aggravating the potential for violent reactions or natural ignition or explosion (Baalisampang *et al.*, 2018). Additionally, breaching relevant safety codes, such as the International Maritime Dangerous Goods (IMDG) Code increases the risk of fire or explosion in a vessel (Ozcayir, 2007). The IMDG Code for instance provides guidelines on the classification, packaging, labelling and stowage of dangerous goods to ensure their safe transport by sea. The lack of thorough risk analysis before loading and transporting HNS increases the likelihood of accidents (Abbassi *et al.*, 2017). Besides, negligence in handling, stowing and monitoring HNS cargoes is also a contributing factor (Baalisampang *et al.*, 2018).

### 2.2.3 Mechanical failure as a cause of ship fires

Baalisampang *et al.* (2018) highlight that corrosion is one of the major contributing factors to mechanical failures in marine vessels and offshore structures, largely due to the harsh environmental conditions. It leads to the degradation of structural materials, resulting in the loss of critical mechanical properties such as strength and ductility, which can ultimately cause structural failure (Popoola *et al*., 2013). Baalisampang *et al.* (2018) also explain that mechanical failures can arise from unforeseen operating conditions. These conditions may include extreme weather or unexpected loads that exceed the design specifications of equipment, leading to failures that can ignite fires. Fires often originate from oil or fuel leaks coming into contact with hot surfaces, particularly in engine rooms. Det Norske Veritas (2000) reveals that some ship fires started this way. Wear and metal fatigue also lead to the degradation of components, making them susceptible to failure.

### 2.2.4 Electrical fault as a cause of ship fires

Poor electrical connections can lead to increased resistance, generating heat that may ignite surrounding materials (Jadin & Taib, 2012). Faulty connections can create hotspots that escalate into larger fires. Likewise, short circuits occur when electrical current flows along an unintended path and leads to excessive current flow and these can cause overheating and potentially ignite fires (Jadin & Taib, 2012). The use of defective electrical devices such as can also lead to fires. Faulty or improperly maintained equipment can malfunction and electrical failures can occur as well as ignite flammable materials. Arcing is a phenomenon where an electrical current jumps across a gap and creates a high-temperature spark which can occur due to poor insulation or damaged wiring (Babrauskas, 2008). Arcing faults are particularly dangerous as they can ignite combustible materials nearby, leading to catastrophic fires on ships.

## 2.3 ISM Code and SMS nonconformity

The IMO developed the ISM Code to be used as a central or fundamental framework maritime operators and shipping companies can implement to ensure maritime safety and environmental protection. The ISM Code was developed as a response to many catastrophic maritime accidents and tragedies that occurred in the late 1980s, the most notable was the Herald of Free Enterprise disaster that occurred on March 6, 1987, where a passenger ferry capsized shortly after leaving port, resulting in 193 deaths (Yves, 2018; Anderson, 2015). Investigations into this particular incident and related incidents revealed systemic failures in ship management, particularly concerning safety procedures and the organisational culture of shipping companies (Anderson, 2015).

With the advent of the ISM Code, all shipping companies are mandated to develop and implement a personalised Safety Management System (SMS), to safely manage their ship operations and prevent environmental pollution (Golapalli, 2003). The Safety Management System is a well-structured and documented system that ensures ship or maritime operators maintain safe practices in ship operation and a safe working environment (Li & Guldenmund, 2018). In addition, the system specifies procedures for reporting accidents and nonconformities, in order to ensure that lessons are learned and that continuous improvements are implemented (Li & Guldenmund, 2018). There are safety procedures, policies, standards and regulations are outlined in an SMS and any deviation from any of them is referred to as nonconformity. The deviation may pose serious risks to the safety of the vessel and its crew, whether they arise from inadequate maintenance, insufficient crew training or procedural lapses (Kverndal, 2020).

Nonconformities can range from minor administrative errors to major safety oversights, each potentially compromising the ship's compliance with the ISM Code and its overall safety performance (Chaudhari, 2021). Most importantly, these nonconformities can have severe consequences, particularly when they affect critical safety systems, such as those designed to prevent or respond to fire hazards. For example, if a ship's fire detection and suppression systems are not regularly maintained as required by the SMS, they may fail to detect a fire in its early stages, leading to a rapid escalation of the fire. Similarly, if crew members are not adequately trained in emergency procedures, their response to a fire outbreak may be delayed or ineffective, increasing the risk of widespread damage and loss of life. These risks are addressed by the ISM Code by explicitly mandating regular SMS audits and reviews to identify nonconformities and address them. The audits are required by shipping organisations or maritime operators to comply with the ISM Code and support continuous improvement in safety practices (IMO, 2020). Corrective actions are also required to be promptly implemented to address all identified nonconformities with the establishment of follow-up procedures to prevent recurrence of the nonconformities.

## 2.4 SOLAS and fire hazard mitigation

The International Convention for the Safety of Life at Sea (SOLAS) is an important international maritime treaty that was established to ensure that ships comply with minimum safety standards in construction, equipment and operation (Joseph & Dalaklis, 2021). The SOLAS Convention was first adopted in 1914 in response to the Titanic disaster, but it has been revised several times to keep it up to date as new maritime safety challenges keep emerging (Cook, 2020). SOLAS 1974 as amended, includes numerous amendments that cover various aspects of maritime safety, with fire safety provisions for all categories of ships (IMO, 2020). Chapter II-2 of SOLAS is for fire protection, fire detection and fire extinction (see Figure 2). This chapter outlines regulations aimed at preventing fire incidents on ships, controlling the spread of fire and ensuring the effective extinguishment of fires should they occur (IMO, n.d.). Additionally, it includes requirements for fire-resistant materials in ship construction, mandatory fire detection and alarm systems and the provision of fire-extinguishing appliances on board. Moreover, SOLAS mandates that all ships have a fire safety operational booklet (Regulation 15), detailing the procedures for handling various fire scenarios which must be readily accessible to all crew members (Shiokari, 2019).

Compliance with SOLAS fire safety regulations is a legal obligation and an important part of maritime safety management. As a rule, a shipping company cannot be certified to operate internationally, if its vessels are fully compliant with SOLAS provisions. The certification process involves regular inspections and audits conducted by classification societies, which assess the adequacy of fire safety measures on board. Hence, ships found to be non-compliant may be detained or face penalties.

SOLAS Chapter II-2 primarily aims to mitigate fire hazards by establishing a set of preventive measures and response protocols. The measures are the design and arrangement of ships to minimise the risk of fire and its spread, the installation of fire detection and suppression systems and the training of crew members in fire prevention and emergency response (MDM, 2023). By enforcing these standards, the SOLAS Convention reduces the probability of fire incidents on board and ensures that, if a fire does occur, it can be quickly contained and extinguished, thereby minimising damage to the vessel and risk to human life (Sanchez, 2016). According to Kristiansen (2013), SOLAS regulations for fire safety can be more effective when they are properly implemented and crew members are continuously trained.

## 2.5 Crew compliance and ship Bridge Procedures Guide

Ensuring the safe operation of vessels requires that the crew comply with all safety regulations and protocols that are in place, most especially those stationed on the bridge. They also play a vital role in maintaining safety on board and responding to emergencies. If the crew is unable to fully comply with the established safety procedures, it may result in accidents, damage and loss of life. Hence, compliance with established safety procedures is highly important to minimise risks or prevent accidents on board.

Baldauf et al. (2016) emphasise that training crew members on safety procedures is an effective way to promote compliance. There is a need to always train crew members in the safety protocols, operational procedures and emergency response measures related to the ship bridge. Parts of training include providing refresher courses on safety and regular drills. These are necessary to ensure the crew remains proficient in handling the ship's navigation and communication systems and responding to potential fire hazards and incidents. Moreover, the Standards of Training, Certification, and Watchkeeping for Seafarers (STCW) sets the international requirements for seafarers' training, including essential competencies in firefighting and fire prevention. Under STCW, all crew members must undergo basic training in firefighting techniques, fire prevention strategies and the use of fire safety equipment. This training ensures that crew members are well-prepared to respond to fire emergencies, which is crucial for maintaining safety on the ship's bridge (Saarheim & Browne, 2016).

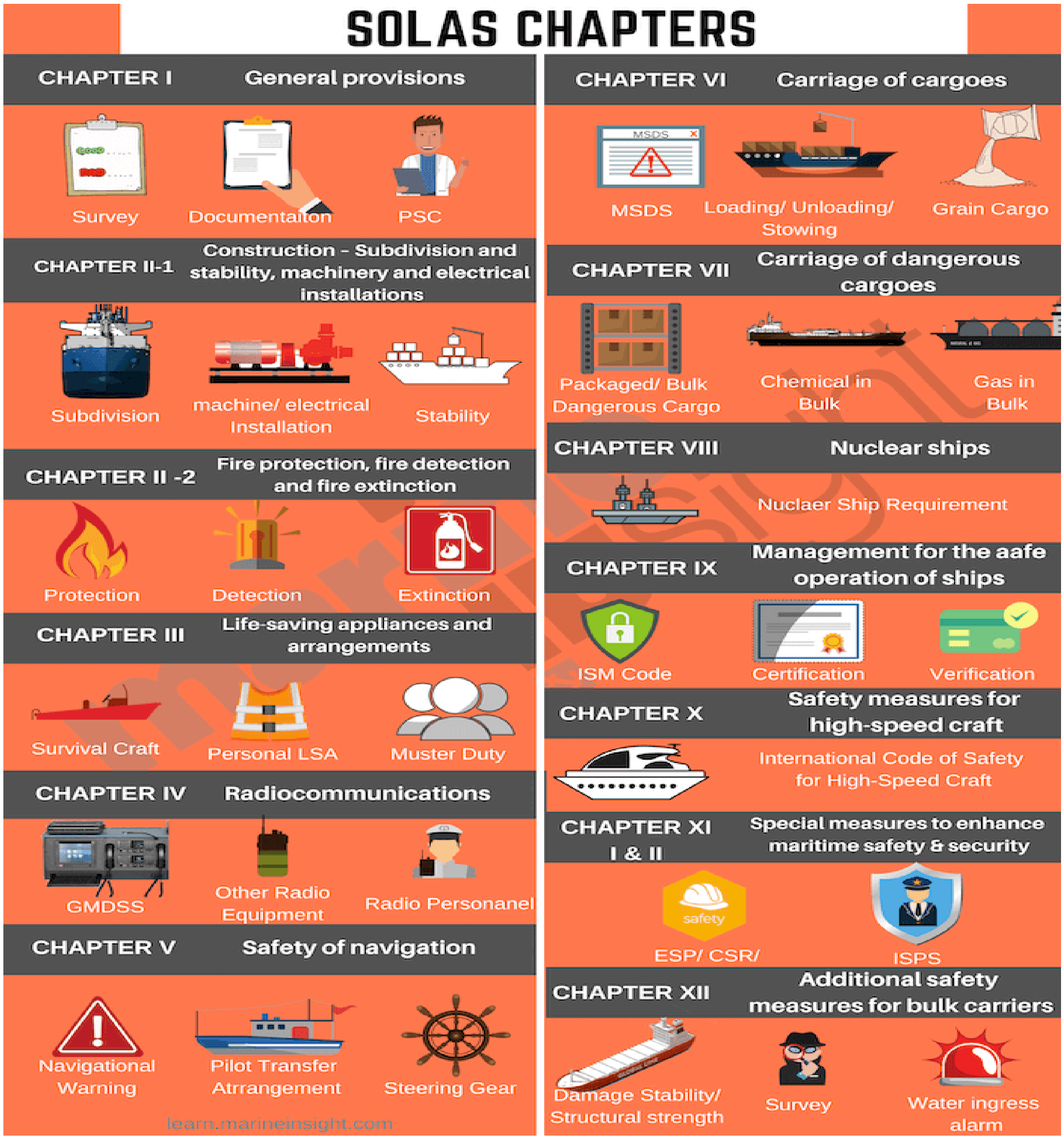


Figure 2. A pictorial illustration of the SOLAS Chapters (Kantharia, 2020)

The International Chamber of Shipping (ICS) Bridge Procedures Guide serves as a comprehensive manual that outlines the safe operation of the ship's bridge. It includes detailed instructions on the use of navigational equipment, communication protocols and emergency procedures (ICS, 2016). It also provides guidelines on maintaining situational awareness and adhering to safety regulations while operating on the bridge. Compliance with the Bridge Procedures Guide ensures that all bridge operations are conducted safely and efficiently (ICS, 2016). The Bridge Procedures Guide is used together with the SMS in daily operations. As emphasised in section 2.3, the SMS includes regular audits and inspections to verify that bridge procedures are being followed correctly. The SMS also emphasises the importance of reporting and addressing any nonconformities or safety concerns related to bridge operations.

# 3.0 Case studies and analysis

After diligently searching through the investigation reports database of the National Transportation Safety Board (NTSB), checking and skimming through several reports, two incidents met the selection criteria which are publicly available and accessible investigation reports and the fire incidents started on the vessel's bridge or wheelhouse.

## 3.1 Case 1 – S-Trust oil tanker fire incident

The S-Trust Oil Tanker, on November 13, 2022, experienced a significant fire while docked at the Genesis Port Allen Terminal in Baton Rouge, Louisiana. The fire originated on the bridge of the vessel at approximately 15:30 Central Standard Time (CST) Position (30°26.47' N, 91°11.99' W). The crew acted swiftly to extinguish the blaze within 20 minutes, preventing any injuries and avoiding environmental contamination. However, the fire resulted in substantial damage to the vessel's bridge equipment and infrastructure (see Figure 3), with repairs estimated to cost around $3 million.

The S-Trust had docked two days earlier, on November 11, 2022, to offload approximately 464,926 barrels of high-sulphur fuel oil. During the early afternoon of November 13, 2022, while offloading operations were ongoing, the master of the vessel noticed that the video feed from the bridge camera was no longer visible on his monitor. Concerned, he went to the bridge to investigate and upon opening the door, he was met with thick smoke. He immediately ordered the cessation of cargo operations and notified the chief mate, who then informed the terminal personnel and contacted the local fire department.

The master and the crew quickly mustered into two firefighting teams. They used hoses to combat the fire from both the port and starboard bridge doors after securing the electrical power on the bridge. By 15:50, the fire was successfully extinguished. The local fire department arrived shortly thereafter to ensure the fire was completely out.

Figure 3. Damage of fire to the bridge. (NTSB, 2023).

The fire caused extensive damage to the bridge, including the destruction of the navigation, communication, and alarm systems, all of which were deemed irreparable. However, the fire did not spread beyond the bridge, leaving the lower decks and other parts of the vessel undamaged.

### 3.1.1 Analysis of the fire incident

Investigation of the incident by the Coast Guard and Bureau of Alcohol, Tobacco, Firearms and Explosives (ATF) reveals that the fire, which broke out on November 13, 2022, at the Genesis Port Allen Terminal in Baton Rouge, Louisiana, was initiated by a lithium-ion battery cell. This fire occurred on the vessel's bridge, where batteries and chargers for hand-held radios communication table were located.

The fire was initiated by the thermal runaway of a lithium-ion battery cell, which is a condition where the cell overheats and undergoes a chemical reaction that can lead to an explosion. This was evidenced by the closed-circuit camera footage that captured an orange flash and subsequent smoke from the communication table where the batteries were kept (see Figure 4). Moreover, the investigators from ATF discovered the remains of three batteries (one nickel-metal hydride and two lithium-ion) on the communication table. One lithium-ion battery was identified as the source of the explosion, while the other likely exploded due to the heat generated by the initial explosion.


Figure 4. CCTV photos of how the fire started. (NTSB, 2023).

It was reported that the thermal runaway likely ignited nearby combustible materials, causing the fire to spread rapidly across the bridge. The analysis confirmed that the subsequent heat and flames were responsible for total damage to the bridge's alarm, communication system and navigation systems.

The vessel did not have a fire or smoke detection system on the bridge, which allowed the fire to grow undetected until it was visible through the loss of the camera feed to the master's office. The absence of personnel on the bridge during docked operations also delayed the detection and response to the fire.

### 3.1.2 Contribution of nonconformity to the fire incident

In the S-Trust case, some nonconformities were observed and they might have contributed to the occurrence and escalation of the fire incident. Firstly, the vessel's safety management system (SMS) appears to have lacked adequate measures to mitigate the risks associated with lithium-ion batteries. Specifically, there was no clear protocol for the handling, charging, and monitoring of these batteries to prevent incidents like thermal runaway. Given the known risks of lithium-ion batteries, particularly their potential for thermal runaway, the absence of specific risk management measures constitutes a major nonconformity.

Secondly, according to the investigation report, the bridge was not legally required to have smoke detectors alarm system complied with Method IC from the *International Convention for the Safety of Life at Sea (SOLAS)* 1974 (IMO/MSC.1/Circular 1456 Annex 1). However, the lack of fire detection system on the bridge also contributed to the delayed response to the fire. The incident was only detected because the master noticed the camera feed was no longer working. Had there been a more effective fire detection system in place, the fire could have been identified earlier, potentially reducing the damage. This represents a shortcoming in emergency preparedness.

The investigation revealed that there were issues with the charging of the batteries on the day of the fire, suggesting potential deficiencies in the maintenance and inspection of the charging equipment and electrical systems on the bridge. If the battery chargers or the batteries themselves were not functioning correctly, this could have contributed to the thermal runaway. The failure to identify and rectify these issues before they led to a fire represents a nonconformity.

### 3.1.3 Safety considerations and lessons learned from the incident

The S-Trust incident emphasises the risks associated with lithium-ion batteries, particularly in enclosed spaces like a ship's bridge. These batteries can be dangerous if they overheated and damaged or are improperly charged. This particular incident stresses the need for strict adherence to manufacturer guidelines for battery maintenance and charging. Additionally, the incident suggests the importance of considering enhanced fire detection and suppression systems in areas of a vessel where lithium-ion batteries are stored or charged.

## 3.2 Case 2 – Blue Dragon fishing vessel fire incident

A fire broke out aboard Blue Dragon Fishing Vessel on November 10, 2021, at approximately 00:15 PST, while it was engaged in longline fishing operations in the North Pacific Ocean, about 350 miles off the coast of Monterey, California. The fire escalated so fast and engulfed the vessel (see Figure 5), forcing the six crew members and one National Marine Fisheries Service (NMFS) observer onboard to abandon the ship. They were later rescued by a passing vessel. Despite the severity of the incident, no injuries were reported, and the Blue Dragon was eventually towed back to San Pedro, California. The estimated damage to the vessel exceeded $500,000.


Figure 5. Damage of fire to the vessel. (NTSB, 2022).

The vessel departed from Honolulu, Hawaii, on October 25, 2021, and was on its way to Long Beach, California, after completing its fishing operations. On the night of the incident, the crew was preparing to retrieve fishing gear when the NMFS observer noticed a fire originating from underneath the control panel in the wheelhouse. The captain, who was napping at the time, was alerted, and the crew attempted to extinguish the fire using portable fire extinguishers. However, their efforts were unsuccessful, as the fire rapidly spread, destroying the wheelhouse and filling it with thick black smoke.

On recognising the futility of their firefighting attempts, the crew abandoned the vessel after retrieving the emergency position indicating radio beacon (EPIRB) and deploying the liferaft. They also activated various emergency communication devices, including a personal locator beacon (PLB) and a satellite emergency notification device (SEND). These devices alerted the United States Coast Guard and initiated a rescue operation.

### 3.2.1 Analysis of the fire incident

The investigation conducted by the NTSB on the Blue Dragon incident suggests that the fire likely originated from an electrical fault under the wheelhouse console. The fire then spread rapidly due to the presence of combustible materials in the wheelhouse and accommodation areas, including wooden construction elements and stored items like paint cans and welding rods. The fire most likely started under the wheelhouse console due to substandard electrical wiring. The console's wiring on a similar vessel, Blue Dragon II, was found to be below marine standards, supporting the theory that an electrical issue ignited the fire.

The extensive use of combustible materials in the vessel's construction and furnishings, as well as the storage of flammable items, contributed to the rapid spread of the fire. The limited firefighting equipment on board, including insufficient hose reach and the reliance on fire extinguishers, was inadequate to control the fire.

The quick actions of the crew and NMFS observer, including the deployment of the life raft and activation of emergency beacons, were crucial for their survival. The observer’s use of a satellite emergency notification device (SEND) and personal locator beacons (PLBs) played a significant role in the timely rescue operation.

### 3.2.2 Contribution of nonconformity to the fire incident

The discovery of substandard electrical installations on a sister vessel (Blue Dragon II), which had similar conditions to the Blue Dragon, indicates that the electrical system on the Blue Dragon was likely below the required safety standards. The use of non-marine grade wiring, improper connections, and loose wiring present a clear risk of electrical faults and fires. This constitutes a major nonconformity, as it directly compromises the vessel's safety and could have been a preventable cause of the fire.

Furthermore, the affected vessel lacked a smoke detection system in the wheelhouse, which delayed the detection of the fire and allowed it to spread unchecked. The absence of such a critical safety system is another nonconformity, as it hindered the crew's ability to respond effectively to the fire in its early stages, thereby exacerbating the damage.

Besides, the crew's difficulty in effectively using the water (wash down) hose to fight the fire indicates that the firefighting equipment was inadequate. The hose was either too short or poorly maintained, preventing the crew from reaching the fire. This is a nonconformity that potentially contributed to the fire's uncontrolled spread.

Finally, the Blue Dragon had a high fire load due to the extensive use of combustible materials in its construction, furnishings and the presence of paint cans and welding rods stored beneath the wheelhouse. The improper management of these combustible materials, which is another nonconformity, contributed to the rapid spread of the fire.

### 3.2.3 Safety considerations and lessons learned from the incident

The Blue Dragon incident provides an insight into the critical dangers posed by substandard electrical installations on vessels, particularly in high-risk areas like the wheelhouse or bridge. This case highlights the importance of ensuring that all electrical systems onboard are installed and maintained according to marine standards to prevent electrical faults that could lead to catastrophic fires. The necessity of equipping key areas of the vessel with effective fire detection systems to enable early intervention is also shown in this case. Furthermore, the incident emphasises the need for proper management and storage of combustible materials, which can exacerbate fire hazards if not handled appropriately.

## 3.3 Survey results and analysis

This subsection reveals the results from the survey questionnaire and data analysis. The inferences drawn were also highlighted in this subsection. The survey questionnaire was designed via Microsoft Forms and shared digitally with individuals who are members of the Marine Office Forum of Nigeria and personnel of the Marine Department of Saudi Aramco's Industrial Services.

### 3.3.1 Demographic information of respondents

Thirty-eight (38) respondents answered the survey questionnaire distributed electronically via Microsoft Forms. As shown in Figure 6, the majority of respondents were seafarers, with 65.8% (25) identifying as deck officers. This group plays a pivotal role in ship navigation, safety, and compliance with bridge protocols, making their perspectives invaluable. 15.8% (6) were engine officers, whose expertise in machinery and technical systems provides a unique understanding of equipment-related fire hazards. 5.3% (2) were seamen, who perform general duties onboard, offering frontline observations of operational nonconformities. Another 5.3% (2) were ship managers or Designated Persons Ashore (DPA), individuals responsible for implementing safety management systems, adding a managerial perspective. Similarly, 5.3% (2) were motormen, skilled in maintaining engines and auxiliary machinery, contributing technical insights. Finally, 2.6% (1) were ship inspectors/surveyors, who assess regulatory compliance and safety, offering a regulatory viewpoint.

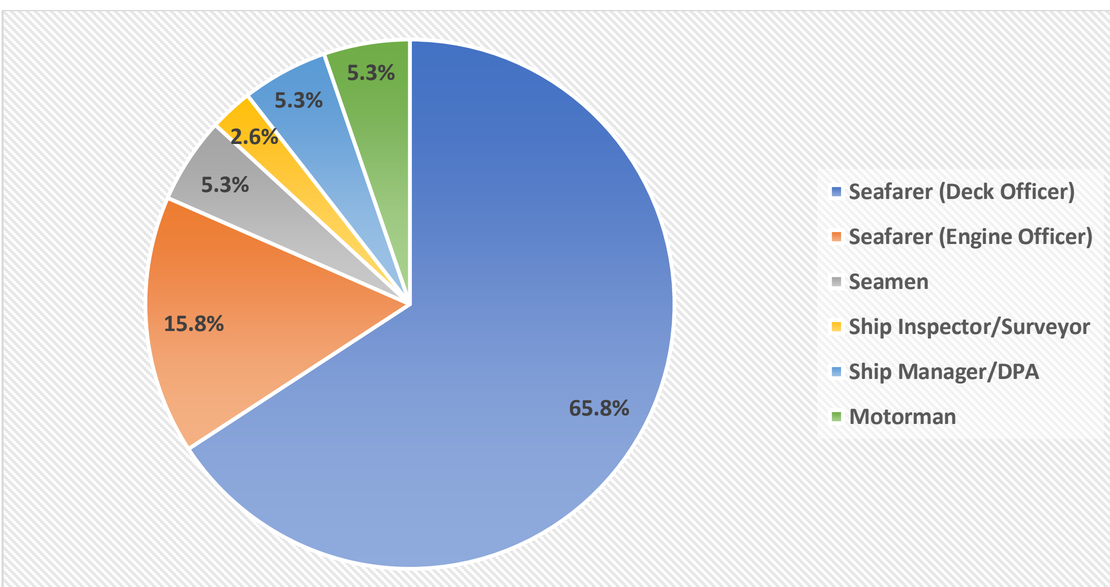


Figure 6. Current roles of survey respondents.

Figure 7 depicts the years of experience of the survey respondents in the maritime industry. Respondents' years of experience varied significantly, providing a broad spectrum of expertise. 39.5% (15) had less than 5 years of experience, representing newer entrants who may have fresh perspectives on current safety protocols. 26.3% (10) had 4-10 years of experience, combining familiarity with ship operations and ongoing professional development. 13.2% (5) had 11-15 years of experience, reflecting a strong command of industry practices. Similarly, 13.2% (5) had more than 20 years of experience, bringing veteran insights into long-term trends in maritime safety. Finally, 7.9% (3) had 16-20 years of experience, balancing seasoned expertise with familiarity with contemporary safety advancements.

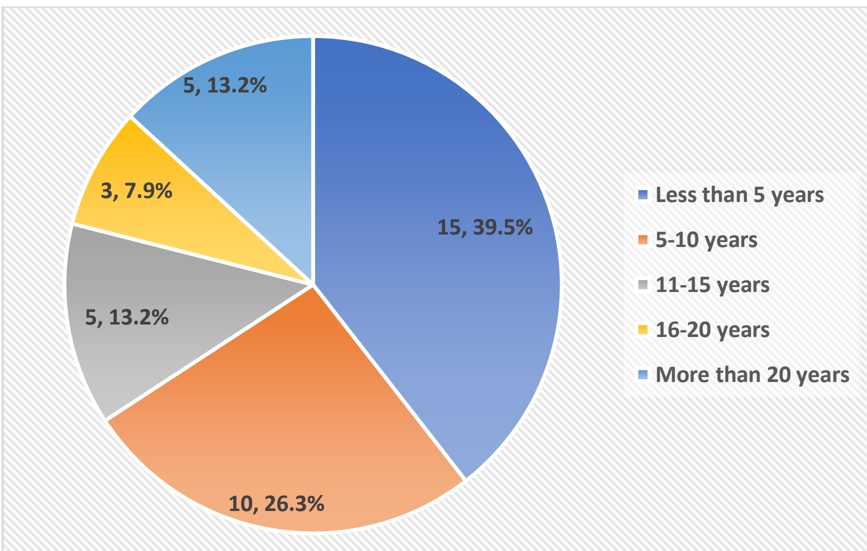


Figure 7. Years of experience of survey respondents.

Most respondents had diverse experience with various ship types, highlighting their comprehensive understanding of bridge operations. As shown in Figure 8, 68.4% (26) had worked on cargo ships, commonly used for transporting goods, where fire hazards may arise from cargo handling. 55.3% (21) had experience on passenger ships, emphasizing safety-critical operations for large populations. 26.3% (10) had operated tanker vessels, known for heightened fire risks due to hazardous cargo. Additionally, 23.7% (9) had worked on offshore vessels, while 2.6% (1) each had experience on hospital ships, fishing vessels, and icebreaker vessels, illustrating familiarity with niche operations and associated safety challenges.

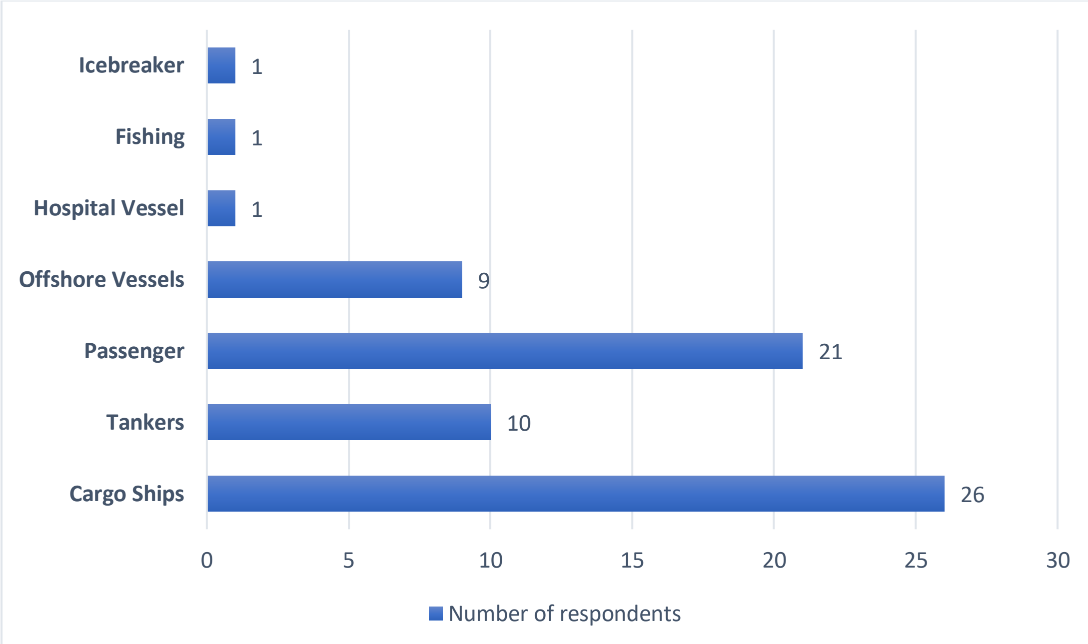


Figure 8. Types of vessel respondents have worked on.

The respondents possessed a wide range of maritime certifications, showcasing varied expertise levels. 52.6% (20) held a "Rating Forming Part of a Navigational Watch" certification, reflecting fundamental navigation skills. 39.5% (15) held the "Officer in Charge of the Navigational Watch (OICNW)" certificate, indicating advanced bridge operational knowledge. Additionally, 21.1% (8) had "Rating Forming Part of an Engineering Watch" certifications, showcasing technical expertise in monitoring engineering systems. Higher certifications included 13.2% (5) as Master, 10.5% (4) as Chief Mate, and smaller proportions as Second Engineer Officer (5.3% (2)), Third Engineer Officer (2.6% (1)), and Chief Engineer (2.6% (1)), highlighting representation across operational and managerial roles.

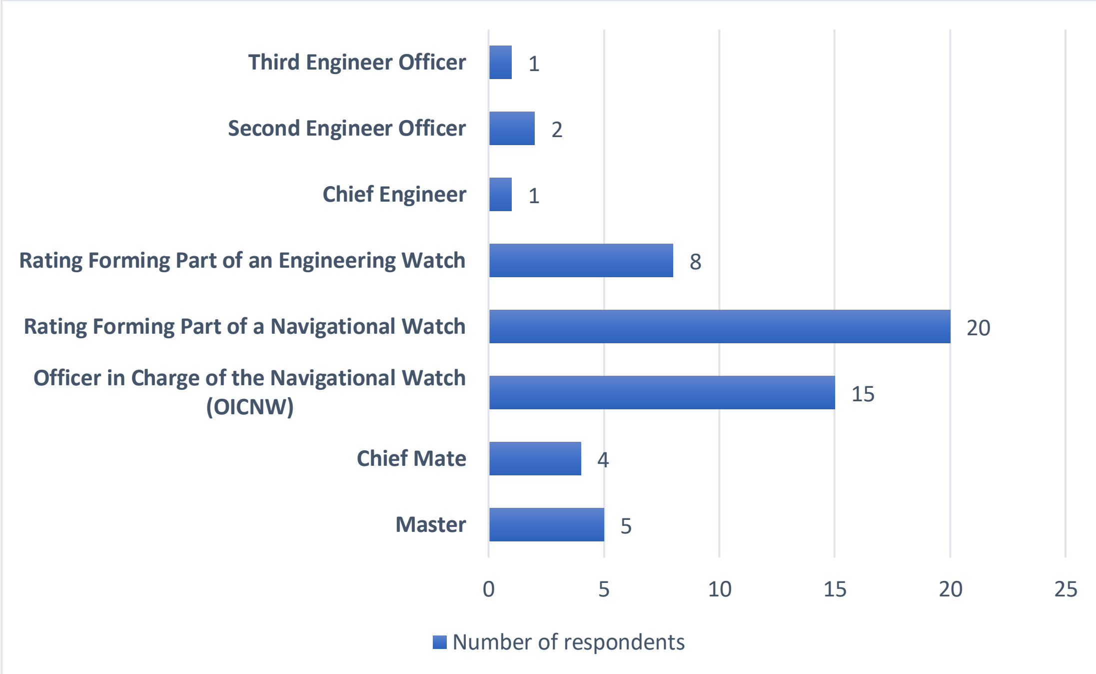


Figure 9. Certifications held by survey respondents.

### 3.3.2 Identification of common ship bridge nonconformities

Respondents were how often they encountered nonconformities on the ship bridge and the ship bridge nonconformities they had encountered. As shown in Figure 10, 15 respondents (39.5%) rarely encountered nonconformities on ship bridges, 14 respondents (36.8%) sometimes encountered bridge nonconformities, 4 respondents (10.5%) never encountered ship bridge nonconformities while 3 respondents (7.9%) and 2 respondents (5.3%) often and always encountered ship bridge nonconformities respectively.

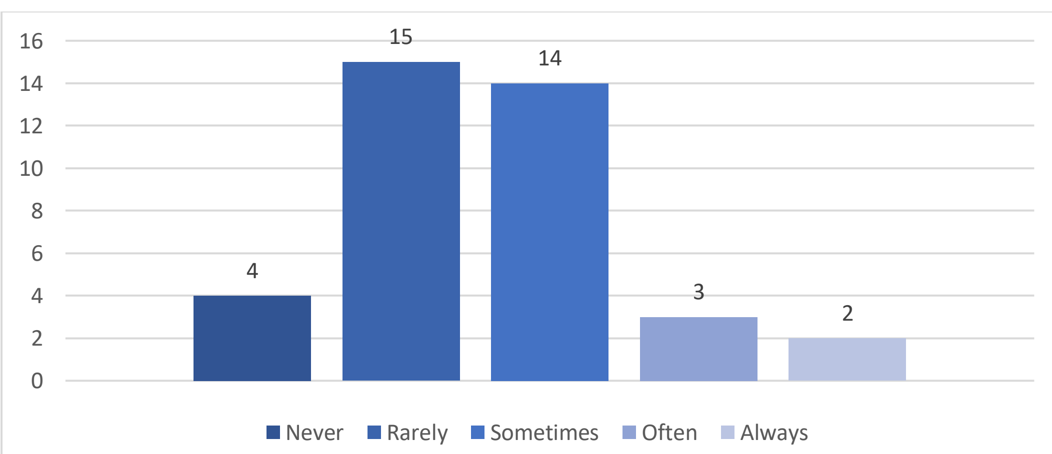


Figure 10. Frequency of encountering ship bridge nonconformities.

The 38 respondents were asked to select all the ship bridge non-conformities they have observed before, however only 37 responded to this question. As shown in Table 1, 11 respondents (29.7%) chose inadequate maintenance of equipment. 10 respondents (27.0%) selected poorly functioning fire detection system. 7 respondents (18.9%) chose faulty electrical wiring while 12 respondents (32.4%) chose lack of proper communication systems. 10 respondents (27.0%) chose obstructed emergency exits. 14 respondents (37.8%) selected inadequate training of bridge personnel, and 15 respondents (40.5%) selected poor housekeeping. 1 respondent (2.7%) chose inadequate lashings on loose items and 1 respondent (2.7%) chose disobeying safety signs and instructions. 3 respondents (8.1%) wrote no conformities were observed. This indicated that poor housekeeping, inadequate training of bridge personnel and other nonconformities selected by respondents contribute to an increased risk of accidents and hinder efficient operations on the bridge of any vessels.

Table 1. Ship bridge nonconformities encountered

| | **Number of Responses** | **Percent (%)** |
|---|---|---|
| Inadequate maintenance of equipment | 11 | 29.7 |
| Poorly functioning fire detection systems | 10 | 27.0 |
| Faulty electrical wiring | 7 | 18.9 |
| Lack of proper communication systems | 12 | 32.4 |
| Obstructed emergency exits | 10 | 27.0 |
| Inadequate training of bridge personnel | 14 | 37.8 |
| Poor housekeeping | 15 | 40.5 |
| Inadequate lashings on loose items | 1 | 2.7 |
| Disobeying safety signs and instructions | 1 | 2.7 |
| None | 3 | 8.1 |

When asked if they agree these bridge nonconformities contribute to bridge fire hazards, as revealed in Figure 11, 18 respondents agreed while 5 respondents strongly agreed that these bridge nonconformities contribute to bridge fire hazards. Three respondents disagreed while 2 respondents strongly disagreed that these bridge nonconformities contribute to bridge fire hazards. Ten respondents, however, were neutral (neither agree or disagree). These results confirme the assertion that bridge nonconformities significantly increase fire risk on a ship bridge as reported by Baalisampang et al. (2018).

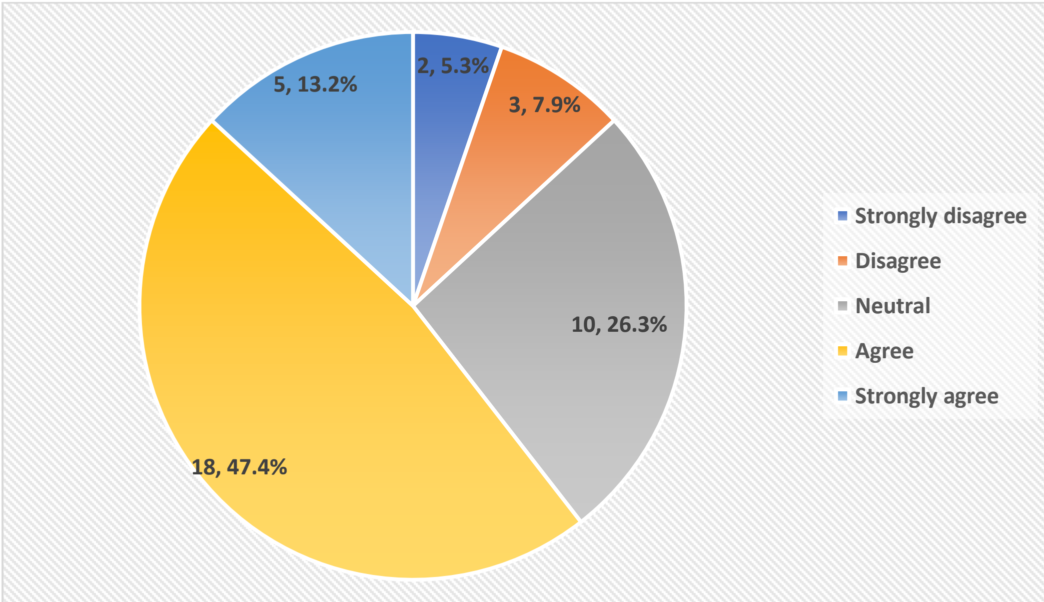


Figure 11. Ship bridge nonconformities contribute to bridge fire hazards.

### 3.3.3 Impact of ship bridge nonconformities on fire hazards

Respondents were how often they believe ship bridge nonconformities lead to fire-related incidents. The results are presented in Figure 12. 18 respondents (47.4%) believed ship bridge nonconformities sometimes lead to fire-related incidents, 15 respondents (39.5%) believed ship bridge nonconformities rarely result in fire-related incidents, 3 respondents (7.9%) believed bridge nonconformities always result in fire-related incidents and 2 respondents (5.3%) believed bridge nonconformities often lead to fire-related incidents.

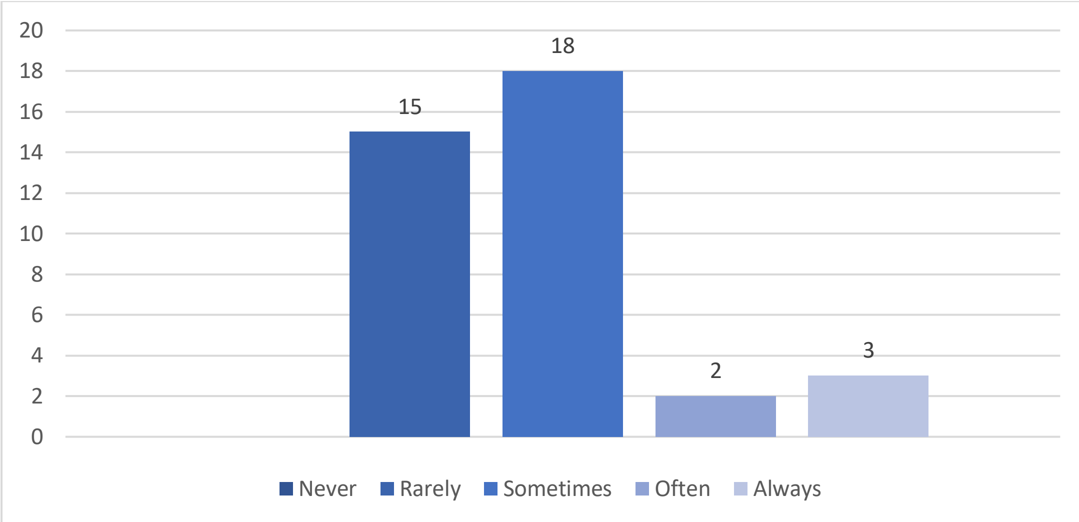


Figure 12. How often do ship bridge nonconformities lead to fire.

For factors that contribute to the escalation of a fire hazard on a vessel due to ship bridge nonconformities, as revealed in Figure 13, 26 respondents selected delayed detection of fire, 26 respondents chose inability to communicate effectively during an emergency, 19 respondents selected electrical fires from faulty wiring while 19 respondents chose failure to initiate proper fire suppression measures.

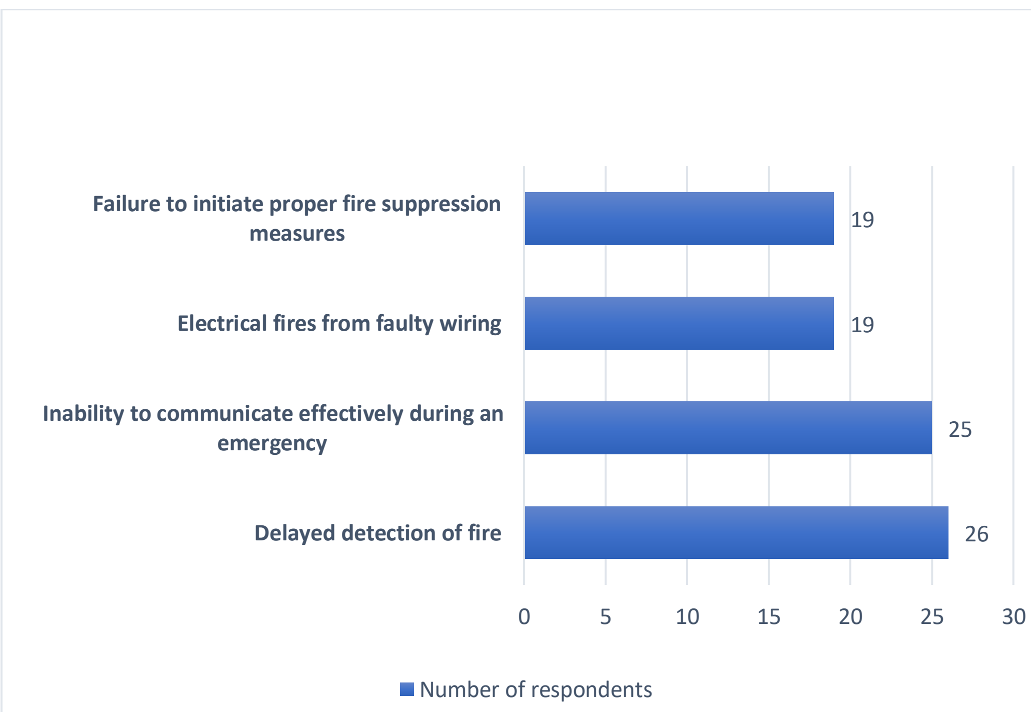


Figure 13. Fire-escalating factors on a vessel due to bridge nonconformities.

Respondents were asked to rate the potential impact of ship bridge nonconformities on certain areas in terms of fire hazard escalation. The results are presented in Table 2. Respondents rated bridge nonconformities to have a moderate impact on navigation equipment to have a moderate impact (Mean=2.82), high impact on communication systems (Mean=3.26), electrical systems (Mean=3.89), emergency protocols (Mean=3.66) and training of personnel (Mean=3.97). As the overall impact is 3.52, it implies that ship bridge nonconformities have a high impact on fire hazard escalation.

Table 2. Potential impact of bridge nonconformities on specific areas regarding fire escalation

| | **No Impact (1)** | **Low Impact (2)** | **Moderate Impact (3)** | **High Impact (4)** | **Very High Impact (5)** | **Mean** |
|---|---|---|---|---|---|---|
| Navigation Equipment | 2 | 17 | 9 | 6 | 4 | 2.82 |
| Communication Systems | 3 | 8 | 9 | 12 | 6 | 3.26 |
| Electrical Systems | 0 | 1 | 12 | 15 | 10 | 3.89 |
| Emergency Protocols | 0 | 6 | 10 | 9 | 12 | 3.66 |
| Training of Personnel | 1 | 4 | 6 | 11 | 16 | 3.97 |
| Overall | | | | | | 3.52 |

## 3.3.4 Evaluation of fire hazard mitigation practices

Respondents were asked to evaluate the effectiveness of the current fire hazard mitigation practices on their vessels and some fire hazard mitigation practices. The results are presented in Figure 14 and Table 3. As shown in Figure 14, 47.4% (18) of the respondents evaluated their vessel's current fire hazard mitigation practices are very effective, 26.3% (10) evaluated them as very effective, 15.8% (6) were neutral in their evaluation while 2.5% (2) and 2.5% (2) evaluated their current fire hazard mitigation practices as ineffective and very ineffective respectively.

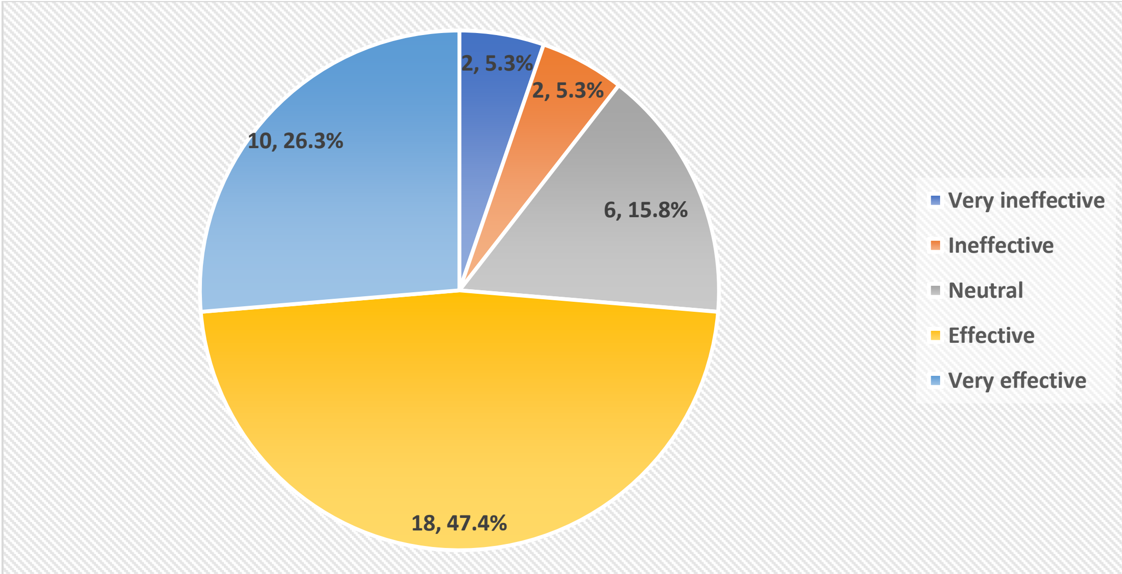


Figure 14. Effectiveness of the current fire hazard mitigation practices.

Table 3. Most effective bridge fire hazard mitigation practices

| | Very Ineffective (1) | Ineffective (2) | Neutral (3) | Effective (4) | Very Effective (5) | Mean |
|---|---|---|---|---|---|---|
| Regular fire drills | 0 | 0 | 3 | 19 | 16 | 4.45 |
| Routine maintenance and inspections | 0 | 0 | 3 | 15 | 20 | 4.45 |
| Proper training of bridge personnel | 0 | 0 | 3 | 15 | 20 | 4.47 |
| Use of updated fire detection systems | 0 | 0 | 4 | 12 | 22 | 4.18 |
| Regular review and updating of fire safety protocols | 0 | 0 | 9 | 12 | 17 | 4.45 |
| Overall | | | | | | 4.40 |

As shown in Table 3, respondents rated regular fire drills (Mean=4.45), routine maintenance and inspections (Mean=4.45), proper training of bridge personnel (Mean=4.47), use of updated fire detection systems (Mean=4.18) and regular review and updating of fire safety protocols

(Mean=4.45) as very effective bridge fire hazard mitigation practices with an overall mean effectiveness of 4.40. As the overall impact is 4.40, it implies that these bridge fire hazard mitigations are very effective in mitigating fire hazard mitigations. These justified the SOLAS fire safety regulations and confirmed the findings of Kristiansen (2013).

# 4.0 Conclusions and recommendations

This study investigated how ship bridge nonconformities contribute to the occurrence and escalation of fire hazards on vessels. Based on the findings of this current research, it can be concluded that ship bridge nonconformities significantly contribute to occurrence and escalation of ship fire. Poorly functioning or lack of fire detection system, inadequate or maintenance of bridge equipment, substandard electrical installations or faulty electrical wiring and inadequate training of bridge personnel are some of the major nonconformities that can result in bridge fire. Furthermore, delayed detection of fire, inability to communicate effectively during an emergency, electrical fires from faulty wiring and failure to initiate proper fire suppression measures can escalate fire hazard on ship bridges. Moreover, the finding of this current research revealed that ship bridge nonconformities have high impact on fire hazard escalation. Regular fire drills, routine maintenance and inspections, proper training of bridge personnel, use of updated fire detection systems and regular review and updating of fire safety protocols are effective bridge fire hazard mitigation practices.

Based on the research findings, the following are recommended:

i. Routine inspection and maintenance schedules should be established for all bridge equipment including electrical systems and wiring. To would help to identify and correct any nonconformities that pose a fire risk.
ii. Fire safety protocols should be reviewed and updated in line with the latest regulatory standards. The ship crew should be acquainted with the fire safety protocols and understand whey compliance is vital to mitigating fire hazards. Additionally, frequent fire drills should be conducted to assess the readiness of ship personnel for real fire events and adherence to latest fire safety protocols.
iii. Early detection of fire plays a great role in preventing escalation of fire. Hence, reliable fire detection systems must be installed on ship bridges. This would ensure fire are detected early and increase responsiveness to potential fire hazards.

## 4.1 Limitations and suggestions for future research

This current study focused on ship bridge nonconformities only and other areas were overlooked, making the generalisation of the findings of this research to other areas or contexts to be limited. Therefore, future studies can investigate the impact or contribution of nonconformities in other areas of ships to the occurrence of ship fire. Furthermore, the effectiveness of ship fire hazard mitigation practices or strategies can be evaluated.

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# Appendix 1

Survey Questionnaire

## Ship Bridge Nonconformity and Fire Hazard Mitigation

Hello,
My Name is Boboye Dayo. I am currently pursuing a Bachelor's Degree program in Maritime Management Studies at Novia University of Applied Sciences, Turku. I am researching my final thesis, **Ship Bridge Nonconformity and Fire Hazard Mitigation**. Your participation in this survey is greatly appreciated and will be a valuable contribution to the maritime industry.
**Purpose:** This study aims to determine how ship bridge non-conformities contribute to the occurrence and escalation of fire hazards on vessels. Your valuable insights will enable us to identify critical areas of improvement and develop effective strategies to mitigate fire risks. By understanding the impact of these non-conformities, we can work towards creating safer maritime environments and preventing future incidents.
**Participation and Confidentiality:** Participation in this survey is entirely voluntary. Your responses will only be used for statistical analysis, as your identity will remain anonymous throughout the study. The data collected will be used solely for research purposes and will not be shared with third parties. Please answer the questions to the best of your ability,
**Survey Details:**

- The survey consists of multiple-choice questions, Likert scale questions, and an optional open-ended comment section.
- It should take approximately 3 minutes to complete.
- Your honest and candid responses are greatly appreciated and will contribute to the success of this research.

**Contact Information:** If you have any questions or concerns about this survey or would like to receive the survey results when they become available, please feel free to contact me at **boboyedayo@gmail.com**

**NB: Your participation is VOLUNTARY, and your responses will be kept CONFIDENTIAL.**

* Required

1. **Role in the Maritime Industry** *

- ◯ Seafarer (Deck Officer)
- ◯ Seafarer (Engine Officer)
- ◯ Seamen
- ◯ Ship Inspector/Surveyor
- ◯ Ship Manager/DPA
- ◯ Other

2. **Years of Experience in the Maritime Industry** *

- ◯ Less than 5 years
- ◯ 5-10 years
- ◯ 11-15 years
- ◯ 16-20 years
- ◯ More than 20 years

3. **Type of Vessels Worked On** (Select all that apply) *

- ☐ Cargo Ships
- ☐ Tankers
- ☐ Passenger Ships
- ☐ Offshore Vessels
- ☐ Other

4. **Certifications Held** (Select all that apply) *

- ☐ Master
- ☐ Chief Mate
- ☐ Officer in Charge of the Navigational Watch (OICNW)
- ☐ Rating Forming Part of a Navigational Watch
- ☐ Rating Forming Part of an Engineering Watch
- ☐ Other

**5. How often do you encounter nonconformities on the ship bridge?** *

- ○ Never
- ○ Rarely
- ○ Sometimes
- ○ Often
- ○ Always

**6. Which of the following ship bridge nonconformities have you observed?** (Select all that apply) *

- ☐ Inadequate maintenance of navigation equipment
- ☐ Poorly functioning fire detection systems
- ☐ Faulty electrical wiring
- ☐ Lack of proper communication systems
- ☐ Obstructed emergency exits
- ☐ Inadequate training of bridge personnel
- ☐ Poor housekeeping (e.g., cluttered bridge)
- ☐ Other

**7. Do you agree these bridge nonconformities contribute to bridge fire hazards?** *

- ○ Strongly Disagree
- ○ Disagree
- ○ Neutral
- ○ Agree
- ○ Strongly agree

8. **How often do you believe ship bridge nonconformities lead to fire-related incidents?** *

- ◯ Never
- ◯ Rarely
- ◯ Sometimes
- ◯ Often
- ◯ Always

9. **Which of the following do you believe is most likely to escalate a fire hazard on a vessel due to ship bridge nonconformities?** (Select all that apply) *

- ☐ Delayed detection of fire
- ☐ Inability to communicate effectively during an emergency
- ☐ Electrical fires from faulty wiring
- ☐ Failure to initiate proper fire suppression measures
- ☐ Other

10. **Please rate the potential impact of ship bridge nonconformities on the following areas in terms of fire hazard escalation:** (1 = No Impact; 2 = Low Impact; 3 = Moderate Impact; 4= High Impact; 5 = Very High Impact) *

| | 1 - None | 2 - Low | 3 - Moderate | 4 - High | 5 -Very High |
|---|---|---|---|---|---|
| Navigation Equipment | ◯ | ◯ | ◯ | ◯ | ◯ |
| Communication Systems | ◯ | ◯ | ◯ | ◯ | ◯ |
| Electrical Systems | ◯ | ◯ | ◯ | ◯ | ◯ |
| Emergency Protocols | ◯ | ◯ | ◯ | ◯ | ◯ |
| Training of Personnel | ◯ | ◯ | ◯ | ◯ | ◯ |

11. **How effective do you find the current fire hazard mitigation practices on your vessel?** *

- ◯ Very ineffective
- ◯ Ineffective
- ◯ Neutral
- ◯ Effective
- ◯ Very effective

12. **How effective do you think the following fire hazard mitigation practices are?** (1 = Very ineffective; 2 = Ineffective; 3 = Neutral; 4= Effective; 5 = Very Effective) *

| | 1 - Very Ineffective | 2 - Ineffective | 3 - Neutral | 4 - Effective | Very Effective |
|---|---|---|---|---|---|
| Regular fire drills | ◯ | ◯ | ◯ | ◯ | ◯ |
| Routine maintenance and inspections | ◯ | ◯ | ◯ | ◯ | ◯ |
| Proper training of bridge personnel | ◯ | ◯ | ◯ | ◯ | ◯ |
| Use of updated fire detection systems | ◯ | ◯ | ◯ | ◯ | ◯ |
| Regular review and updating of fire safety protocols | ◯ | ◯ | ◯ | ◯ | ◯ |

13. **Which fire hazard mitigation practices do you consider most effective on ships?** (Select all that apply) *

- ☐ Personnel training
- ☐ adequate equipment
- ☐ active implemented process
- ☐ regular maintenance
- ☐ Other

14. **In your opinion, what changes should be made to improve fire hazard mitigation on ship brigdes?** (Select all that apply) *

- [ ] Improved maintenance of navigation and communication equipment
- [ ] Enhanced training programs for bridge personnel
- [ ] Implementation of advanced fire detection and suppression systems
- [ ] Regular audits of ship bridge compliance
- [ ] Integration of new technologies for fire hazard mitigation
- [ ] Other

15. **Please provide any additional suggestions or strategies you believe could help Mitigate fire hazards related to ship bridge nonconformities:** *

Enter your answer

Submit