Distribution of Maritime Safety Information and Improvement Measures for Safety of Navigation

Distribucija pomorskih sigurnosnih informacija i mjere poboljšanja sigurnosti plovidbe

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Summary

The number of losses and accidents in the maritime industry is steadily growing according to the annual report of the European Maritime Safety Agency (2015). Maritime accidents occur partly because of inaccurate, dubious, unreliable and/or misunderstood Maritime Safety Information (MSI). Therefore, this paper analyses the distribution of maritime safety information according to the developed model. The subsystem existence in the systematic functioning of the maritime safety information distribution is noticed. Apart from the others, information is distributed by the authorized national coordinators through the radio-distribution and the infrastructure of the coastal radio stations, the Very High Frequency-VHF, Navigational Text-NAVTEX and the International Maritime Satellite-INMARSAT by Safety NET. A proposal for maritime safety improvement measures is based on the expected distribution of maritime safety information. The application of new measures may increase the level of the investigated part of the maritime safety in the state systems responsible for maintenance or logistics of maritime motorways as well as seafarers themselves.

KEY WORDS
MSI
safety
logistics
maintenance
safety measures

Sažetak

Prema godišnjem izvješću Europske pomorske agencije za sigurnost (EMSA), broj nesreća na moru u stalnom je porastu. Pomorske se nesreće dijelom događaju i zbog netočnih, nepravodobnih, dvojbenih, nepouzdanih i/ili pogrešno protumačenih pomorskih sigurnosnih informacija (Maritime Safety Information – MSI). Stoga se u ovom radu prema razvijenom modelu analizira distribucija pomorskih sigurnosnih informacija. One su sadržane u redovitim emisijama radiooglasa (Radio Navigational Warnings – RNW) ovlaštenog nacionalnog koordinatora. Uočava se funkcionalna važnost podsustava u sustavnom funkcioniranju distribucije pomorskih sigurnosnih informacija. Njih, pored ostalih, distribuiraju ovlašteni nacionalni koordinatori distribucijom radiooglasa s pomoću infrastruktura obalnih radijskih postaja koristeći se pomorskim frekventnim pojasom vrlo visokih frekvencija (Very High Frequency – VHF), navigacijskim tekstom (Navigational Text – NAVTEX) i Međunarodnim sustavom za pomorske satelite (International Maritime Satellite – INMARSAT), i to službom sigurnosne mreže (SafetyNET). Na osnovi postignutih rezultata istraživanja daje se prijedlog novih mjera poboljšanja sigurnosti plovidbe temeljene na očekivanoj distribuciji pomorskih sigurnosnih informacija. Primjena novih mjera može povećati razinu istraživanog dijela sigurnosti plovidbe pri državnim tijelima zaduženim za održavanje ili logistiku pomorskih plovnih putova, kao i samih korisnika, tj. pomoraca na brodovima.

KLJUČNE RIJEČI
pomorstvo
sigurnost
logistika
održavanje
mjere sigurnosti

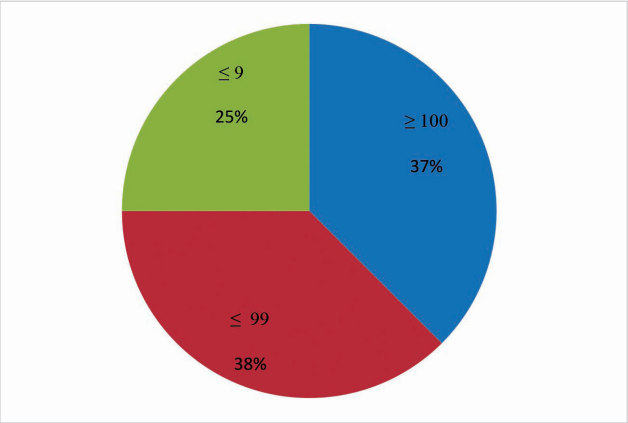
1. MARITIME ACCIDENTS / *Pomorske nesreće*

According to the EMSA report 32 areas of special frequency of maritime accidents are defined. Maritime accidents are classified in these areas by density.

According to the classification, areas are distinguished by the way of marking:

- grey colour areas with ≤ nine maritime accidents,
- orange colour areas with ≤ 99 marine accidents and
- blue colour areas with ≥100 marine accidents.

According to this report, in the period from 2011 to 2015, a total of 25 272 maritime accidents occurred. (Figure 1).



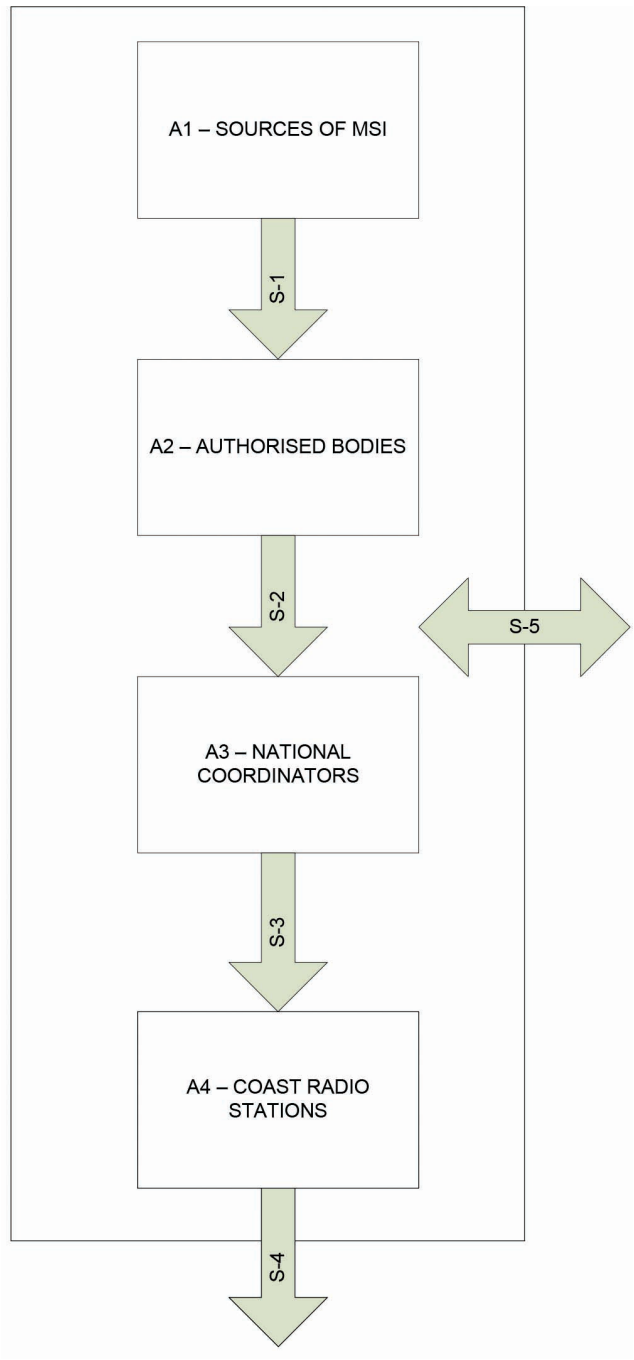
Source: Made by authors according to the EMSA http://www.emsa.europa.eu/implementation-tasks/accidentinvestigation/items.html?cid=141&id=2903

Figure1 Number of maritime accidents in the world
Slika 1. Broj pomorskih nesreća u svijetu

71% of maritime accidents happened due to human error. It was partly due to inaccurate, unreasonable, dubious, unreliable and/or misunderstood Maritime safety information [1]. So, in order to determine the impact, their distribution is shown through the MSI model [6, 7, 8, 9, 10].

2. MODEL OF DISTRIBUTION OF MARITIME SAFETY INFORMATION / *Model distribucije pomorskih sigurnosnih informacija*

Maritime safety information includes various navigational and meteorological alerts and warnings as well as meteorological forecasts. MSI refers to all other urgent information and/or messages that must be distributed to ships in different areas of navigation. Considering the importance of MSI, it should be distributed in a strictly defined and highly qualified manner. In the MSI distribution, common standards are applied in certain stages of creation and verification itself. That is the reason IMO Resolution A.705, called Promulgation of Maritime safety information has appeared. It defines the organizational structures, norms and methods required during the process of MSI creation, distribution and acceptance. It should be noted that MSI follows the internationally and nationally harmonized Global Maritime Distress and Safety System [3]. The model of maritime safety information distribution is shown in the figure (Figure 2).



Source: Authors

Figure 2 Model of MSI Distribution
Slika 2. Model MSI distribucije

Model of MSI distribution includes the following subsystems:

- A1- Sources of maritime safety information,
- A2- Authorized state administration system,
- A3- National coordinators and,
- A4- Coast Radio Station-CRS.

These subsystems are further analysed in the paper.

A1. Sources of maritime safety information are different. In a dynamic environment such as sea and other waterways, changes constantly happen. They are a result of human activity or natural process [10]. For example, sources of maritime safety information may include processes related to sea and underwater exploitation, military and police activities, construction activities, sporting events, natural disasters and occurrences, meteorological conditions etc. Such information containing planned activities or circumstances is delivered to the state administration system and similar authorities. They filter and check the information received in their area of responsibility. In accordance with the preferences, it is forwarded to the marine safety information distributing system.

A2. In the subsystem there are various state administration systems in charge of maritime affairs, maritime safety services, maritime safety information and similar activities and procedures. Each country with the obligation to provide maritime safety information authorizes individual systems within its competence to do activities related to MSI distribution. In the Republic of Croatia, for example, such state bodies are: The Ministry of Maritime Affairs, Transport and Communications, the Ministry of Defence, the Ministry of the Interior Affairs, the Port Authority etc. In accordance with the legal regulations, they jointly participate in the work of the MSI distribution system.

A3. National coordinators are responsible for receiving and further maritime safety information processing. They check content, comply it with standards and pass on to the coastal radio stations. Today, several national coordinators are distinguished, such as navigation alerts and warnings, search and rescue, and maritime alerts and warnings [3]. The coordinators for National navigational alerts and warnings collect, synchronize and forward navigational alerts and warnings in their area of responsibility. The National Search and Rescue Coordinators perform their tasks in connection with search and rescue activities [4]. The national coordinators for maritime alerts and warnings in their area of responsibility also perform given activities.

A4. Coastal radio stations are elements of the GMDSS system. They do communication services in accordance with the recommendations in the areas provided for maritime use. The NAVTEX is used in the distribution part of MSI. In navigation areas that are not included in the NAVTEX system, MSI must be distributed by using the INMARSAT Safety NET service for distances up to 250 NM from the coast. There are one-way and two-way links in the model:

- S1,
- S2,
- S3,
- S4 and,
- S5.

S1. By the two-way connector S1, there is communication between the system environment and all subsystems in accordance with the recommendations based on a specific situation.

S2. By the two-way connector S2 communication between MSI sources and authorized state system is accomplished. The first information is forwarded. Its importance for navigation safety is checked and according to the analysis, it will be decided if it is the MSI. Once MSI status is obtained, it is forwarded to the system.

S3. The two-way connector S3 is associated with authorized state administration system with named national coordinator. In this section, communication is made in order to coordinate the received requests for radio navigational warnings, performing various checks and forwarding it further to the system.

S4. The two-way connector S4 performs communication in relation to the created radio navigational warnings which contains MSI and sends it to distribution subsystem. The subsystem is usually a Coastal radio station.

S5. By the one-way connector S5, radio navigational warning is distributed to end users, depending on the assigned category of the warning through VHF, NAVTEX and/or INMARST Safety NET system.

In the analysed system, in accordance to the analysis of the subsystems and with regard to the defined system, important are processes with the final result, distributed radio navigational warnings. In the given algorithm, the system subsystems and the processes at sufficient level of generalizing are illustrated (Figure 3).

The algorithm presents basic processes in decision making in order to transmit the radio navigational warnings with the MSI to the end user. The algorithm does not show all processes in the radio navigational warning distribution. Only processes at the chosen level of production are covered. It is considered sufficient to understand the analysed problem and to do further research.

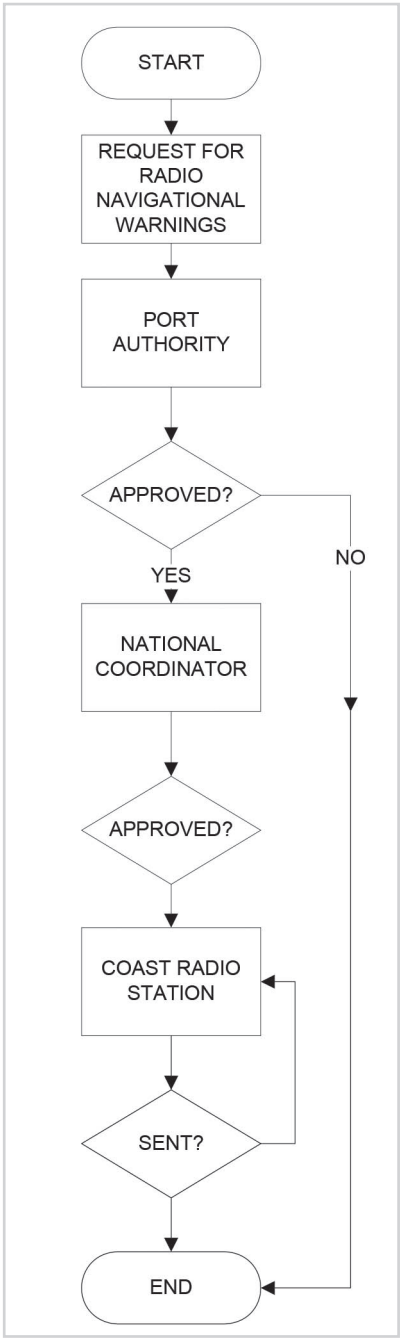


Figure 3 Algorithm of maritime safety information
Slika 3. Algoritam pomorskih sigurnosnih informacija

It can be concluded that radio navigational warning is one of the main sources of MSI for seafarers in navigation. It is assumed that apart from its first and fundamental role in informing seafarers, the radio content can be utilized better for logistic organizations involved in the maintenance of sea waterways. With that aim, further measures for maritime safety are being developed.

3. MARITIME SAFETY IMPROVEMENT MEASURES / *Mjere poboljšanja sigurnosti plovidbe*

Based on the analysis of the relevant recommendations, model and algorithm of distribution of maritime safety information, new measures to improve the part of maritime safety can be proposed. They are related to the following:

- Density of maritime safety information – radio navigational warning areas,
- Density of maritime safety information – radio navigational warning sub-areas,
- Density of maritime safety information of sub-areas – radio navigational warning per square miles and,
- Average time for malfunction repair.

Many maritime countries are responsible for maintenance of maritime waterways. Each of them is responsible for their area of responsibility. Therefore, it is proposed to use the measure named Density of Maritime Safety Information – radio warnings of the area. (G_{MSI})

$$G_{MSI}=\frac{n}{P_a} \quad [3.1.]$$

It is calculated according to the parameters of the following meaning:

G_{MSI} – density of the maritime safety information of the area – radio navigational warnings

n – total number of distributed radio navigational warnings

P_a – area

Some of the various organizational forms of maritime countries responsible for the implementation and maintenance of maritime waterways are divided into two and more sub-areas. In this case, it is proposed to use the measure named Density of Maritime Safety Information – radio navigational warning of sub-area (GPMSI).

$$G_{PMSI}=\frac{np}{P_{1,2,\ldots,n}} \quad [3.2.]$$

It is calculated according to the parameters of the following meaning:

G_{PMSI} – density of the maritime safety information of the sub-area – radio navigational warnings

n_p – total number of distributed radio navigational warnings of sub-area

P_a –sub-area

It is also considered useful to have data on the occurrence of maritime safety information – radio navigational warnings in some minor area. It is therefore proposed to calculate the density of the maritime security information subsystem – radio navigational warnings per square mile (GS_{MMSI}).

$$G_{S\,MMSI}=\frac{np}{M^2} \quad [3.3]$$

It is calculated according to the parameters of the following meaning:

$G_{S\,MMSI}$ – density of the maritime safety information of the subarea – radio navigational warnings per square mile

n_p – total number of distributed radio navigational warnings of sub-area

M^2 - square mile

Various organizational forms of maritime countries do maintenance of maritime waterways using a variety of technological processes. These processes are carried out in different ways and speed. So, the same failure and/or malfunction in different navigation areas occurs in the same and different organizational forms that carry out processes of maintenance of maritime waterways with different time of malfunction and/or failure repair. In navigation, it is considered useful to know the time of malfunction and/or failure essential for safety of navigation on a particular maritime waterway [5]. The average time to repair the malfunction (Te) in e.g. a year can be measured in this way.

$$T_e=\frac{T_u}{n} \quad [3.4]$$

Average time for malfunction repair is calculated according to the parameters of the following meaning:

T_e – Average time for malfunction repair

T_u - Total time from the time of malfunction to the time of repair

n – number of malfunctions

If the measure (T_e) exceeds tolerant or acceptable values, it can affect seafarers' attention. Therefore, the proposed new measures are considered to be clearly displayed on the maritime chart [4]. It is suggested to include the data on the density of the GMSI maritime safety information and the average time of malfunction repair. The areas can also be marked in the special way with red, yellow and green colour as shown in the following table, indicating the value of one of the measures for GMSI (Table 1).

Table 1 Signification of T_e

Tablica 1. Označavanje T_e

T_e	Sign	Description
≤ 24 h	Δ	Good
1-7 dana	Δ	Average
≥ 7 dana	Δ	Alarming

It is suggested to use the following sign for T_e and G_{MSI} on the maritime charts and navigation publications (Figure 4).

Figure 4 Display of measures T_e and G_{MSI}

Slika 4. Prikaz T_e i G_{MSI}

Where the marks have the meaning:

Δ – according to the colour, good, average or alarming maintenance (Table 1)

n – number of radio navigational warning in the observed year

g – the observed year

MSI – Maritime Safety Information

It is assumed that the application of new measures in the proposed manner may increase the level of the investigated part of the safety of navigation. Different state organizational systems in charge of maintenance or logistics of maritime waterways can compare the maintenance quality of a particular area, optimize its process, and inspect the criticality of the particular waterway areas. It is reasonable to expect that the existence of the proposed way of marking would cause additional caution in potentially more dangerous navigation areas in terms of MSI distribution. This significantly affects the degree of safety of navigation. The authors are also developing new measures to improve the investigated part of the navigation safety.

4. CONCLUSION / *Zaključak*

The research carried out in this paper undoubtedly points the fact that the maritime accidents constantly happen partly due to seafarers' mistakes, and inaccurate interpretation of maritime safety information. Maritime safety information in the section radio navigational warnings is distributed by authorized national coordinators. If maritime safety information relates to the dangers and/or malfunctions of infrastructure objects essential to the safety of navigation, then they should be eliminated properly. The time of malfunction repair is different in different navigation areas and/or subareas. New developed measures (GMSI), (GPMSI), (GS MMSI), (Te) allow observing changes in the analysed parameters. In addition to the proposed way of maritime charts display, the level of navigation safety may be increased by the maritime shipping logistics as well as by seafarers. By applying the proposed one, it is important to increase the degree of safety of navigation. The authors also develop a set of new measures and simulation models for further safety improvement that will contribute to development of the IMO's E navigation system.

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