



## Enhancing Maritime Safety and Compliance through .NET Applications

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### ABSTRACT

This paper delves deeper into exploring how .NET applications can be used to improve maritime safety and compliance in the marine industry. Due to the nature of the industry, maritime safety needs safety protocols to protect those working in the marine vessels and surrounding areas. The workers face a lot of challenges in terms of security and operation of the ship; therefore, developing a .NET application will be very helpful to them because through the application, they may attain the necessary skills to operate in such an environment, and they will also get a solution to their problems. This paper highlights the features that a .NET application needs to cater to the security issues that people working in the marine industry face in their line of work. The paper also contains successful case studies of how .NET applications have helped to enhance maritime security. The technical considerations needed to create this application have been highlighted, as well as future considerations regarding improving the functionality of the application.

**Key words:** .NET applications, maritime

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### INTRODUCTION

The maritime industry is one of the most important industries in the world because it is very important when it comes to maintaining global trade. Transportation of cargo and passengers also takes place in the marine industry. It is very crucial in the economic development of many countries because most of the items used for trade are transported by sea. The marine sector continues to face many problems regarding the safety of the people working in the marine industry as well as the passengers [1]. The bodies that have been tasked to implement rules and policies to enhance maritime safety often need to comply with the standards they have set; therefore, the industry is deeply in need of maritime stakeholders.

Due to the advancement of technology and the creation of smartphones, maritime safety has improved with the help of technologies such as mobile applications, which are very informative to those working in the maritime industry. These applications have the necessary information to equip workers with the right skills and technology to maneuver in certain situations and remain safe in the seas and oceans. Software applications that have communication tools have proven to be very powerful in ensuring the safety and performance of the maritime industry.

.NET applications will be very useful in the maritime industry because they are reliable and have the necessary information to solve the complicated challenges that may surface in the maritime sector. The .NET applications were developed by Microsoft in 2002; they are very flexible, scalable and have cross-compatibility. They are very popular because they can integrate data, automate tasks and provide useful insights about any topic. This paper focuses on the technical considerations that a .NET application should meet in order to be efficient and effective in the maritime industry [2]. This paper focuses on some of the case studies that have success stories about how .NET applications have been useful in the maritime field.

### 1. CHALLENGES IN MARITIMES SAFETY AND COMPLIANCE

- A. **Collision risks:** factors such as human risks and equipment malfunction play a big role in vessel collisions in the waterways. Navigation of water vessels often relies on radar equipment, GPS devices, and autopilot. Sometimes, this equipment fails to provide reliable information, causing the ships to lose direction and collide with other ships, especially in busy waters. Human error comes into play in times of poor decision-making, inadequate training and miscommunication among the crew in the water vessels [3]. Between the years 2013 and 2021, 801 ships were lost in the sea, and 301 of them were cargo ships.

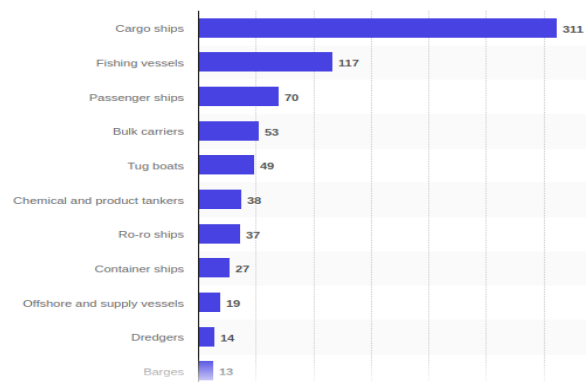


Figure 1: shows the number of ships lost in the waterways

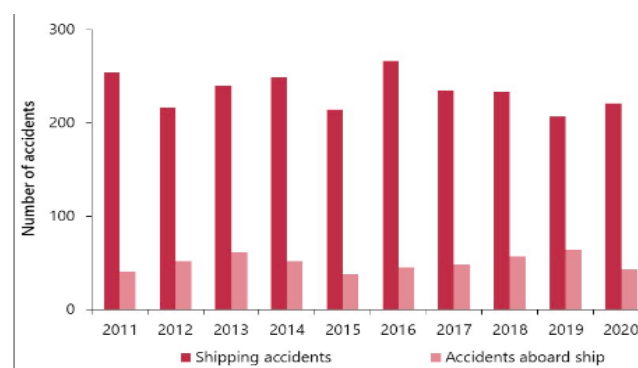


Figure 2: shows the number of accidents that have happened due to the collision of ships

**B. Navigational hazards:** Many external factors contribute to the navigation problems ships face. One of the main ones is shallow waters. Large ships that have deep drafts are hard to navigate in shallow waters because they may run aground, which will cause a lot of damage to the vessel and destroy the navigation route, causing problems for other ships. Icebergs and other underwater obstructions make the navigation of ships hard when ships collide with rock or other sunken vessels; it causes effects such as flooding, which will destroy the navigation route. Icebergs usually cause damage to the water vessels, causing catastrophic effects. A total of 209 accidents happened in 2020 in the sea due to navigation hazards [4].

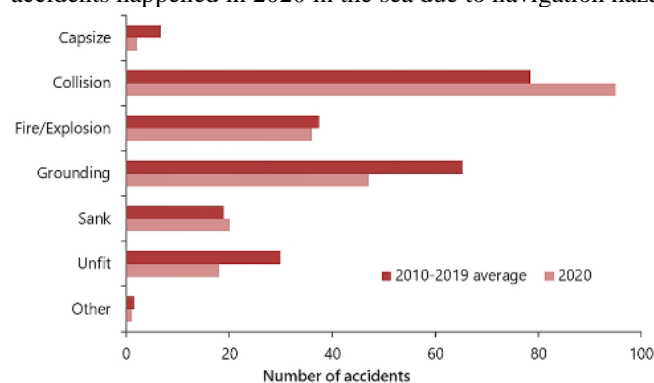


Figure 3: shows the number of accidents in 2020

**C. Weather-related hazards:** Maritime workers operate in areas with very harsh weather conditions like atoms, heavy rains, strong winds and fog. These weather conditions make it hard for maritime workers to operate and also compromise the safety of the cargo, passengers and crew on the ship. In 2020, a total of 262 people died in the water vessels due to harsh weather conditions [5]. During heavy rainfall, cargo carrying petrol and oil is usually at risk because when lightning strikes the ship, there are traditionally fires and explosions, which are fatal and cause environmental pollution in the sea due to oil spillage.

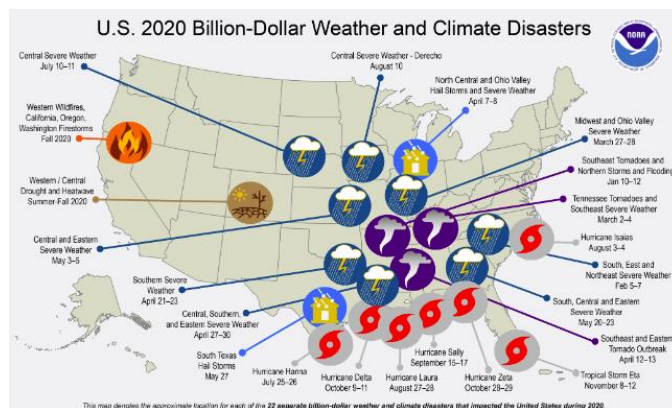


Figure 4: shows accidents that happened in the sea due to weather conditions

## 2. ROLE OF .NET APPLICATIONS IN MARITIME SAFETY

### A. Relevance of .NET application to maritime safety

Microsoft developed .NET applications to provide a platform for building, deploying and managing applications on various operating systems. These applications contain many tools and libraries that are very important in developing reliable, scalable and high-performance applications [6]. 34.2% of all websites run on .NET applications, which means that they are effective and efficient.

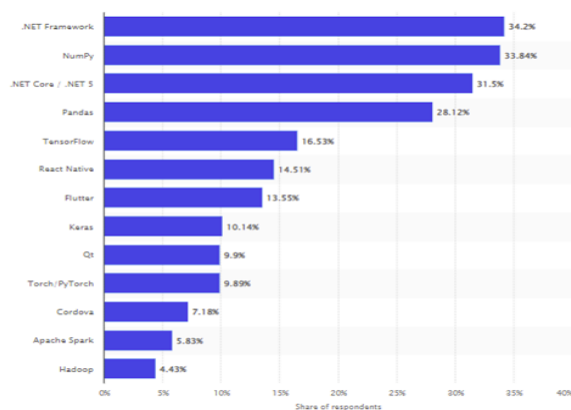


Figure 5: shows the percentage of websites operating in .NET frameworks.

The .NET applications are crucial in enhancing safety in the maritime industry. The following highlights its relevance to this industry.

- [1]. Cross-platform compatibility: .NET applications run on any operating system, be it Windows, Linux or MacOS, which makes them suitable in the maritime industry because they will serve users' needs regardless of their device [7].
- [2]. Scalability: .NET frameworks allow the building of applications that can be scaled up or down depending on their workload [7]. They are usually high-performance, so they can process large amounts of data in a short time and manipulate the complex calculations that are done in the maritime industry.
- [3]. Security: Security is paramount in the development of .NET applications, which have numerous security features for authentication, authorization and validation. They also create secure communication channels where data is encrypted to deter hackers from accessing the communication lines.
- [4]. Integration: .NET applications can be integrated with other third-party applications, such as APIs, which were useful in this case for communication and navigation. They can also be integrated with databases to store data about relevant information.
- [5].

## 3. DESIRED FEATURES FOR .NET APPLICATIONS

### A. Vessel tracking capabilities

The .NET applications should be integrated with a real-time Automatic Identification System (AIS), which is useful in tracking water vessels in terms of direction, speed and their position in the water body. This technology is imperative to the crew members because it helps in the navigation process of the sea vessel. This technology helps the rescue and emergency teams to locate a vessel that is in danger of collision or sinking [8]. This is

because, with the accurate position of the vessel, help can be sent swiftly to save the lives of the people on the ship. Radar and satellite technologies are also useful in this sector because they help in providing accurate coordinates of the ships to the rescue team.

#### B. Risk assessment and management

Risk management and assessment technologies should be incorporated into the application to help navigate through harsh weather conditions. The crew member should be able to enter the position and direction of the ship into the application, and it will display the correct reports and maps the crew member should use to navigate the ship safely. When accidents occur in the ship, there should be information in the application that help the crew navigate and maintain safety [9].

#### C. Training models

Crew members need to be trained on how to handle different situations in the ship therefore simulation will be the perfect way for them to be educated on various issues. This training would equip the crew with crisis management knowledge, which is important in maintaining maritime safety.

#### D. Regulatory compliance tools

The .NET application that would be developed to improve maritime safety should incorporate safety information provided by the International Maritime Organization (IMO). The information should be up to date so that the workers on the vessels have access to correct information about the standards and policies set by the IMO.

### 4. CASE STUDIES

#### A. Fleet Management System by Kongsberg Maritime

Kongsberg Maritime was founded in 1814 in Kongsberg, Norway. This company developed the Fleet Management System (FMS) and is responsible for providing technical maritime solutions worldwide. Over 34,000 water body vessels operate using Kongsberg Maritimes' technological solutions. FMS is a .NET application that offers multiple functionalities that are very useful in maritime safety.

- [1]. Improved fleet visibility: FMS makes data-driven decisions by collecting and processing various data about vessels, such as weight, speed, position, fuel level, environmental conditions and many more and generates reports on how to navigate the vessel. FMS represents information and produces various information, such as maps when representing positions, dashboards, and reports [10]. This feature is very useful in navigation because it ensures safety. This technology outputs reports of risks that the ship is prone to and helps the crew take efficient measures to mitigate the risks.
- [2]. Improved maritime safety: the Fleet Management System has been incorporated with the Automatic Identification Systems (AIS) algorithm, which is imperative in maintaining the security of the ship and its crew member. This technology can calculate the level to which the water vessel is prone to risks such as collisions with other water vessels or those that are submerged. After this, it produces dashboards and reports that clearly explain the potential problems faced and produce means to avoid the problem through the generated mitigation plans. Weather forecasting algorithms come in handy in this section the .NET application will analyze the weather conditions of different navigation routes in the sea and suggest one with lesser risks [10].
- [3]. Compliance monitoring: FMS contains the regulatory laws and regulations of marine authorities such as the International Maritime Organization (IMO). This feature is very helpful because it educates the crew on the rules and regulations to enhance maritime safety. This feature ensures that the crew is not ignorant of the laws put in place to ensure the maritime industry's safety [10].

The Fleet Management System (FMS) has had several positive impacts on maritime safety. The workers in the marine industry practice better safety precautions because the application has provided several features to enhance the safety of vessels in the sea, such as collision alert systems. FMS has improved the operations of water vessels because it has helped them utilize resources more efficiently, automate many tasks, and also increase the productivity of the crew in water vessels [10]. Kongsberg Maritime made over NOK 400 million in 2020 to shuttle tanker orders.

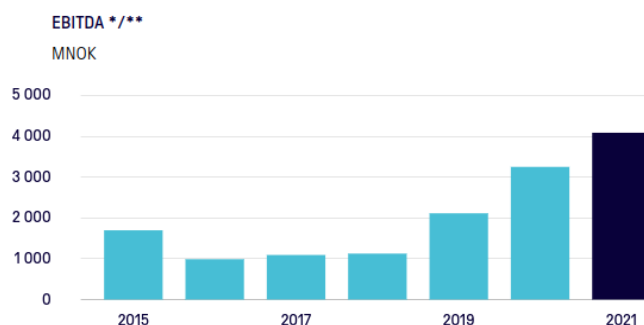


Figure 6: shows the net revenue of Kongsberg Maritime in Millions in the Norwegian Kroner.

## 5. TECHNICAL CONSIDERATIONS OF BUILDING A .NET APPLICATION

### A. Technical considerations

Building a .NET application that will enhance maritime safety involves various layers. The application should be developed using the agile methodology to ensure continuous improvement in every section [2].

- [1]. Presentation layer: This is the layer that will be displayed as the output. It can be developed using ASP.NET or any other platform that the developers may see fit. The standard for this layer is that it should be user-friendly and simple to use. The programmers should also ensure that the language used is compatible with any operating system so that all the needs of the users are met.
- [2]. Business logic layer: AIS is usually used in this layer because it helps with weather forecasting, which is a key feature in this application. The framework VB.NET is advised to be used in this layer because it is very robust and scalable.
- [3]. Data layer: This is the layer that handles the actual data transfer in the application between the backend, frontend, database, third-party applications and compliance authorities. The database used should be ADO.NET, although other databases can be used in this sector and will still be efficient. APIs are also integrated into this sector to obtain data from third-party sources and send data to and from the front.
- [4]. Integration layer: This layer ensures that the application works well with other applications, such as radar and satellites, to help with positioning. Information from the Maritimes Regulation Authority is incorporated into the application to ensure the users comply with the standards set.
- [5]. Security layer: All operations in the .NET application need to be secure, so this layer applies security measures to the application to avoid being tapped by hackers.

### B. Design considerations

- [1]. Reliability: The .NET application should be high-performance, fault-tolerant and available so that it continuously works even when electricity is unavailable.
- [2]. Security: The application should be very secure, using firewalls to detect cyberattacks and implement measures to mitigate the risks of cyber attacks.
- [3]. Scalability: The application should be developed to scale up to match the users' needs. Cloud-native architectures and distributed caching should be used to ensure that the application can handle the increasing volume of data and features.

## 6. CONCLUSION

In conclusion, the maritime industry needs to be given more attention and researched to find better means of enhancing the safety of the marine industry. This paper highlights the challenges that the sector faces each year and offers a solution, which is through the creation of a .NET application that will cater to the needs of the workers in the maritime industry. The paper also highlights the designed features that the .NET application should have, which include vessel tracking capabilities, risk assessment and management, training models and regulatory compliance tools; this paper also highlights a case study that turned out to be successful, which is the Fleet Management System (FMS) by Kongsberg Maritimes. Some of the important features of FMS and their usefulness have been highlighted. The technical considerations of building a .NET application have been highlighted, and lastly, the future considerations of .NET applications have been looked into.

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