

Port State Control Inspections During the COVID Pandemic – Case Study: Republic of Croatia

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The paper analyzes the Port State Control system established to ensure that ships meet international safety standards, are safe for the environment and provide adequate living and working conditions for the ship's crew. The results of the research on Port State Control inspections of foreign state-owned ships in the waters of the Republic of Croatia are presented, with an emphasis on deficiencies in the safety of navigation. The research was conducted over the three-year period of the COVID pandemic, i.e. from 2019 to 2021. The Thetis and Paris MoU inspection databases were used for analysis. The aim of the analysis was to determine the number of inspections in the ports of the Republic of Croatia, the causes of ship detention and the most common deficiencies in the domain of safety of navigation identified by inspections during the COVID pandemic. Given that safety of navigation is one of the components of the safety system at sea, emphasis was placed on the identification of deficiencies in the area of safety of navigation.

KEY WORDS

- ~ Safety of navigation
- ~ Port state control
- ~ Paris MoU
- ~ Marine safety
- ~ Inspection data

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1. INTRODUCTION

Maritime transport plays an important role in world trade, giving rise to the international character of maritime transport. In the European Maritime Transport Environmental Report 2021 [1], EMSA states that maritime transport accounts for 77% of the EU's external trade and almost 4 billion tons of goods are loaded and unloaded in EU ports. According to the data from the European Maritime Transport Environmental Report 2021, although there was a drop in these figures in 2020 due to the impact of the COVID pandemic, further growth in international maritime transport is expected.

The Paris Memorandum of Understanding (Paris MoU) on Port State Control was adopted to eliminate ships of substandard quality that represent high risk to safety of navigation, human life and the marine environment [2]. Although the flag state is primarily responsible for compliance with the relevant international rules and standards for the safety of navigation, ship and human lives at sea, as well as for the protection of the marine environment, Port State Control is the basis for conducting inspections of ships sailing under a foreign inspection flag, which dock in the ports of Paris MoU members states.

The aim of the Port State Control is to check whether the condition of the ship and its equipment comply with international regulations and whether ship crew and management are in accordance with the standards specified in the relevant instruments of the Paris Memorandum. The results of the Port State inspection indicate a constant decrease in the number of maritime accidents in recent decades, as well as a decrease in the number of deficiencies identified during inspections. For comparison, the Paris MoU report for 1996 [3] stated that 16,070 inspections were carried out which identified 53,967 deficiencies, resulting in the detention of 1,719 ships, while the Paris MoU report for 2021 stated that 15,387 inspections were carried out which identified 3,274 deficiencies and resulted in the detention of 528 ships.

Given that the safety of navigation [4] is the most variable of all maritime safety components, the detection of deficiencies in the area of navigation safety during port state inspections is extremely important. In Fan L. et al., a study on the influence of factors on ship accidents and the identified deficiencies of port states conclude that „along with the impact of the ship-inherent attributes, the PSC-inspected deficiency items also impact accident probability and if deficiencies are identified in these key items in a ship inspection, the probability of having an accident for that ship will increase“. [5] (p.81). Randić M. et al. reached a similar conclusion in their paper on the Swift analysis of ship component deficiencies identified by Port State Control inspections. Their conclusion was that the most important recommendations that can be given based on inspection evaluation, namely recommendations that affect the ability of the ship to continue navigation and perform a specific task, are those that concern the safety of navigation and life saving appliances. [6]

Looking at the data on inspections performed in eight Memorandums of Understanding, Yan R. et al. [7] found that the number of inspections was significantly reduced in most Memorandums and that the impact of the COVID-19 pandemic in different Memorandums differs depending on the intensity of the pandemic, pandemic prevention measures and PSC inspection strategies. At the same time, the average number of deficiencies in some Memorandums is lower than the average level in the 2017-2019 period, while others show a similar trend as before the outbreak of COVID-19, with fluctuations (deviations) in the remaining detentions.

According to the Paris MoU Annual Report 2021, safety of navigation deficiencies accounted for 10% of all deficiencies recorded in 2021 and 11% of all deficiencies recorded in 2020. The number of deficiencies increased from 3,144 in 2020 to 3,677 in 2021 [8]. Due to the importance of this area and the frequent amendment of navigation equipment, and navigation equipment deficiency regulations – approx. 6.21% over a six year period – have been noted as high in the Paris MoU area, a Concentrated Inspection Campaign (CIC) on Safety of Navigation was conducted, which showed that navigation equipment deficiencies accounted for a major proportion (1.2%) of the overall CIC-topic deficiency rate (average number of deficiencies reported per

inspection), which is a satisfactory result [9]. Deficiencies in the safety of navigation area according to the Paris MoU Overview of Deficiency Codes are the following: Pilot ladders and hoist/pilot transfer arrangements, Type approval equipment, Radar, Gyro compass, Magnetic compass, Compass correction log, Automatic radar plotting aid (ARPA), Lights, shapes, sound-signals, Signalling lamp, Charts, Electronic charts (ECDIS), Automatic Identification System (AIS), Voyage Data Recorder (VDR) / Simplified Voyage Data Recorder (S-VDR), GNSS receiver/terrestrial radio navigation system, Nautical publications, Echo sounder, Speed and distance indicator, Rudder angle indicator, Revolution counter, Variable pitch indicator, Rate-of-turn indicator, International code of signals- SOLAS, Life-saving signals, Use of the automatic pilot, Records of drills and steering gear tests, Voyage or passage plan, Navigation bridge visibility, Navigation records, Communication - SOLAS Chapter V, Bridge operation, HSC operation, Monitoring of voyage or passage plan, Establishment of working language on board, Long-Range Identification and Tracking system (LRIT), Bridge Navigational Watch Alarm System (BNWAS), Other (navigation). [10]. In addition, safety of navigation deficiencies also affect other areas, such as working and living conditions, and pollution prevention. According to EMSA's data from the Annual Overview of Marine Casualties and Incidents 2021, 6.5% of safety recommendations or actions taken were related to safety of navigation when deficiencies related to the "structure and equipment of the ship" were found [11]. Also, in their analysis of the correlation between the relevant ship factors (i.e., ship type, age, deadweight and gross tonnage, etc.) and ship deficiency category, Fu J. et al. came to the conclusion that the type of ship, age, deadweight and gross tonnage are closely related to the identification of ship deficiencies, which is particularly visible in ship detention incidents. [12] Ports of the Republic of Croatia have been studied taking into account the importance and specifics of the Adriatic Sea. Namely, given that the Adriatic Sea penetrates deep into the European mainland, it has great traffic significance. The Adriatic is the shortest connection between the densely populated and economically developed Central European area, the Mediterranean, and Asian and African countries, which is why it is the most important longitudinal traffic route. [13] In 2021, Croatian seaports had the overall turnover of 17,890,000t of cargo and 12,280,000 passengers. [14]

The emergence of COVID-19 also affected the maritime industry given its international character, especially during lockdown, which made it even more difficult to organize the Port State Control system. As PSC involves the physical boarding of foreign vessels by PSCOs and two-way communication between onboard and onshore staff, it was inevitably influenced by the COVID-19 pandemic from various perspectives. [15]

In the first 24 weeks of 2020, the number of global ship calls decreased by 8.7 per cent, down from 1.1 million calls recorded in the first 24 weeks of 2019. [16]

2. RESEARCH METHODOLOGY

The analysis was conducted using the Thetis database (EMSA THETIS) and the Paris MoU. The Thetis inspection database contains information on ship data, previously performed inspections on EU territory and in the Paris Memorandum area, and informs national PSC authorities about ships due for inspection. Post-inspection data entered into the inspection database (Thetis) help identify substandard ships and target them for priority inspection.

The data obtained from this research refer to inspections in the area of port authorities in the Republic of Croatia in the 01/01/2019 - 31/12/2021 period, with an emphasis on inspections which identified safety of navigation deficiencies. The Croatian port authorities carry out safety of navigation and maritime property supervision. Some of the safety of navigation tasks performed by port authorities are: predicting, preventing, limiting, ensuring readiness to react and respond to sudden sea pollution and to extraordinary natural events in the sea in order to protect the marine environment and the coastal area, as well as to protect the environment from pollution from inland navigation facilities, monitoring and management of maritime traffic, inspection supervision of the safety of navigation, inspection supervision of environmental protection from pollution from maritime facilities and inland navigation facilities, inspection supervision of legal and natural persons authorized

to perform certain safety of navigation tasks, and other tasks in accordance with maritime and navigation regulations, inspection supervision of transport in public coastal liner shipping, supervision over the maintenance of order, safety of navigation and environmental protection conditions in ports and other parts of internal sea waters and the territorial sea of the Republic of Croatia, as well as at ports, docks and other parts of internal waters, inspection work, collection of evidence and investigation of maritime and navigational offenses that caused a maritime or navigational accident, and ensuring seaport and ship safety. [17] There are eight port authorities on the territory of the Republic of Croatia: Pula, Rijeka, Senj, Zadar, Šibenik, Split, Ploče and Dubrovnik. In order to analyze the key deficiencies in the area of safety of navigation, the key variables included in the methodology have been identified:

1. number of inspections,
2. number of inspected ships, age and type of ships with safety of navigation deficiencies,
3. flags and recognized organizations,
4. the age of the ship and the number of detentions.

The variable related to the number of performed inspections and the number of inspected ships is crucial for analyzing the impact of the COVID pandemic on the Port State Control system in the Republic of Croatia.

The age of the ship, apart from being one of the criteria used to determine the ship's risk profile, is also an indicator of its possible negative impact on the marine environment and safety of navigation. It is important to point out that ships older than 12 years are considered to be risky ships [18].

The results of the research on ship deficiencies from historical port control inspections by Fu J. and associates [19] showed, among other things, that the type of ship and its age are closely related to the incidence of ship deficiencies, which is especially visible in incidents that led to the ship detention. In their analysis of the annual report on the safety of navigation in the Republic of Croatia, Stanivuk et al. [20] also pointed out ship age and type as important inspection parameters, being the factors that affect inspection frequency and extent.

The results obtained by Wan Y. [21] in their research on the dependence and interdependence of risk factors affecting port state inspection indicate that deficiencies related to the safety condition of the ship, as well as the technical features of the inspected vessel itself, are among the most influential factors when it comes to PSC inspections and detention. They suggest that special attention should be paid to ship age, type of inspection, place of inspection, fire safety, navigation safety, type of ship, classification society, working conditions and health protection.

In their analysis of flag state characteristics, Corres A.J. et al. [22] concluded that the age of the fleet correlated with the flag's compliance with international conventions and that the best open flags lag behind the best national flags, while the worst are no worse than their national counterparts.

It is the duty of the flag state to ensure compliance with international rules and standards in order to prevent pollution of the marine environment by ships. The Paris MoU annually publishes a "White, Grey and Black List" based on the total number of inspections and detentions over a 3-year period for flags with at least 30 inspections over the observed period.

Recognized organizations play a key role in the safety of the ships they inspect and issue certificates to, and form one of the general parameters for determining a ship's risk rating.

Investigating the differences in the types of deficiencies that caused the detention in the Black Sea region during the Covid-19 pandemic and before the pandemic, Maşalacı Ç.B. et al. [23] conclude that safety inspections conducted by flag state classification societies and administrations on board and IMOs circular

resulted in non-standard inspections, that each country in the Black Sea region implemented a different PSC regimen, and that during the pandemic there were deficiencies in the Certificate and Documentation domain.

By applying multivariate statistical techniques, such as indicators of variability in the effects of COVID-19 on the Paris Memorandum of Understanding on Port State Control, Prieto J.M. et al. [24] came to the conclusion that there are countries stable inspection development; countries which realized slight progress; countries most negatively affected by the pandemic, the inspections of whose ships were influenced by the sheer number of older ships with a higher number of deficiencies; and countries that were affected by the pandemic, but with more positive inspection results (the Republic of Croatia belongs to this group).

By declaring the COVID-19 pandemic, countries introduced various measures to prevent the spread of the virus, including border closures, social distancing, and travel restrictions that resulted in supply chain and traffic disruptions.

Given that measures to prevent the spread of COVID-19 have affected seafarers and shipping as a whole, as they faced serious challenges in connection with quarantine requirements, border crossing restrictions with border closures, repatriation and crew transfers, abandonment, renewal of seafarers' certificates and licenses, supply and ship inspections, Henry D.C. [25] believes that there will be an increased need to move forward with greater integration of the global supply chain, digitization and standardization.

The COVID-19 pandemic also affected classification societies, which adopted a temporary measure approving the extension of the inspection by 3 months. Investigating the legality of such decisions in class rules and IMO instruments, Nam D. et al. [26] suggest the modification of the force majeure clause in class rules to cover scenarios such as the COVID-19 pandemic, and that the IMO initiates a discussion on the amendment of the extension clause, e.g. Rule 14 (e) Chapter 1 of the SOLAS 1988 Protocol with respect to discretion in granting inspection extensions.

Despite everything, the number of detentions did not decrease in 2020, which implies a higher ratio of inspections that resulted in detention, which could be evidence of a greater number of detected violations of international convention provisions that regulate maritime traffic [27].

3. RESEARCH RESULTS

3.1. Number of inspections

Due to the crisis caused by the COVID-19 virus, "As the Paris Memorandum sought to protect port control officers and seafarers on ships, as well as keep supply chains open, it developed guidelines for members during the crisis indicating the need to be flexible in special crisis circumstances, which included the effect of review, inspection and audit delays; extensions of the ship certificate validity, extended periods of service on board and periods personnel certification delay (STCW'95 and MLC, 2006)" [28]. These measures reduced the number of PSCs in the area of the entire Memorandum, including in the Republic of Croatia.

A total of 788 ship inspections were performed in the 2019-2021 period in the Republic of Croatia: 1,750 deficiencies were identified (ISM+ISM related) and 24 ships detained. In the safety of navigation domain, 177 inspections identified 339 deficiencies. The data suggest that safety of navigation accounts for 19.54% of all deficiencies detected in the three-year period. The majority of inspections were carried out on the territory of the Rijeka Port Authority (255), followed by Ploče (127), Split (97), Raša (56) and Pula (52). The reason for the highest number of inspections on the territories of these port authorities is that the ports in their territories account for almost 90% of the total turnover of goods in seaports (the ports of Omišalj, Rijeka, Pula, Bakar and Split), based on the data of the State Statistical Office of the Republic of Croatia [29].

Year	Total inspections	Safety of navigation related inspection	% inspections that detected safety of navigation deficiencies
2019	299	83	27.76
2020	219	61	27.85
2021	270	63	23.33

Table 1. Total number of inspections and number of inspections which detected safety of navigation deficiencies in 2019-2021.

The data from Table 1 show that the number of total inspections has not yet reached the number of inspections before the COVID pandemic. The decrease in the number of inspections was 26.8% in 2020, and 9.7% in 2021 compared to 2019. However, in 2021, the number of inspections increased by 3.2% compared to the previous year, 2020. Despite the decrease in the number of inspections, the percentage of inspections that detected safety of navigation deficiencies was almost identical in 2019 and 2020, with a 14.8% decrease in 2021. The biggest decrease in the number of inspections occurred between 01/04/2020 and 30/06/2020 owing to the strict COVID-19 measures, which included complete lock down and travel restrictions, with the gradual and continuous increase in the number of performed inspections from the third quarter of 2020.

The most inspected flags were Panama 103, Malta 78, Italy 55, Liberia 37, Marshal Islands 37, Togo 26, Portugal 25, Turkey 22, Antigua and Barbuda 18, and the Bahamas 18. These flags account for 64.6% of inspected ships. In 2021, the flag of Togo was the only black-listed flag in the Paris MoU, the flags of Antigua and Barbuda were not on the list of the Paris MoU at all, while others were white-listed. The position of the flag state on Paris Memorandum lists is important because it shows the level of maritime security of the flag and is one of the elements used to calculate the ship's risk profile in the Memorandum area. Panama, Liberia, and Marshal Islands flags accounted for almost 44% of the world fleet in dwt [30] in 2021, and consequentially the highest number of inspections. The number of individual flag state inspections varied between PSC regimes depending on the region of travel, but Panama ranks first in all PSC regimes as per inspection rates, except for the Abuja MoU [31].

Over the three-year period, 18 initial inspections, 134 detailed inspections and 55 expanded inspections were carried out that detected safety of navigation deficiencies. They included inspections of the following areas: Accommodation and Galley (206), Navigation bridge (206), Engine room (205), Decks and fore-castle (203), Steering room (203), Cargo area (138), Ballast tank-from manhole (49), Passenger cabins (12), Vehicle deck (5), and Operational control: fire drill (169), emergency steering drill (112), abandon ship drill (88), rescue boat drill (13), enclosed spaces emergency drill (11), man over board drill (2) and other drills (19).

Although the number of total inspections in 2020 and 2021 decreased compared to the year before the appearance of the COVID-19 virus, the number of more detailed inspections and expanded inspections remained almost at the same level, as they accounted for 68% of inspections in 2019, 66% in 2020 and 66% of inspections in 2021. Therefore, we can conclude that inspections in the Republic of Croatia had positive results regardless of the fact that Croatia was affected by the COVID-19 pandemic. Such results were referenced in the Pietro J.M. et al. study on the impact of the pandemic on maritime transport using Paris MoU inspection data [32]. This is particularly significant since detailed inspections are the basis for ship detention decisions, which have an impact on maritime safety.

3.2. Number of inspected ships, age and type of ships with safety of navigation deficiencies

In the 2019-2021 period, port authorities in the Republic of Croatia inspected 649 ships, of which 177 ships had one or more safety of navigation deficiencies.

Inspections performed per ship	Number of ships	% of total
1	154	87
2	17	9.6
3	3	1.7
4	3	1.7

Table 2. Number of ships and number of inspections with safety of navigation deficiencies

Table 2 shows that 17 ships (9.6%) were inspected twice, 3 ships (1.7%) were inspected 3 times, and 3 ships (1.7%) were inspected four times in the 2019-2021 period. The average age of the inspected ships was 30.63.

The majority of the ships in the performed inspections with safety of navigation deficiencies are: General cargo/multipurpose (120), followed by Livestock carrier (11), Tug (6), Container (5), Other special activities (5), Passenger ship (5), Ro-Ro passenger ship (5), Commercial yacht (4), Bulk carrier (3), Gas carrier (3), Oil tanker (3), Dredger (2), Oil tanker/Chemical tanker (2), Chemical tanker (1), Refrigerated cargo (1) and Ro-Ro cargo (1). General cargo/multipurpose ships have the largest portion in the total number of inspected ships (39.45%).

3.3. Flags and recognized organizations

The ship's flag is a sign of its state affiliation and represents its nationality. The country of the flag under which the ship sails is required to enforce international regulations. Recognized organizations (classification societies) carry out ship surveys and inspections, and the flag state can authorize a recognized organization to act on its behalf in the conduct of surveys and certification of its ships.

During the three-year period, the ships from 55 flag states were inspected, of which safety of navigation deficiencies were detected on the ships from 39 flag states.

Paris MoU list 2021	Flag states
White list	Bahamas, Belgium, Cayman Islands, Cyprus, Denmark, France, Greece Hong Kong (China), Isle of Man, Italy, Latvia, Liberia, Luxembourg, Malta, Marshall Islands, Panama, Portugal, Russian Federation, Turkey, Gibraltar
Gray list	Belize, Cook Islands, Lebanon, Palau, Saint Kitts and Nevis, Saint Vincent and the Grenadines, Sierra Leone, Tanzania, Vanuatu
Black list – medium risk	Comoros
Black list – medium to high risk	Albania, Moldova, Togo
Black list – high risk	Cameroon
Flag not on Paris MoU list	Antigua and Barbuda, Honduras, Jordan, Niue, Tuvalu

Table 3. Flag states with safety of navigation deficiencies on the Paris MoU list

Table 3 shows that navigation safety deficiencies were found in 20 flag states from the White List, 9 from the Gray List, 5 from the Black List, while 5 flag states were not on the lists of the Paris MoU for 2021.

The inspected ships had been classified by 30 recognized organizations, with the majority of classifications (61.83%) conducted by: Dromon Bureau of Shipping (31), followed by RINA Service S.p.A. (26), Bureau Veritas (22), International Naval Surveys Bureau (16) and Bulgarian Register of Shipping (11), DNV GL (11), and Polski Rejestr Statkow (11). RINA, Bureau Veritas, DNV have high performance level on the Paris MoU list 2021, while Dromon Bureau of Shipping, International Naval Surveys Bureau, Bulgarian Register of Shipping and Polski Rejestr Statkom have medium performance level on the Paris MoU list 2021.

3.4. Safety of navigation deficiencies

The safety of navigation depends on several factors. In the Republic of Croatia, safety of navigation refers to minimum conditions that need to be met: waterways and navigation safety facilities in internal sea waters and in the territorial sea of the Republic of Croatia; hydrographic activities, search and rescue of persons in peril at sea, maritime traffic monitoring and management, coastal radio stations, maritime meteorological and hydrological service, ports, maritime facilities belonging to the Croatian state, as well as vessels sailing in internal sea waters, in the territorial sea of the Republic of Croatia, and along the economic zone of the Republic of Croatia, and the implementation of inspection supervision [33]. Due to the potential consequences of safety of navigation deficiencies (collision, loss of life, pollution of the marine environment, etc.), this area is highly important in any inspection. Biočić T. et al. [34] found that "looking at the sub-areas of detected deficiencies, safety of navigation is at the top, as it represents potential danger of the occurrence of unwanted events, and tugboats, among the ten types of ships, have the largest portion of safety of navigation deficiencies."

Over the three-year period, safety of navigation deficiencies were detected on 177 inspected ships, where a total of 339 such deficiencies were discovered.

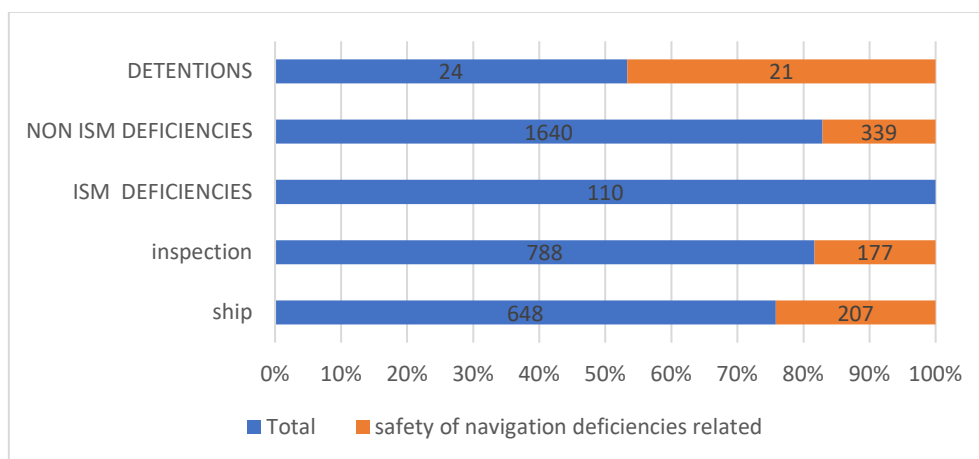


Figure 1. Number of inspected ships, inspections and deficiencies

Figure 1 shows the share of inspected ships, inspections and detected deficiencies in the total number of inspected ships and of ships on which safety of navigation deficiencies were detected.

Safety of navigation deficiencies were detected on 31.94% of all inspected ships. The percentage of inspections in which navigational safety deficiencies were detected is 22.46%, while the number of navigational safety deficiencies in total deficiencies is 19.37%. The share of detained ships with safety of navigation deficiencies was extremely high – 87%. The average number of safety of navigation deficiencies per inspection in which deficiencies were detected was 0.52.

Year	Total deficiencies (ISM+ISM related)	Safety navigation deficiencies related	% of deficiencies safety of navigation related
2019	740	138	18.64
2020	489	95	19.42
2021	521	106	20.34

Table 4. Total deficiencies and safety of navigation deficiencies

Table 4 illustrates the correlation between the number of total deficiencies and safety of navigation deficiencies, showing that in the three-year period there were no significant deviations in the share of safety of navigation in the total number of deficiencies detected during inspections.

Years	Inspections	Total deficiencies	Total safety of navigation related	ISM+ISM related
0-4	2	11	3	2
5-9	6	16	6	0
10-14	21	99	33	11
15-19	10	53	15	6
More than 20	168	972	281	148

Table 5. Number of inspections, the correlation of deficiencies and ship age

The data in Table 5 show that the number of inspections, total deficiencies and deficiencies related to navigation safety increases with ship age. This is in relation to the ship's risk profile, as ships older than 12 years are, according to the Paris Memorandum, high-risk ships, and they are subject to periodic inspections between 5-6 months after the last inspection in the Paris Memorandum area.

The five flag states with the highest number of safety of navigation deficiencies were: Panama (259), Togo (216), Moldova (140), Sierra Leone (71), and Comoros (58). This result is expected considering that Togo, Moldova and Comoros are on the Black List, Sierra Leone on the Gray List, while Panama is on the White List of the Paris MoU 2021. Only two deficiencies related to the recognized organization were found, and in both cases, it was the Dromon Bureau of Shipping.

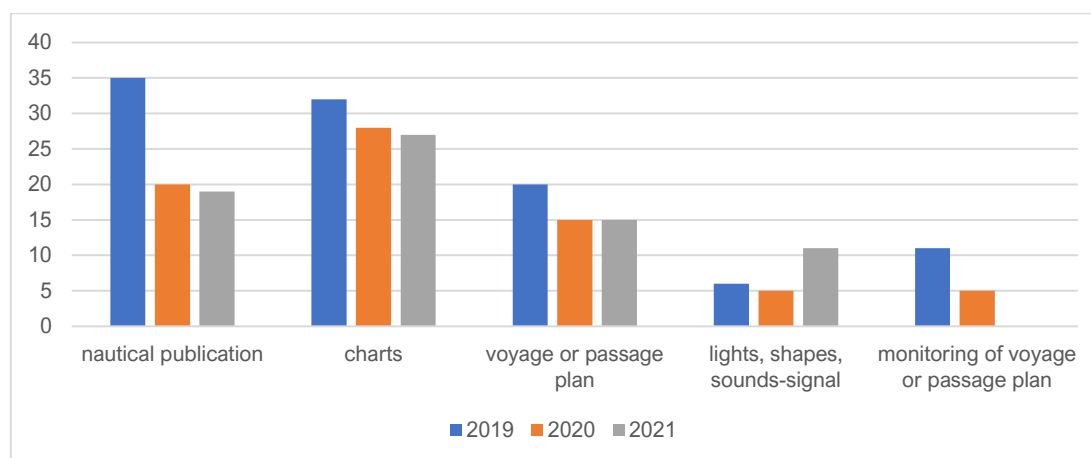


Figure 2. Number of inspected ships, inspections and deficiencies

The five most common safety of navigation deficiencies detected in inspections were: charts (87), nautical publication (74), voyage or passage plan (50), lights, shapes, sound-signals (22) and monitoring of voyage or passage plan (20). These deficiencies accounted for 73.5% of all deficiencies detected by inspection.

Graph 2 shows there are no deviations in terms of the type of deficiencies that account for the majority of safety of navigation deficiencies. The graph shows that nautical publication, charts, voyage or passage plan and monitoring of voyage or passage plan showed a trend of decrease in 2020 and 2021 compared to 2019, while lights, shapes, sound signals showed growth. In 2020 and 2021, no significant deviations in deficiency type and number were recorded. This result corresponds to the results of inspections in the Paris MoU area, according to which the database of detected deficiencies shows that the largest portion of safety of navigation deficiencies were found in the field of nautical publication, charts, voyage or passage plan, lights, shapes, sound signals. Due to the increase in the number of safety of navigation deficiencies, we believe that CIC inspections are a must, since they focus on areas with greater risk of non-compliance with regulations.

3.5. Detentions and causes of detention related to safety of navigation

Detention of a ship has an impact on the flag state's annual white, gray and black list score in the Paris MOU, as it is based on the total number of inspections and detentions over a three-year period, with blacklisted states divided into very high risk, high risk, medium to high and medium risk, depending on the number of detentions. Ships with a high detention rate are considered risky ships. The duration of detention depends on the severity of deficiencies found during the inspection, and understanding the relationship between a deficiency and the detention period can contribute to the improvement of the inspection system [35]. If the ship is detained more than once in a certain period, it can be banned from entering the port of a member state of the Paris Memorandum.

Out of 207 inspections, 21 resulted in ship detention due to multiple deficiencies onboard. 250 defects were discovered during inspections of the detained ships.

Year	total deficiencies	total deficiencies ground for detention	% of deficiencies for detention in total deficiencies	Deficiencies – safety of navigation area - ground for detention	% safety deficiencies in total detention deficiencies	RO related deficiencies -safety of navigation area-ground for detention	ISM+ISM related deficiencies – safety of navigation area-ground for detention
2019	107	55	51.4	18	33.72	1	17
2020	57	32	56.1	10	31.20	1	8
2021	86	43	50	11	26	0	11

Table 6. Number of deficiencies, detained ships with safety of navigation deficiencies

The total number of deficiencies that led to the detention of the ship was 130, 39 of which were safety of navigation related, 2 were related to a recognized organization, while 36 deficiencies were ISM+ISM related.

The data from the table indicate that, regardless of the decrease in the total number of deficiencies, as well as in deficiencies that were grounds for detention, the share of safety of navigation deficiencies in total deficiencies resulting in detention was the same in 2019 and 2021, while compared to 2019; it was higher by 10%. The number of safety of navigation deficiencies that resulted in detention decreased by 21% in 2021 compared to 2019. Average detention duration was 8 days, with a ship sailing under the flag of Sierra Leone having the highest number of detention days (85).

Bolat F. et al. [36] conducted an analysis of PSC in the Paris Memorandum area which showed that although the number of inspections decreased dramatically when COVID-19 hit the EU, statistics related to the detention /inspection ratio show the effectiveness of PSC inspections.

Deficiencies discovered during inspections are potential risk indicators for maritime accidents. Investigating whether deficiencies detected during port control inspections (PSCs) can be used to predict future accident risk, alongside other vessel-specific risk factors such as ship type, age, size, flag and owner, Heij C. et al. came up with results that showed a strong correlation between past deficiencies and future accident risks, especially when dealing with deficiencies of a higher level of severity. The factor by which this accident risk is higher for bad compared to good ships is about 6 for a total loss, 2 for very serious, 1.5 for serious and 1.3 for less serious accidents [37]. This shows us that PSC inspections are extremely important both for the vessel itself and for the safety of maritime navigation as a whole. The effectiveness of PSC inspections depends on the application of correct exemplary criteria and assessment, as well as on the identification of potential risks, in which PSC officials play a role. Misjudgment by an inspecting officer may result in failure to detect deficiencies that may endanger maritime safety. However, giving favorable scores to ships that do not meet the standards results in an extension of intervals between inspections, as such intervals depend on the risk profile of the ship in accordance with the Paris Memorandum. Due to the influence of the professional profile of PSC inspectors on the example of the Spanish Maritime Administration, Ravir et al. emphasize the limitations of the New Inspection Regime (NIR) considering that the interval between ship inspections depends on variations in the rigor of inspections and results [38]. The effects of inspection results vary, hence research on the influence of the composition of the inspection team and their experience on the inspection result on the territory of the European Union, showed a correlation between team composition and experience on the one hand, and the number of detected deficiencies on the other, as well as that there are marked differences between member states in deficiency detection and detention [39].

In the three-year period, the flag of Panama had the largest number of halts (6), followed by Togo (5), Moldova (3), Comoros (2), and Antigua and Barbuda, Honduras, Sierra Leone, Albania and Greece with one halt each. The flag states with the highest percentage of detained ships were Greece (33.33%), Comoros (28.6%), Albania (50%) and Honduras (100%). The flags of Panama and Togo had the highest number of detentions in the CIC – Safety of Navigation Paris MoU implemented in 2017. [40].

According to ship type, the majority of detentions were general cargo/multipurpose (17); followed by livestock carrier (2), tug (1) and dredger (1). As expected, the majority of detained ships were over 20 years old.

According to the criteria of the Paris memorandum for calculating the risk profile of ships, Chemical tankers, Gas Carriers, Oil tankers, Bulk carriers, Passenger ships, and NLS-tankers are classified as high-risk ships.

Years	number of safety of navigation detentions	safety of navigation related detentions as % of inspection	Total deficiencies	Total safety of navigation deficiencies	ISM+ISM related – total safety of navigation	Safety of navigation – ground for detention	ISM+ISM related- safety of navigation – ground for detention
0-4	0	0	0	0	0	0	0
5-9	0	0	0	0	0	0	0
10-14	1	4.7	22	6	5	2	0
15-19	1	4.7	12	2	2	2	2
More than 20	19	90.5	216	51	46	35	2

Table 7. Ship age and number of detentions

The majority of detention deficiencies from the domain of safety of navigation were detected in: Charts (15), Nautical publication (12), Voyage or passage plan (6), followed by: BNWAS (2) and (1) compass log correction, navigation records, magnetic compass, signaling lamp, voyage data record VDR/simplified voyage data record S-VDR, magnetic compass, signaling lamp, voyage date recorder, light, shapes, sounds-signals, echo sounder, monitoring voyage or passage plan, AIS and Gyro compass.

Detention depends on detected non-compliances and the inspector's judgment. Based on the iForest model developed by Yan R. et al. on the example of Hong Kong ports, the number of deficiencies can be used to predict detention and influence the detention decision "which can contribute to improving the role played by the PSC inspection in guaranteeing maritime safety, protecting the marine environment and guaranteeing good living and working conditions for seafarers[41]."

4. CONCLUSIONS

In the 2019-2021 period, 788 Port State Control inspections were carried out in the Republic of Croatia, and 339 safety of navigation deficiencies detected. Safety of navigation accounted for 19.54% of all detected deficiencies in Port State Control inspections in the previous three years. The decrease in the number of inspections in 2020 can be attributed to the impact of the COVID pandemic on the maritime industry, especially during the enforcement of strict lock down measures, movement restrictions and social distancing in the Republic of Croatia. Although an increase in the number of inspections was recorded in 2021, they still did not reach figures from the pre-pandemic 2019. In 2021, there was a 14.8% decrease in inspections which detected safety of navigation deficiencies, compared to the previous two years. In the 2019-2021 period, 55 flag states were inspected, 39 of which had safety of navigation deficiencies. Safety of navigation deficiencies were detected in 20 flag states from the White List, 9 from the Gray List, 5 from the Black List, while 5 flag states were not on the lists of the Paris MoU for 2021. Flag states with the largest number of deficiencies were: Panama (259) from the White list and Togo (216), Moldova (140), Sierra Leone (71) and Comoros (58) from the Black or Gray lists of the Paris MoU for 2021. The number of deficiencies increased with ship age, and the largest number of deficiencies was detected in general cargo/multipurpose ships, which also had the highest number of

detentions (17). Ship age was found to have an effect on inspection results. As expected, Black and Gray-listed flags have the highest detention percentage by number of inspections: Togo 17.9%, Moldova 16.7%, Sierra Leone 7.1% and Comoros 28.6%. The following recognized organizations had the largest detention percentage (61.83%): Dromon Bureau of Shipping (31) followed by RINA Service S.p.A. (26), Bureau Veritas (22), International Naval Surveys Bureau (16) and Bulgarian Register of Shipping (11), DNV GL (11) and Polski Rejestr Statkow (11). In 2021, the number of total deficiencies increased from 489 to 521, and the number of safety of navigation deficiencies from 95 to 106 compared to 2020. The largest number of safety of navigation deficiencies were found in: charts (87), nautical publication (74), voyage or passage plan (50), lights, shapes, sounds-signals (50), monitoring of voyage or passage plan (20). Safety of navigation deficiencies accounted for 73.5% of all deficiencies detected by inspections. Given that in this part the results correspond to the results of inspections in the Paris MoU area, it can be concluded that there were no significant deviations in the inspection results in the Republic of Croatia compared to other member states of the Paris MoU. PSC inspections in the Republic of Croatia in the observed period had good results in the sense of the ratio of detained and inspected ships.

Due to the obvious impact of the COVID-19 pandemic, issues that arose during the organization of inspections need to be analyzed, especially those pertaining to the mobility of PSC inspectors, to allow them to be better prepared for future emergency situations, and the use of robots, drones, etc. in inspections considered.

With respect to the number of detentions, which increased with ship age, investments in new ship construction are required, and when it comes to deficiency types, it is considered justified to improve crew training and supervision by ship inspectors in the domain of safety of navigation.

CONFLICT OF INTEREST

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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