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MARINE ACCIDENTS AS POTENTIAL CRISIS SITUATIONS ON THE BALTIC SEA

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Abstract:

People responsible for crisis management, especially in coastal voivodships (Pomeranian, West Pomeranian and Warmian-Masurian Voivodeship) must be aware and prepared to take effective action in the event of emergencies in maritime waters. The geographical, hydro meteorological conditions and geographical conditions of the Baltic Sea of the Baltic Sea and the increasing intensity of Baltic shipping, and in particular the increase in oil transport, mean that the likelihood of maritime accidents that can generate crises in sea areas increases significantly. There are about 2000 ships in the Baltic marine area at any given moment and about 3500 - 5500 ships navigate through the Baltic Sea per month. Approximately 20% of the ships in the Baltic Sea are tankers. Despite different uncertainties some trends in the Baltic shipping can be expected. For example ship traffic is likely to increase yearly and it is expected that vessel size will increase because the maritime transport must be more efficient and cost-saving. Such trends create serious threats for Baltic States. The maritime administrations of the Baltic States and international maritime organizations undertake a number of actions to increase maritime safety in the Baltic Sea. The publication characterizes Baltic shipping and analyzes the scale of threats generated by maritime accidents, as well as ways of responding and minimizing the probability of emergencies in the Baltic Sea. Activities including: legislative and organizational activity were also characterized; practical use of modern technology both on vessels and in land navigation monitoring systems; marine traffic engineering and shipbuilding, which aim is to minimize the likelihood of maritime accidents in the Baltic Sea and analyses of Baltic states capacity to oil spill response. In addition, the publication proposes a definition of a crisis situation in relation to sea areas and presents when a maritime accident or incident can generate a crisis situation in sea areas. The result of the research process is proposals for actions that, in the author's opinion, should be taken to reduce the number of maritime accidents in the Baltic Sea.

Keywords: *maritime security, maritime safety, crisis situation, maritime accidents, safety at sea*

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1. Introduction

The maritime collision and incidents may occur at anytime and anywhere. In the last Annual overview of marine casualties and incidents we can find that in 2018 were 3174 ships accidents in European waters (9 accidents per day) in which 3315 ships were involved (23073 marine casualties and incidents that happened from 2011 to 2018, the total number of ships involved was 25614). In 2018 in maritime accidents 941 person were injured (95 very serious marine casualties, 53 fatalities, 25 ships sunk) **Very serious marine casualty** means a marine casualty involving the total loss of the ship or a death or severe damage to the environment. According the EMSA a **serious marine casualties** are casualties to ships which do not qualify as very serious casualties and which involve a fire, explosion, collision, grounding, contact, heavy weather damage, ice damage, hull cracking, or suspected hull defect, etc., resulting in: immobilization of main engines, extensive accommodation damage, severe structural damage, such as penetration of the hull under water, etc., rendering the ship unfit to proceed or pollution (regardless of quantity) and/or a breakdown necessitating towage or shore assistance (EMSA, 2019). Similar definition of very serious marine casualties can be found in International Maritime Organization (IMO) Resolution MSC.255(84).

The average numbers of accidents in last 5 years are systematically increasing. The same trend we can see not only in the Baltic Sea, but also in the other maritime area (JTSB, 2020). Various sources suggest that there are huge numbers of under-reporting marine casualties and incidents, with a total of 4000 occurrences per year being a best estimate. On average the study results document that the number of unreported accidents makes up roughly 50% of all occurred accidents. Even in a best case scenario, only a few flag states come close to perfect reporting (94%) for example Norway (Hassel et al., 2011; Psarros et al., 2010). In same sources we can find information that unreported accidents makes up roughly 75% of all occurred accidents (JTSB, 2020). The ship collision and maritime accidents can be divided into those which did not cause harmful consequences, but could have caused, and accidents which indirectly or directly caused the loss of life, endangering health, and material damage at sea or ashore, pollution, and other consequences. In the case of reducing marine accidents, it is important to concentrate on the type of human factors that cause casualties. Despite the fact that the human error is probably the main cause of majority of marine accidents, a continuous improvement of safety culture and knowledge of crew members can minimize the number of marine accidents caused by human errors (Ćorović and Djurović, 2013).

The maritime administrations of the Baltic States and International Maritime Organizations undertake a number of actions to increase maritime safety in the Baltic Sea. The publication characterizes Baltic shipping and analyzes the scale of threats generated by maritime accidents, as well as ways of responding and minimizing the probability of emergencies in the Baltic Sea. Activities including: legislative and organizational activity were also characterized; practical use of modern technology both on vessels and in land navigation monitoring systems; marine traffic engineering and shipbuilding, which aim is to minimize the likelihood of maritime accidents in the Baltic Sea.

The main research goal of this article was to develop, based on the analysis of long-term statistical data on maritime accidents and hydro meteorological and geographical conditions of the Baltic Sea, solutions which can reduce the risk of crisis situations generated by maritime accidents in Baltic shipping. Based on the results of this analyze, using methods of induction and synthesis, solutions have been proposed. Presented solutions may contribute to reducing the risk of crisis situations caused by collisions and maritime accidents in the Baltic.

In the article, the main causes of maritime collisions and accidents in the Baltic Sea were identified and systematized, and then changes which could contribute to reducing the likelihood of maritime accidents Baltic Sea were proposed. In addition, the publication proposes a definition of a crisis situation in relation to sea areas and presents when a maritime accident or incident can generate a crisis situation in sea areas. The result of the research process is proposals for actions that, in the author's opinion, should be taken to reduce the number of maritime accidents in the Baltic Sea. Transport of large amounts of cargo, mining and exploiting natural mineral resources, carrying large number of passengers by sea are characterized by high risk, even if the latest technologies are employed (Mironiuk, 2015).

The role and importance of maritime transport in the modern world is steadily increasing, this statement seems to be obvious, however, most of the citizen of Poland are not fully aware of the role and importance of maritime transport not only for the Polish economy, but also how it affects our daily lives. Recent decades have brought many examples of the fact that disruptions to shipping operations or shipping accidents have had negative economic or ecological effects not only on a regional, but also global scale.

As on land, there are also crisis situations on sea waters, which may be the result of accidents of sea vessels or breakdowns of mining installations. Tankers' accidents or failures of mining installations located in sea basins may indicate the scale of these threats. An example of a crisis situation is the explosion and fire of the Haven tanker as a result of which 40,000 tons of oil spilled into the sea and oil from Italian beaches was cleaned for 12 years (ITOPF, 2019).

Another example is the explosion at the *Deepwater Horizon* oil rig in the Gulf of Mexico that took place in April 2010. As a result, approximately 3.5 million barrels of oil were spilled. Platform owner BP paid a US $ 18.7 billion fine to the US government. In addition, a USD 20 billion fund has been created to cover private and legal claims. The scale of threats may also be confirmed by the case of a sunken barge filled with 700 tonnes of stones on the Szczecin-Świnoujście fairway, which blocked the fairway for large and medium-sized vessels for 15 days.

The above examples show that marine casualties and incidents can generate serious emergencies. Therefore, it is necessary to analyze the scale of threats that can be generated by maritime accidents and incidents in the Baltic Sea and the ways to be taken to minimize the scale of these threats.

2. Characteristics of the Baltic sea and Baltic shipping

The Baltic Sea with an area of 427 362 km² is a mid-continental arm of the Atlantic Ocean, squeezed into northeastern Europe. It is located in the northern zone of moderate marine and continental climate. This reservoir is characterized by changing weather conditions with high humidity, its waters reach almost under the northern Arctic Circle. Its meridian extent is almost 1500 km, while latitudinal 600 km. It has the following natural connections with the North Sea: Great Belt, Little Belt, Sound, Kattegat and Skagerrak and two artificial connections: Kiel Canal (connecting the Baltic Sea with the North Sea) and White Sea-Baltic Canal (being the connection of the Baltic Sea with the White Sea).

The Baltic Sea is one of the largest brackish sea basins in the world. The average depth of the Baltic Sea is 52.3 m. More than a third of its surface is water areas less than 30 meters deep. In the context of potential environmental pollution, it should be remembered that the water exchange in this reservoir is about 30 years (Stigebrandt, 2001).

During severe winters, icing can be a significant impediment to Baltic shipping. Mainly due to the formation of piled up ice dumps, which can reach a thickness of up to several meters. Registrations carried out indicate that in the last 100 years only twice in 1942 and 1966 the entire Baltic area was covered with ice, while in 1996 - 96% of the Baltic area froze. During "moderate" winters, on average 45% of the Baltic Sea area is covered by ice, while during severe winters more than 250,000 km^2 is ice-covered (which is over 60% of the Baltic area). The icing of watercraft is associated with icing and low air and water temperatures (BIM, 2020).

The Baltic Sea is a relatively small sea basin, which reduces the height of waving, but it is a turbulent sea where the waves are short and steep. The typical height of the Baltic waves is 3-8 m (the average value is 5 m), but during very strong storms they can reach a height of over 10 m. On December 23, 2004, during a storm, a single recorded wave in the North Baltic region was almost 14 m high (while the average wave height in this region is 7.7 m) (BHMW, 2001). The presented geographical and hydro meteorological conditions have a direct or indirect impact on the safety of navigation in the waters of the Baltic Sea.

The sea transport is characterized by a high potential of danger and accidents that happen during shipping are difficult to predict. In the face of these problems appeared the necessity of regulating administrative legislation as well as technical and quality standards, the aim of which is to protect the life and the marine environment (Caban et al., 2017).

According to Eurostat data, Baltic shipping in 2017 with the result of 21% was in third place in terms of the volume of transported goods. However, only 25% of ships operating in the Baltic Sea are registered under the flag of the Baltic States. At any time, around 2,000 vessels operate in the water areas with

the highest intensity of maritime traffic. The structure of vessels operating in the Baltic Sea is as follows: over 50% of vessels are bulk carriers, 20% are tankers. It must be mentioned that shipping to the Baltic is prohibited for single-hull tankers carrying oil, which transport over 200 million tons of oil, 11% are passenger ships carrying over 50 million passengers, and the remaining 19% are other units (container vessels, ro-ro, fishing vessels and others) (HELCOM, 2019; HELCOM, 2018a).

The most intensive shipping in the world takes place in the Baltic, the intensity of the Baltic shipping is best evidenced by the fact that the surface of this basin is only 0.1% of the global ocean, and 15% of global trade by sea is carried along its waters. The structure of sea transport on the Baltic Sea is as follows: liquid cargo 38%, bulk cargo 22%, ro-ro cargo 16%, containers 15% and other 9%.

New oil terminals in Russia have resulted in doubling of oil transport in tonnage from the Gulf of Finland in recent years, it should be expected that in the following years these transports will continue to increase.

Because of the constantly increasing sea transportation of dangerous goods (for example crude oil) leads to increase in a probability of uncontrolled release of these dangerous goods into to the marine environment. To reduce the risk it is necessary to take action to improve standards which will provide an acceptable level of control of the dangerous goods hazard to people, property and environment (Popek, 2017; Bogalecka et al., 2017). Fig. 1 below shows the most important shipping routes in the Baltic Sea. There are 14 lines defined on the Baltic Sea on which shipping intensity is recorded. The most important from the point of view of Baltic navigation include: Skagen, Great Belt, Sound (Drogden), Kadet Rinne, on "N" from Bornholm, on "W" from Gotland, on "E" from Gotland, the entrance to the Gulf of Finland and entrance to the Bothnian Bay.

The map presented above shows the intensity of navigation in the Baltic Sea in 2019. The main shipping routes and fairways shown in the figure have been unchanged for many years. The only difference in individual years is the number of vessels moving on individual shipping routes and fairways. In addition, it should be remembered that the data presented regarding the movement of vessels do not fully reflect the intensity of movement of vessels, because the data collected and presented below refers to units equipped with the AIS system, i.e. units that must be equipped with transponders of this system. AIS transponders must be equipped in vessels over 300 tonnes operating internationally and vessels over 500 tonnes not operating internationally, and all passenger vessels regardless of their size.

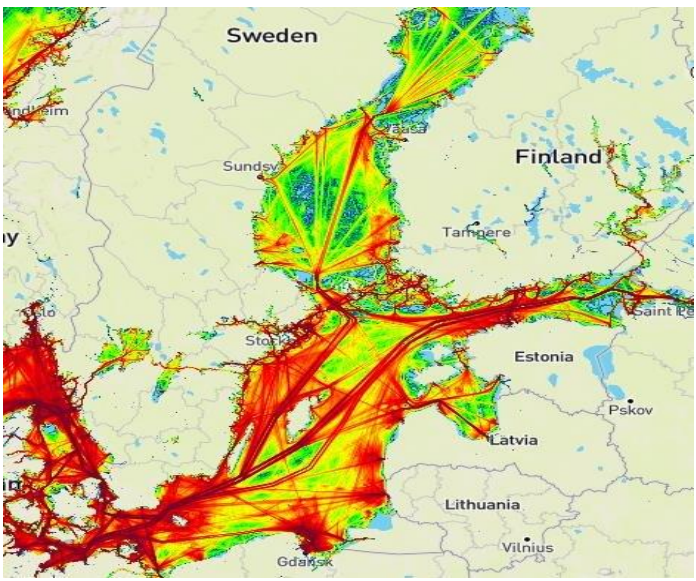

Fig.1. Main Baltic Sea shipping routes (Available at: Baltic Sea Traffic AIS)

Geographical conditions (very elongated shape, numerous islands, rocks, shallows and narrow passages) and hydro meteorological (ice, strong winds, high sea levels, strong currents in the straits and narrow passages) make navigation in this area difficult. In recent years, offshore wind farms and protection zones established around them have become an additional difficulty. The protection zone around wind farms is 500 meters.

It should also be emphasized that in the Baltic Sea region (especially in the Scandinavian countries) the number of tourist yachts and boats is systematically growing, currently it is estimated at 3.5 million units. For the most part, these vessels conduct sailing in short distance from the coast.

3. Characteristics of selected crisis situations in sea areas

In the Act on crisis management (article 3 item 1), we define a **crisis situation** as an event that adversely affects the level of safety of people, property of considerable size or the environment, causing significant restrictions in the operation of competent public administration bodies due to the inadequacy of the forces and resources (Ustawa z 26 kwietnia 2007 r. o zarządzaniu kryzysowym).

The definition above must be modified for the marine environment. The need for such a modification results from the specificity of human activities at sea and the marine environment. Thus, a **crisis situation in sea areas** should be defined as an event that has a negative impact on the level of: safety of people, watercraft, transported cargo, maritime infrastructure or the natural environment, which causes: death or serious injury of many people, damage or loss of a watercraft or cargo, significantly reducing human activity at sea or causing serious pollution of the environment. The catalog on sea waters is open. Naturally, the most likely crisis situations that may occur in sea areas have been identified; these are marine casualties or incidents.

Subsequent analyzes did not take into account crisis situations that may be generated by the infrastructure for obtaining natural resources (primarily oil and natural gas), underwater transmission installations and those that relate to the natural environment caused by pollution arising in the catchment area of the Baltic Sea.

Further analysis focuses on crisis situations that are or can be generated by Baltic shipping. The intensity and scale of the crisis situation caused by a maritime accident or incident are determined by: the place of occurrence of the sea accident, participants, transported load and hydro meteorological conditions. The legal definitions of a marine casualty and incident are described below.

According to Marine Accidents and Incidents Investigation Committee (MAIC) marine accidents may be classified (ordered by severity) as follows: very serious marine casualties, serious marine casualties, less serious casualties and marine incidents (MAIC, 2020). According to current qualifications, marine incident is defined as any occurrence, other than an accident, that is associated with the operation of a ship and affects or could affect the safety of operation.

We define a **marine accident** as an event or several consecutive events directly related to the operation of a ship, as a result of which happened: death or serious damage to human health; disappearance of a man on board; sinking, missing or losing the ship in any other way; damage to a ship which significantly affects its construction, maneuverability or operational capacity requiring major repairs; grounding the ship; contact with the bottom; hitting an underwater obstacle; immobilization or collision of ships; fire; explosions; impacts on the structure, device or installation; load shift, damage caused by bad weather; ice damage; hull cracks or suspected hull damage, material damage caused to the port infrastructure by the ship, infrastructure providing access to maritime ports or harbors, installations or structures at sea, causing a serious threat to the safety of the ship, other ships or persons or causing damage to the environment or causing danger causing such damage (Ustawa z 31 sierpnia 2012 r. o Państwowej Komisji Badania Wypadków Morskich). Not all maritime accidents generate a crisis at sea. The basic criterion for recognizing a maritime accident as a crisis is its scale or the consequences of the accident. A sea collision may or may not generate a crisis. For example, the collision of two fishing boats usually does not generate a crisis situation, while the same collision of two tankers combined with an oil spill will certainly be a crisis situation.

A maritime accident is a very broad concept, but one cannot consider a deliberate and conscious act or omission taken with the intention of violating the safety of the ship, personal injury or environmental

damage. Marine accidents were divided into two categories: very serious and serious marine accidents. A very serious maritime accident is considered to be the case in which the total loss of the ship, the death of a person took place or caused damage to the environment in significant sizes. The most tragic example of the loss of a vessel connected with the death of crew members and passengers was the Estonia ferry disaster on September 28, 1994, which killed 852 people. Others are classified as serious maritime accidents. Therefore, a crisis situation will be generated by a rather serious maritime accident. However, the term **marine incident** should be understood as an event or several consecutive events that cannot be classified as a maritime accident, are directly related to the operation of the ship, and which have had or could have had an adverse effect on the safety of the ship, persons on board or environment (Ustawa z 31 sierpnia 2012 r. o Państwowej Komisji Badania Wypadków Morskich).

As in the case of a maritime accident, a maritime incident is not an intentional act or omission intended to violate the safety of a ship, personal injury or environmental damage.

Table 1 presents data relates to statistics of maritime accident in the Baltic Sea in 2004-2018, they allow to illustrate the scale of potential threats.

Table 1. Statistics on maritime accidents in the Baltic Sea in 2004-2018

year	Number of maritime accidents		
	total	collisions	ship groundings
2004	133 (8)	41	56
2005	146 (13)	54	53
2006	117 (5)	54	46
2007	120 (4)	40	54
2008	135 (9)	41	60
2009	105 (10)	34	38
2010	130 (10)	48	39
2011	143 (11)	48	43
2012	149 (10)	47	37
2013	150 (6)	57	41
2014	163 (4)	52	40
2015	184 (9)	60	20
2016	131 (18)	35	35
2017	139 (21)	50	33
2018	246 (14)	74	66

note: failures with leakage of hazardous substances are shown in brackets
source: [HELCOM, 2019]

The statistics presented above are not complete. All maritime administrations or other competent authorities of the Baltic States are obliged to send information on the occurrence of maritime accidents that took place in waters under their jurisdiction. However, the transmitted data on maritime accidents in the Baltic Sea include maritime accidents involving tankers with a displacement of 150 tonnes and other vessels with a displacement of over 400 tonnes. Therefore, they do not take into account maritime accidents of all vessels. However, it can be stated that marine accidents of these units are unlikely to result in crisis situations in sea areas. The environmental damage accounted for more than half of the total cost. The cost on the environment is the cost due to damage restoration of infrastructure and costly techniques used to recover ecosystem. In recent years, the cost of environmental damage has increased significantly (Popek, 2017; Bogalecka et al., 2017).

From the point of view of the scale of potential crises in the Baltic waters, the adoption of the above data will not have a significant impact on the results of the analyzes carried out.

The conducted analyzes show that it is very difficult to clearly indicate the cause of the occurrence of maritime accidents or incidents, because they are often of a complex nature, due to more than one cause. A detailed analysis of data on marine accidents or incidents in the Baltic Sea in 2004-2018 leads to the following conclusions (HELCOM, 2019; HELCOM, 2018a):

1) the long-term analysis of the place of accidents in shipping in the Baltic Sea indicates that they most often occur in: narrow areas, on approaches to ports and in ports. Only 34% of accidents occurred in the open sea, but in recent years there has been a trend of increasing the number of accidents in the open sea. According to data provided by HELCOM, in 2018 the number of accidents in the open sea was higher than the number of accidents in ports or on approaches to ports;
2) in 2004-2018 the structure of maritime accidents presented as follows: 32% collisions, grounding is 24.8%, and technical damage accounted for 14.9% of all accidents. Other accidents, which include: damage to the vessel in ice, damage to ship equipment, fire, explosions are 28.3% of the total number of accidents that took place in 2004-2018;

3) the most common cause of accidents was human error (28%), technical reasons accounted for 19% of accidents. As many as 62% of accidents resulting from human error were caused by unintentional errors and wrong decisions. However, it is very worrying that the reason for as much as 17% of accidents, which were caused by human error, was the intended violation of applicable laws and principles of good maritime practice;
4) in the years 2004-2018 there were 152 cases of environmental pollution resulting from marine accidents. The most common causes of spillages (80%) were human error and the failure of ship equipment;
5) Bulk carriers and passenger ships are the most frequent participants in maritime accidents. Marine accidents involving these vessels accounted for 65% of all accidents, and depending on the year, the participation of these two types of vessels varied from 46 to 20%. When comparing the number of maritime accidents in relation to the number of ships operating on the Baltic Sea, the accidents of passenger units in 2018 were overrepresented, constituting 25% of all accidents, while they accounted for 11% of ships operating in the Baltic. Tanker accidents accounted for 10% of all accidents in the Baltic, while they accounted for 20% of vessels operating in the Baltic;
6) Ship grounding while maneuvering usually took place during absence of the pilot on the watercraft. The number of stranding in the presence of a pilot on board was inconsiderable; however, it was in most cases caused by a failure or damage to ship equipment or due to difficult hydro meteorological conditions. In the years 2014-2018, the largest number of grounding or stranding took place in the Baltic Straits and these were units with a submergence less than 7 meters;
7) in the event of stranding, a downward trend can be seen which has reached 7% over the past year. 37% of the cases are stranded units with a submergence less than 7 meters, whose passage was not secured by the pilot. No grounding of vessels with submergence greater than 15 meters was noted. It is worth to emphasize that more than 60% of vessels operating in the Baltic Sea have a submergence less than 7 meters, and only 5% have a submergence greater than 11 meters.

The analysis presented above indicates that in the analyzed period there were 2191 maritime accidents, and in 152 cases also leakage of hazardous substances. The average annual number of accidents for the last 15 years is 146, including almost 10 ended with the spill of hazardous substances. This shows the potential threat of crisis situations that can be generated by Baltic shipping.

4. Ways to respond and minimize consequences of crisis situations in the Baltic Sea

As mentioned earlier, the intensity of shipping in the Baltic Sea is steadily increasing. Increasing oil transport in regions with an increased risk of navigation in ice and the semi-closed nature of the Baltic Sea means that the risk of environmental pollution caused by spills of petroleum substances is very high in the Baltic. Effective minimization of the probability of a maritime accident resulting in a crisis situation must be composed of related activities including, among others: legislative and organizational activity; practical use of modern technology both on vessels and in land navigation monitoring systems; marine traffic engineering and shipbuilding.

In the area of legislative activities, we can talk about national and international activity. An example of legislative actions in the international dimension can be considered the request of the Swedish maritime administration sent to the International Maritime Organization (IMO) for granting the Baltic Sea the Status of Particularly Sensitive Marine Area (PSSA). This status was granted in 2005. It imposes special requirements on vessels operating in the Baltic Sea, which may include, among others duty: compliance with designated shipping routes, establishment of a vessel traffic monitoring and information system, possession of AIS and VDR systems by vessels, establishment of a compulsory ship reporting system, the need to report dangerous cargo and registration of travel data, and establishment of TSS (Traffic Separation Schemes). However, the introduction of all these requirements is not easy, because they require investment by both ship-owners and maritime administrations of the Baltic States. The key words in this case are "may cover"; this does not mean an absolute obligation, thus compliance with these recommendations, will require time and significant financial outlays and good will of both ship-owners and maritime administrations of the Baltic States.

Another example of such activities are recommendations developed by the Baltic States that form the Helsinki Convention, which were adopted in 2004. The new recommendations refer to the obligatory ice classes of vessels sailing in the waters of the Gulf of Finland in winter. According to these recommendations, EU countries may refuse to enter their ports tankers if they have navigated in ice without an appropriate ice class. Nowadays, the main problem is that many vessels operating in the Baltic Sea, especially in the northern part of this basin; do not have an adequate ice class. There are cases when tankers entering the waters of the Gulf of Finland in winter are not adapted for sailing in ice with a thickness of 70 cm.

The COLREG Convention (International Regulations for Preventing Collisions at Sea) developed by the IMO should also be mentioned. It contains rules and regulations determining the safety of vessel movement, which include: rules for passing vessels, mandatory lights, signs, sound and light signals. This convention may be colloquially referred to as the "maritime traffic code".

The SOLAS Convention should be considered a very important dimension of activities for increasing the safety of navigation. It aims to increase the safety of life at sea by establishing uniform rules and regulations for shipbuilding, as well as defining uniform patterns of issued documents. It contained provisions including regulations for the classification and construction of seagoing ships, taking into account, among others, aspects such as: stability and subdivision, hull equipment, hull, fire protection, machinery and refrigeration equipment, engines, mechanisms, boilers and pressure vessels, electrical installations and control systems.

One example of national legislative action to reduce the likelihood of marine casualties is the introduction of pilot systems. In the case of the Baltic, pilotage is available (recommended but not mandatory) for vessels entering the Baltic Sea through the Baltic Straits (Kattegat, Sound and the Great Belt). The use of pilot services is recommended by IMO for tankers transporting petroleum substances and chemicals, and for units transporting nuclear fuel or radioactive waste. In addition, local maritime pilotage is available for vessels crossing waters difficult in navigation. Local maritime pilotage is available when crossing the Kalmar Strait or when sailing among the archipelago of islands in the Stockholm and Turku region. However, pilotage is mandatory when passing through the Kiel Canal and at the entrance and exit from or to the port.

The next action is the implementation of verification tasks under Port State Control, which include checking the competence of crew members and the technical condition of the ship. The controllers check whether the ship has valid mandatory certificates and whether its equipment complies with international conventions as well as whether the composition of the crew and its operation is in accordance with applicable international law.

Due to the steadily increasing oil transport, the Baltic States had to expand their potential, improve cooperation procedures and raise the level of training of crews of units intended to combat the spillages of hazardous substances. Currently, the Baltic States have about 80 units dedicated to the control of spills. Every year since 1989, international BALEX DELTA trainings have been organized, the training goal of which is to check and improve the ability of the countries of the Baltic Sea region to respond to serious marine incidents.

No less important in minimizing the negative effects of marine casualties or incidents are the national search and rescue (SAR) services. The main tasks of the SAR Service include: searching for and rescuing every person in danger at sea, regardless of the circumstances in which they find themselves in danger, and combating threats and oil and chemical pollution of the marine environment. Therefore, it is obvious that this service should be qualified as entities that play an important role in responding to crises in maritime waters.

The volume of transport of crude oil and petroleum substances caused that the risk of oil spills increased significantly. To reduce this risk, the VTMIS (Vessel Traffic Monitoring and Information System) systems have been developed in the Baltic Sea basin. In addition, close cooperation between Estonia, Finland and Russia can also be considered as an organizational dimension, the effect of which is that every ship entering the waters of the Gulf of Finland is registered and is monitored on a continuous basis. There are currently 39 Vessel Traffic Systems (VTS) operating in the Baltic Sea in Denmark (2), Estonia (1), Finland (7), Germany (11), Latvia (3), Lithuania (1), Poland (2), Russia (6) and Sweden (6).

The organizational dimension also includes the creation of an automated system for transmitting navigation, meteorological and other urgent information (e.g. information about dangers) to ships by direct-printing service (NAVTEX). This system is part of the Global Navigation Warning Service and GMDSS. There are two Swedish NAVTEX base stations in the Baltic (Grimeton and Gisövshammar). The NAVTEX, VTMIS, VTS or GPS system can be qualified to the organizational dimension or to the practical use of modern technology in shipping.

An important element to minimize the likelihood of maritime accidents is the Automatic Identification System (AIS), which provides automatic exchange of data between ships, useful to avoid collisions between ships and allows the ship to be identified by the Vessel Coastal Monitoring Systems (VTS). This is an example of using modern technology to increase the safety of navigation, thereby reducing the probability of crisis situations in sea areas (Gucma, 2016).

An example of national solutions aimed at increasing shipping safety is the Shipping Safety Information Exchange System (SWIBŻ - System Wymiany Informacji Bezpieczeństwa Żeglugi). It is used by the Polish maritime and state administration (over 30 entities). It enables cooperation and exchange of data between operational services and institutions caring for maritime safety. The system provides maps of ship traffic in the Baltic Sea, obtained by exchanging data within the HELCOM network. It allows to get full information about the parameters, route or cargo of the ship.

A progressive automation process has been observed in shipping for many years. Unmanned engine rooms are already commonplace on many ships, where the crew operates the engine rooms only during the day and at night it is unmanned. The modern concept of a navigation bridge is different. The watch officer is always present on the bridge during the movement of the unit. On many ships, the navigation bridge has been restricted to one person when crossing the sea. The modern navigation bridge is equipped with numerous navigation devices and systems. They allow to plan and then control the route of passage so that the ship passes at a safe distance to all known navigation obstacles, offshore structures and transmission installations built by man or shallows. However, the unpredictability of shipping makes the officer of the watch remain the most important, but sometimes also the weakest link in terms of shipping safety.

Concerned Baltic countries have taken a number of actions to minimize the risk of grounding and collisions. The system of recommended passage routes and fairways for vessels with high submergence (up to 17 meters) is expanding and modernizing. An example would be the recommended Route T, allowing safe passage of vessels with high submergence through the Kattegat, the Great Belt and the Western Baltic.

In addition, there are numerous traffic separation systems in the Baltic Sea; in the first place they are formed in areas difficult to navigate, in which the shipping routes are narrow and winding. Activities aimed at reducing the risk of maritime accidents, which may include maritime traffic engineering, include deepening the existing fairways and recommended shipping routes, expanding or creating new traffic separation systems, and modernizing and expanding floating and permanent navigation markings.

5. Summary

Analysis presented in publication prove that there is a high probability of occurrence of crisis situations in the Baltic Sea generated by maritime accidents. The crisis situations generated by maritime accidents are especially dangerous for closed waters, and the Baltic is such body of water. Actions taken to minimize these threats must have a different nature.

To reduce the risk of crisis situations caused by Baltic shipping, two simultaneously actions should be taken. Actions should include the reduction of marine accidents and incidents as well as improving the ability to minimize the negative effects of their occurrence.

Still the most common cause of maritime accidents is human error, which shows that raising the level of training of watch officers, their compliance with applicable regulations and good practice can almost without any effort contribute to reducing the number of maritime accidents. However, this is not easy, because it requires a change of awareness and approach to the performance of duties by officer of the watch (OOW). One of the possible ways to achieve this would be a catalog of penalties and their inevitability, penalties for ship-owners and watch officers in the event of breaches of applicable regulations and good maritime practice.

In recent decades there has been a tendency to systematically reduce the number of crews aboard vessels. Such tendency means that, especially in coasting trade shipping, the ships' crews are exploited which is conducive to making mistakes. It seems that the obligation to have a crew numbers able to maintain a three-watch system on board would reduce the number of marine accidents and incidents.
It is necessary to continue investments in shore and ship systems increasing navigation safety and further modernization and extension of recommended shipping routes, fairways and traffic separation systems. In case of development of the coastal infrastructure improving the safety of Baltic navigation (e.g. VTMS, AIS, NAVTEX, GPS and GMDSS), both joint projects of the Baltic States and national projects can be observed. For example, Poland with support of European founds builds a modern maritime communications system. The system will increase the safety of navigation and protection of life in the Baltic Sea, shortening the response time to potential and real threats to life at sea.
For the ships crossing waters difficult to navigate and transporting petroleum substances, chemicals or other hazardous goods – the use of pilot services should be obligatory.
It is obvious that the increase in shipping intensity creates a conflict of economic interest among the Baltic States. In result, it is very difficult to develop the necessary common safety standards in the Baltic area. The analysis presented in the publication prove that despite the fact that modern ships are equipped with numerous technical devices increasing the safety of navigation, the Baltic shipping generates a high probability of occurrence of crisis situations caused by maritime accidents.
Unfortunately, despite the increase in shipping intensity, as a result of conflicting interests of the Baltic States, it is very difficult to develop the necessary common safety standards. It is necessary to define common and uniform international shipping corridors on the Baltic Sea. These corridors should regulate current shipping, but also take into account the economic, environmental and technological conditions of the shipping sector. Various political and legal systems as well as national interests and priorities of states in the Baltic Sea basin make it difficult to undertake joint actions enabling the creation of joint shipping corridors in the Baltic Sea.

Along with the increase in the transport of crude oil and petroleum substances in the Baltic Sea, it is necessary to develop the capacity to oil spill response. There are today around 80 dedicated oil response vessels in the region with equipment which can be used for international assistance, which have the following potential: recovery rate - 8 544 m^3/h, storage capacity - 18 960 m^3 and boom length - 25.3 km. Many of these vessels have also substantial towing capacity (HELCOM, 2018b).
The key element in the oil spills response is the sea state and reaction time. Therefore, in the case of the Baltic Sea, close international cooperation in this area and concentration of the capacity to fight spills in areas with the highest risk of spills is necessary. The dislocation of oil response vessels in the Gulf of Finland is insufficient. All countries around the Baltic Sea should also cooperate in terms of issues related to response on shore, oiled wildlife response and aerial surveillance.

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