
Organization of Vessel Traffic on Dredged Świnoujście-Szczecin Fairway: VTS Operators' Viewpoint on the Use of Infrastructure for Ships Passing

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Abstract:

Purpose: Modernization of the Świnoujście-Szczecin fairway involved the infrastructure investments. As a part of developed infrastructure, the new passing places were designed, allowing the implementation of two-way vessel traffic within this waterway. The commissioning of modernized fairway created challenges for Vessel Traffic Services operators (VTSOs), who plan and organize the traffic in this area. The purpose of the study was to analyze the opinions of VTSOs on the impact of changes in the fairway infrastructure on decision-making process related to planning vessel traffic on the dredged fairway, considering the use of passing places.

Design/Methodology/Approach: A marketing research method was used to conduct the research. A questionnaire was developed, and the survey was carried out among VTSOs employed in Vessel Traffic Services centers in Szczecin and Świnoujście.

Findings: In a result of conducted research, it was found that VTSOs are cautious about the use of newly commissioned Świnoujście-Szczecin fairway infrastructure elements for planning the two-way traffic of maximum-sized ships. The major concerns stemmed from the lack of needed data and the absence of mutual agreements between the process participants.

Practical Implications: The results of the research may be of interest to seaports and institutions planning and organizing vessel traffic on the waterways.

Originality/Value: The article shows the VTSOs' opinion on the possibility to schedule the passing places for two-way vessel traffic on newly commissioned dredged Świnoujście-Szczecin fairway. The operators' viewpoint on the safety level of vessel traffic within fairway specific sections was investigated. Recommendations for improving VTSOs decision-making process related to passing places planning within dredged fairway were formulated.

Keywords: Decision-making; vessel traffic organization; vessel traffic services operator, fairway; passing places, maritime transport.

JEL codes: C8, L9, R4.

Paper type: Research article.

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1. Introduction

The dredging of the Świnoujście-Szczecin fairway, carried out as a part of the project titled "Modernization of the Świnoujście-Szczecin fairway to a depth of 12.5 meters" (Project, 2017), aimed to create a possibility for ships, with greater parameters than before, to call at the Szczecin port. The deepening of the waterway to 12.5 meters and its widening made it possible to accommodate ships with a length up to 260 m and a draft up to 11 m (Gucma *et al.*, 2021).

The capacity of waterways and ports largely depends on the provision and organization of efficient two-way vessel traffic. In order to decongest this traffic on the fairway, especially for large and priority ships, the special meeting places (so-called passing places) are designated for ships that cannot safely pass each other on its straight sections. Such places have also been designed within the Świnoujście-Szczecin fairway.

The changes to fairway infrastructure elements caused the challenges for Vessel Traffic Services (VTS) operators (Resolution, 1997) who plan vessel traffic on the Świnoujście-Szczecin fairway. In addition, the need to change the port regulations has arisen to provide safety rules for navigation on the modernized fairway. New traffic rules were introduced gradually, by modifying the applicable regulations on vessel traffic (Port Regulations, 2013; Durlík *et al.*, 2023). The establishing of new traffic rules was also done in stages, considering the real possibilities and readiness of the Szczecin port to accommodate large ships (Port Regulations, 2013).

Planning of vessel traffic within the waterway is a complex decision-making process (Filina-Dawidowicz and Durczak, 2022). It is important to assure a high level of vessel traffic safety (Formela *et al.*, 2019; Thalassinós *et al.*, 2013). To ensure safe navigation, the accurate planning of ships passing trajectories in ports, channels and fairways is needed (Paulauskas *et al.*, 2022; Urbanyi-Popiolek, 2021). The available literature studies focus, i.e., on the reasons (Galerikova, 2019) and consequences (Li *et al.*, 2019) of navigation safety loss, including ship collisions and groundings. The methods to assess undesirable situations occurrence were elaborated (Cheng *et al.*, 2023; Zhen *et al.*, 2022).

An important role in the process of planning vessel traffic in ports and approach channels is held by VTS operators (VTSOs), whose experience and ability to quickly assess the situation affect the safety of vessel traffic (Crestelo Moreno *et al.*, 2022; Ramos *et al.*, 2019; Xia *et al.*, 2023). Attention is paid to the need of proper operators' training (Alexandrov, 2015), as well as assessment of their physical and

mental state that impacts the real situations perception (Kum *et al.*, 2007a; Kum *et al.*, 2007b; Arvanitis *et al.*, 2012).

In the available subject literature, potential sources of conflicts and their impact on the relationship between VTSOs and the "bridge team" are investigated (Arslan and Nas, 2022). It should be noted that operators use VTS systems to make decisions related to vessel traffic arrangement (Baldauf and Claresta, 2021). Although these systems are constantly being improved (Shakhnov *et al.*, 2023), nevertheless, the operators make the final decisions related to planning and organizing of vessel traffic within the waterways (Yoo and Kim, 2021; Zhang *et al.*, 2023).

Changes in the vessel traffic rules on the fairway due to infrastructural developments affect decision-making processes done by VTSOs, who often must make decisions under conditions of information uncertainty.

The purpose of this study was to analyze the opinions of VTSOs on the impact of changes in fairway infrastructure on decision-making process related to planning vessel traffic on the dredged fairway, considering the use of passing places.

2. Characteristics of the Dredged Świnoujście-Szczecin Fairway

As a result of dredging works carried out on a significant section of the Świnoujście-Szczecin fairway (from 5 km to 67 km), the structure and parameters of the fairway were modified (Project, 2017). Its technical depth has been changed from 10.5 m to 12.5 m, and the width of specific sections has been adjusted appropriately (Table 1).

To ensure two-way traffic for maximum-sized vessels (e.g., for bulk ships the length overall is $LOA < 240\text{ m}$, width $B < 32.3\text{ m}$, draught $T = 11\text{ m}$) (Port Regulations, 2023), two safe meeting and passing places have been designated, named "Mijanka Zalew" (Figure 1a) and "Mijanka Police" (Figure 1b).

"Mijanka Zalew" was established between 23.8 km and 28.8 km of the fairway and occupies the length of 5 km. Figure 1a shows the old fairway boundary (before modernization) with a width of 90 m and the passing place boundary, where between the buoys pairs (MZ1, MZ2, MZ3 and MZ4) there is a 250 m wide track with a technical depth of 12.5 m (Project, 2017). Due to "Mijanka Zalew" location in about halfway along the fairway, VTSOs may plan its use for vessel traffic and have time to provide possible corrections during ships passing.

When planning the passing maneuver, the masters and pilots of both vessels receive necessary information from the VTSOs and should have time to adjust the ships' speed to pass each other safely. VTSOs and vessels' masters/pilots must take into account that the time window needed for ships passing with permitted speeds of 10-12 knots is about 15 minutes.

"Mijanka Police" was designed between 49.4 km and 51.8 km of fairway's track and is 2.4 km long. This passing place consists of a turning area and a section expanded to a width of 220 m between a pair of buoys No. 37 and 38 (Project, 2017).

Table 1. Width of the Świnoujście-Szczecin fairway's sections after dredging

No.	Description of the fairway section	Kilometer [km]	Fairway width [m]
1	Turn	5.3 – 7.6	130
2	Straight	7.6 – 9.8	110
3	Turn	9.8 – 10.8	120
4	Straight	10.8 – 17.0	110
5	Straight	17.0 – 23.8	100
6	Passing („Mijanka Zalew”)	23.8 – 28.8	250
7	Straight	23.8 – 41.2	100
8	Turn	41.2 – 42.2	150
9	Straight	42.2 – 48.8	110
10	Turn	48.8 – 49.4	150
11	Passing („Mijanka Police”)	49.4 – 50.2	350
12	Passing („Mijanka Police”)	50.2 – 51.8	220
13	Turn	51.8 – 53.0	150
14	Straight	53.2 – 54.7	130
15	Turn	54.7 – 55.4	150
16	Straight	55.4 – 59,1	100
17	Turn	59.1 – 60.5	130 - 150
18	Straight	60.5 – 62.9	100
19	Turn	62.9 – 64.0	280
20	Straight	64.0 – 67.1	100

Source: Own elaboration based on Project, 2017.

Figure 1a, 1b. New passing places "Mijanka Zalew" (a) and "Mijanka Police" (b) within the Świnoujście-Szczecin fairway



a)

b)

Source: Own elaboration based on Application VTS, 2023.

The time window for two vessels intended to pass each other within this passing place with permissible speeds of 10-12 knots is about 7 minutes. This makes it more

difficult for VTSOs to plan ships passing using the "Mijanka Police" infrastructure compared to "Mijanka Zalew".

The Maritime Office in Szczecin decided to introduce new regulations on vessel traffic, gradually. This was due to the lack of Szczecin port technical capabilities to handle ships with a maximum draught of 11 m, and scheduled introduction of new port regulations in 2023. Accordingly, the two new essential records appeared in the set of port regulations established on July 1, 2022 (Maritime Office in Szczecin, 2023). The first one identified new areas for maximum-sized vessels possible meetings and defined them as passing places.

The second one introduced new maximum parameters of vessels navigating within waterway (e.g., for cargo ships: length overall $LOA = 240\text{ m}$, width $B = 32.3\text{ m}$, draught $T = 11\text{ m}$). Visibility conditions and parameters for vessels crossing the fairway during the daytime were also defined.

Supervision of vessel traffic on the fairway is carried out by the VTS Świnoujście-Szczecin system that was introduced in 2000 and is managed by the Director of the Maritime Office in Szczecin, it is a part of the Maritime Traffic Safety Inspectorate. This system was designed and built to improve navigation safety, protect the environment in offshore areas and ensure vessel traffic efficiency (Maritime Office in Szczecin, 2023).

The VTS Świnoujście-Szczecin is based on the operation of two centers. First one is located at the entrance to the Świnoujście port (VTS Świnoujście Center) and the second one is situated in the building of the Harbor Master Office in Szczecin (VTS Szczecin Center). These centers cooperate and have well-defined areas of responsibility, including vessel traffic monitoring (Figure 2).

The VTS Świnoujście Center manages the area from the roadstead to II BT (bacon) on the Szczecin Lagoon, while the VTS Szczecin Center covers the area from II BT to the Szczecin port boundaries. Both centers in 2022 employed 22 operators, working in shifts during the whole year.

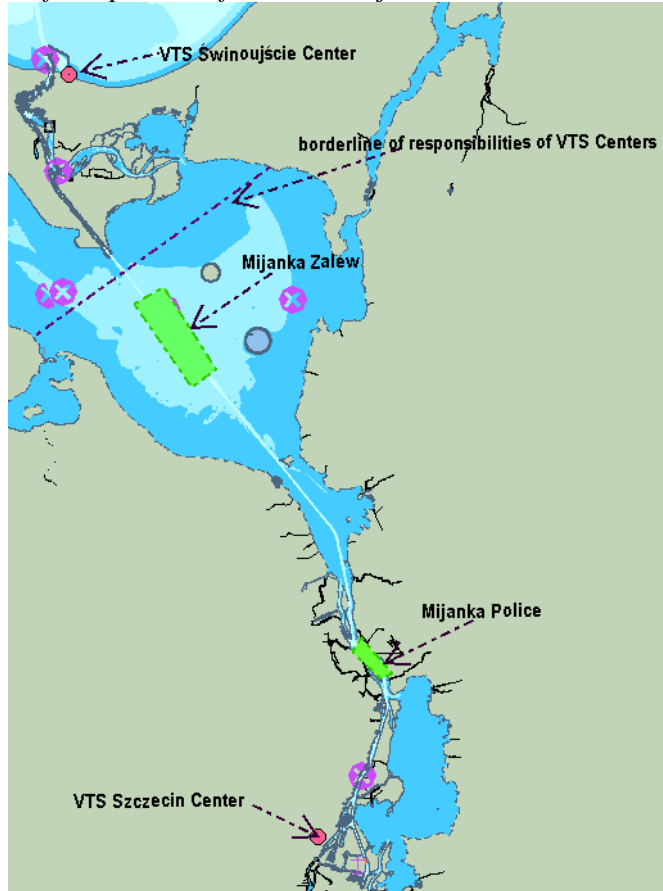
VTS Świnoujście-Szczecin provides service for all vessels with the length greater than 20 m, moving within a 12-mile strip of territorial waters in the Pomeranian Bay, 65 km of the main fairway track, sidetracks, Szczecin Lagoon, as well as the basins of Świnoujście, Szczecin and Police ports (Port Regulations, 2013).

Planning the movement of vessels on the fairway, including ships meeting places, is carried out through cooperation of both decision-making centers and other traffic participants.

When planning vessel traffic, the operators of two centers use the VTS application (Figure 3), consisting of a map and database module, which has been equipped with

the necessary tools allowing identification, traffic simulation and its prediction (Application VTS, 2023).

Figure 2. Area of competence of VTS Świnoujście-Szczecin



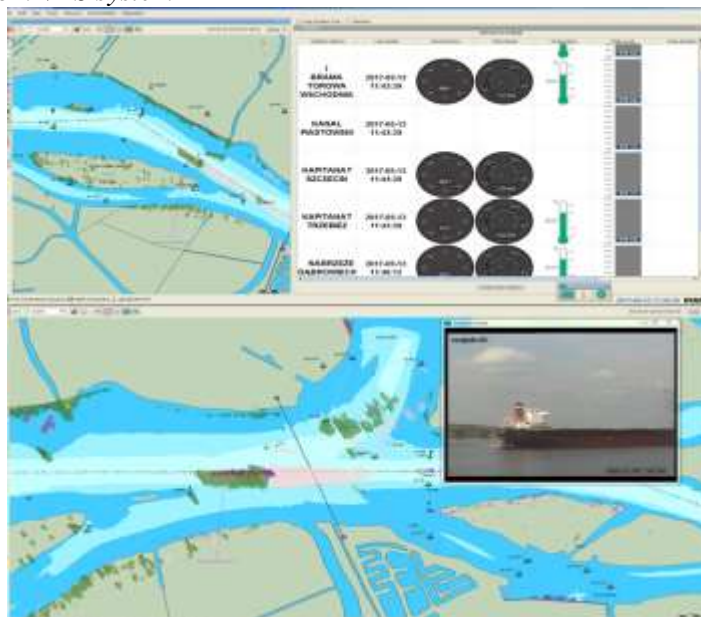
Source: own elaboration based on Maritime Office in Szczecin (2023) and Application VTS (2023), where: yellow and blue circles – islands, purple circles – places of isolated danger.

Figure 4 shows the diagram describing the decision-making process carried out by VTSOs employed in VTS Szczecin Center involved in vessel traffic planning on the fairway. The diagram shows the complexity of decision-making process in each case the vessel is allowed to enter the waterway.

Based on discussions conducted with VTSOs at the VTS centers in Świnoujście and Szczecin, it was noted that when planning vessel traffic, the use of two newly commissioned passing places (“Mijanka Zalew” and “Mijanka Police”) is met with a high level of uncertainty and distrust among operators. From the preliminary discussions, it appeared that the uncertainty is related to the decision-making process

and is influenced by necessary data absence, the lack of comprehensive agreements between the centers involved in planning and organization of vessel traffic, as well as the lack of relevant regulations. Therefore, this problem was studied in more detail.

Figure 3. Visualization of selected sections of Świnoujście-Szczecin fairway obtained from VTS system



Source: Application VTS, 2023.

3. Methodology

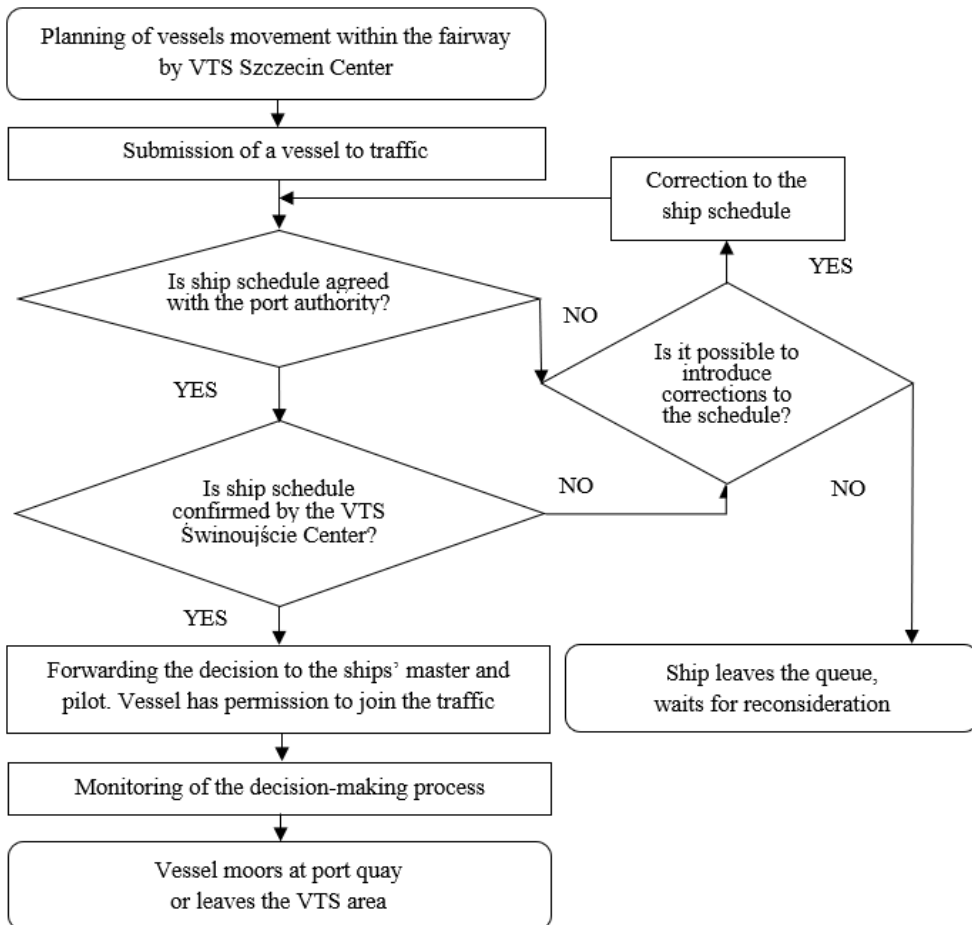
The survey was used to collect the opinions of operators involved in vessel traffic planning within the Świnoujście-Szczecin fairway on the possibility of organizing ships passing using new infrastructure elements designated for this purpose. Two research questions were posed:

1. Are VTSOs willing to use passing places when planning vessel traffic on the Świnoujście-Szczecin fairway?
2. How do VTSOs assess the sections of the modernized fairway considering vessel traffic safety level?

After a literature analysis and interviews carried out with VTSOs, a questionnaire was developed. The questionnaire included 8 questions. One question of a general nature referred to VTSOs' employment place, the remaining questions were related to the studied issue. Among the questions were both closed-choice and those, where respondents were asked to rate the proposed options.

The survey was conducted in July and August 2022, about one month after the date when modernized fairway was commissioned (port regulations that allowed to use passing places went into force on July 1, 2022). Participation in the survey was voluntary and anonymous. 17 of the 22 VTSOs employed at VTS centers both in Szczecin and Świnoujście in July 2022 took part in the survey. The completeness of obtained responses was analyzed.

Figure 4. Simplified diagram of the decision-making process carried out by VTSOs at the VTS Szczecin Center



Source: Own elaboration.

After analyzing the respondents' answers, the conclusions were drawn and recommendations were formulated, as well as presented at a working meeting attended by representatives of VTS centers, Pilot Station and Authority of Szczecin and Świnoujście Seaports. Agreements from the meeting were implemented in the form of a decision issued by the Director of the Maritime Office in Szczecin.

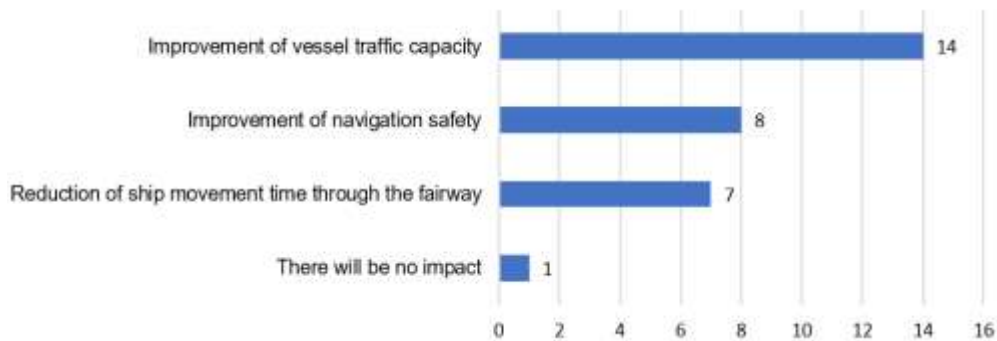
A preliminary procedure was agreed for the gradual implementation of rules for vessel traffic on new passing places.

4. Results

While analyzing the responses given to the general question, it was found that 12 respondents were employed at the VTS Szczecin Center, and 5 respondents represented VTS Świnoujście Center. At the period the survey was carried out, 12 operators were employed at the VTS Szczecin Center, and VTS Świnoujście Center staff counted 10 members.

VTSOs were asked to specify the benefits of implementing new passing places on the Świnoujście-Szczecin fairway (Figure 5). This was a multiple-choice question. According to the respondents, introduction of new infrastructure elements will impact the improvement of vessel traffic capacity, followed by the enhancement of navigation safety and reduction of vessel traffic time. Only one respondent believed that new passing places implementation would not be beneficial.

Figure 5. Benefits of implementing new passing places on the fairway (number of responses)



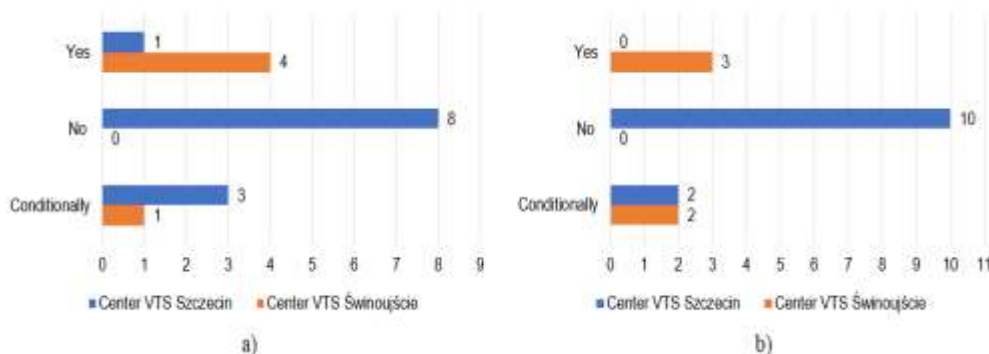
Source: Own elaboration.

Another question concerned the VTSOs' assessment of the possibility to schedule ships passing at the "Mijanka Zalew" (Figure 6a). At this passing places two maximum-sized vessels may meet and pass each other (the parameters of maximum-sized vessels, e.g., cargo ships at the time the survey was carried out, were: $LOA = 215\text{ m}$, $B = 31\text{ m}$, $T = 9.15\text{ m}$ (Port Regulations, 2013); the target ships parameters, after the introduction of new port regulations, e.g., for cargo ships, were supposed to be: $LOA = 240\text{ m}$, $B = 32.3\text{ m}$, $T = 11\text{ m}$ (Port Regulations, 2023)).

Respondents had three options to choose from: yes, no, conditionally. Out of 17 VTSOs only 5 staff members expressed the opinion that they would schedule ships passing at "Mijanka Zalew", 4 employees would do it conditionally, and 8 operators would not decide to conduct such a maneuver. It should be noted that among the 5

affirmative responses, only 1 response was given by VTSO employed at the VTS Szczecin Center.

Figure 6a, 6b. VTSOs' assessment of possibility to schedule the passing of two maximum-sized vessels at passing places "Mijanka Zalew" (a) and "Mijanka Police" (b) (number of responses)



Source: Own elaboration.

The respondents were also asked to assess the possibility of scheduling passing of two maximum-sized vessels at the passing place "Mijanka Police" (Figure 6b) (the parameters of the maximum-sized vessels were the same as given for "Mijanka Zalew"). Out of 17 VTSOs only 3 employees would make a decision to schedule the ships passing, 4 staff members would do it conditionally, and 10 operators stated that would not decide to schedule such a maneuver. Among the 3 affirmative responses, none came from VTSOs employed at the VTS Szczecin Center.

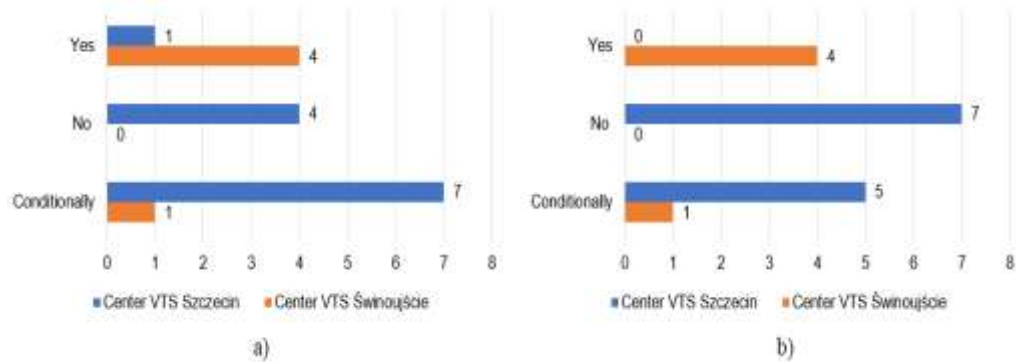
The further two questions concerned the VTSOs' assessment of the possibility to schedule the passing of two vessels, whose parameters would exceed those used to date (length, width, draught) at the "Mijanka Zalew" (Figure 7a) and "Mijanka Police" (Figure 7b) for two-way traffic (e.g., the parameter used so far to plan the traffic was: the sum of two passing vessels lengths $\sum_{i=1}^2 LOA_i < 320 m$). Similarly, when answering the questions respondents could choose from the following options: yes, no, conditionally.

Analyzing the results presented in Figure 7a, it can be concluded that out of 17 VTSOs only 5 operators expressed the opinion that would make a decision to schedule ships meeting at "Mijanka Zalew", 8 staff members would do it conditionally, and 4 employees would not decide to carry out such a maneuver. It should be highlighted that among 5 affirmative responses, only 1 was given by VTSO employed at the VTS Szczecin Center.

On the other hand, while assessing the respondents' opinions on the possibility of scheduling a passing place for mentioned vessels at the "Mijanka Police", out of 17

VTSOs only 4 employees stated that would schedule such a meeting, 6 staff members would do it conditionally, and 7 operators would not decide to carry out such a maneuver (Figure 7b). Among the 4 affirmative responses none came from VTSOs employed at the VTS Szczecin Center.

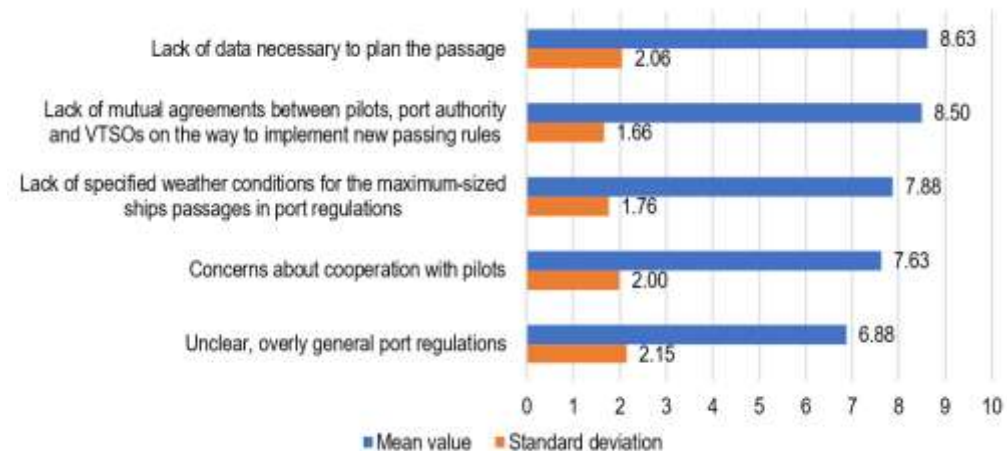
Figure 7. VTSOs' assessment of the possibility to schedule the passing of two vessels with parameters that would exceed those previously used for two-way traffic ($\sum_{i=1}^2 LOA_i < 320 m$) at the passing places "Mijanka Zalew" (a) and "Mijanka Police" (b) (number of responses)



Source: Own elaboration.

The next question was addressed to those VTSOs who had chosen the option to undertake the planning of vessels passing place conditionally. Based on the initial discussions with operators, the five reasons have been identified. Operators were asked to rate proposed reasons from 1 to 10, where 1 - insignificant reason, 10 - very significant reason (Figure 8).

Figure 8. Reasons for conditional planning of ships meeting at the passing places (mean value of received ratings)



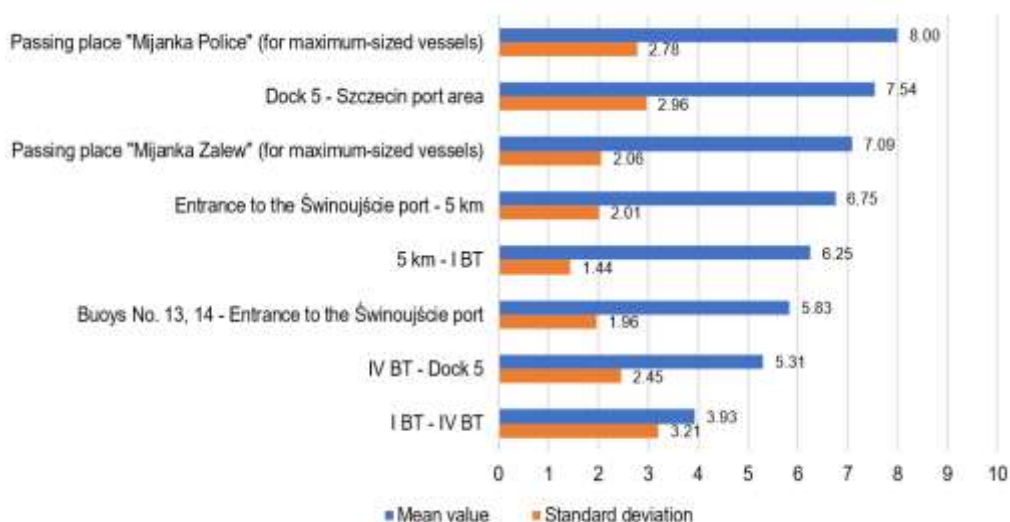
Source: Own elaboration.

It should be noted that all reasons were rated highly by respondents (Figure 8). The highest mean value of obtained ratings was given to the reason related to the absence of the necessary dynamic data on vessel traffic to plan safe passing (e.g., the actual ship passage time along the fairway, the time required for ship unmooring, mooring, turning, etc.). Imprecise, overly general regulations received the lowest mean value of ratings given by VTSOs, that could deal with awareness of new port regulations coming gradual implementation. Standard deviation analysis showed that operators' opinions varied.

The VTSOs were also asked to assess the level of vessel traffic safety on specific sections of the Świnoujście -Szczecin fairway (Figure 9). The assessment covered the fairway beginning from a pair of buoys No. 13-14 at the approach to Świnoujście port, port entrance, through 65 km of the fairway, up to Szczecin port. To conduct the assessment, the fairway was divided into specific sections.

New infrastructure elements (passing places "Mijanka Zalew" and "Mijanka Police") were included into the set of evaluated sections. Respondents were asked to rate each track section using a scale from 1 to 10, where 1 was the safest section, 10 - the least safe. Fourteen VTSOs provided answers to this question. The information presented in Figure 9 shows that the highest rating was given to the "Mijanka Police", while the lowest rating was given to the I BT - IV BT fairway section.

Figure 9. VTSOs' assessment of vessel traffic safety level on specific sections of the Świnoujście-Szczecin fairway (mean value of received ratings)

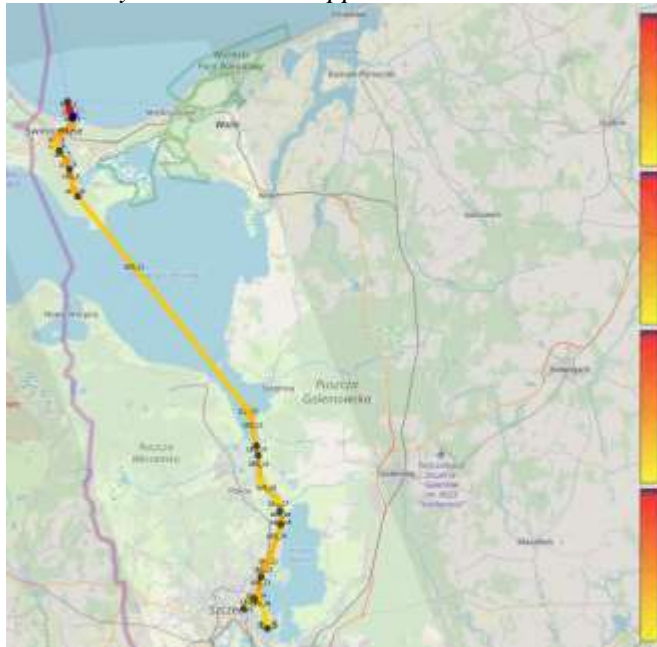


Source: Own elaboration.

The results of the respondents' opinions were compared to the risk assessment of fairway sections performed with the use of IWRAP MK II application (Figure 10).

IWRAP MK II is a tool that assists in the quantification of the risks associated with vessel traffic and allows to rationally evaluate and estimate the number of collisions and groundings in navigational areas (IWRAP MK II, 2022). To identify the frequency of any collision or grounding appearance in analyzed area, it is necessary to insert to the application the detailed data, including i.e., specific routes, associated traffic, etc. In accompanying legend for Figure 10 the blue color indicates the highest risk level, and yellow - the lowest risk level.

Figure 10. Risk assessment of fairway sections from Świnoujście port entrance to the Szczecin port area by IWRAP MK II application



Source: Own elaboration based on IWRAP MK II, 2022.

It should be noted that the risk assessment of the sections from buoys No. 13-14 to 5 km of the fairway received from IWRAP MK II (Figure 10) coincides with the assessment provided by the VTSOs (Figure 9).

According to the detailed image received from IWRAP MK II application, the section of the fairway situated opposite the ferry terminal and the area near the city passenger ferry (blue color) are the most dangerous.

On the other hand, the assessment of fairway sections from I BT to Szczecin port taken from application does not quite match the operators' opinion. Compared to the image received from the IWRAP MK II application, operators indicated the "Mijanka Police" and the Szczecin port area as the most dangerous. However, it should be noted that the IWRAP MK II application images did not include the

evaluation of new passing places due to the lack of data on two-way traffic in these areas.

5. Conclusions

The presented research article analyses the problems related to organization of vessel traffic on the dredged Świnoujście-Szczecin fairway. New solutions, untested in practice, may raise doubts, which are reflected in the decisions-making processes. This situation raised when modernized dredged fairway was commissioned.

The parameters of ships allowed to pass each other within examined places (“Mijanka Zalew” and “Mijanka Police”) were determined on the basis of statistical and quantitative research, as well as were tested in a simulator environment. However, practical implementation of two-way traffic on the fairway is based on individual decisions made for every traffic case by VTSOs in cooperation with other involved participants.

The conducted research results revealed VTSOs’ significant doubts in taking decisions related to using of newly commissioned passing places “Mijanka Zalew” and “Mijanka Police” while planning two-way traffic on the fairway. These doubts were related to worries and uncertainty of implementing tasks within new traffic conditions on the fairway (human factor impact).

It was found that only 30% of VTSOs would decide to arrange the two-way passing of maximum-sized vessels at the “Mijanka Zalew” and 18% of VTSOs’ would schedule such traffic at the “Mijanka Police”. In turn, only 30% of VTSOs would plan a passing of two vessels with parameters that exceed those previously used for two-way traffic on examined fairway ($\sum_{i=1}^2 LOA_i < 320 m$) at the “Mijanka Zalew” and 24% of VTSOs would decide to schedule such maneuver at the “Mijanka Police”.

It should be mentioned that VTSOs employed at VTS Świnoujście Center were more inclined to plan the passing places for ships compared to VTS Szczecin Center staff members. This is essential, taking into account the fact that both passing places are located within responsibility area of VTS Szczecin Center, the actual decision-maker. Therefore, it could be concluded that appropriate activities should be undertaken to facilitate VTSOs’ decision-making process related to vessel traffic planning using passing places.

Research results showed much greater decision-making uncertainty of VTSOs in the case of planning traffic using “Mijanka Police” passing place. This fact is due to both the “Mijanka Police” restricted parameters (its length is 2.4 km, compared to “Mijanka Zalew” length - 5 km) and its location (passing “Mijanka Police” is located close to Szczecin port). This affects the fact that VTSOs have limited time to adjust the planned traffic of ships leaving Szczecin port.

The research results were useful in the real planning of vessel traffic using the new passing places. It should be noted that after two months of commissioning the passings, only two cases of these places implementation were recorded for ships that could not pass each other on the other fairway sections.

The assessment of the reasons for the VTSOs' conditional decision related to passing places scheduling on the fairway, provide a basis for drawing conclusions about changes needed to be done in the near future to influence the VTSOs' decisions.

The research also revealed VTSOs' assessment of safety level associated with vessel traffic on specific sections of the fairway. In most cases, the assessment made by VTSOs coincided with the risk assessment obtained from IWRAP MK II application.

The significant difference was observed in evaluation of Szczecin port area, that was assessed by VTSOs as a fairway section with a low level of vessel traffic safety. VTSOs' evaluation seems to be justified, considering specific traffic conditions prevailing in the Szczecin port area which include, e.g., intersecting shipping routes, heavy traffic of seagoing, inland, and port vessels, variable external conditions, etc.

It should be noted that the research results formed the basis for the development of a procedure for vessel traffic organization on the fairway, requiring cooperation between the VTS centers in Świnoujście and Szczecin. The information flow for planning the passing places has been established. A step-by-step plan for implementing two-way traffic at passing places "Mijanka Zalew" and "Mijanka Police" was agreed, this plan involved the following conditions:

- at current stage of new regulations implementation, the maximum-sized vessels could not meet at the passing places,
- when two vessels with the large draught (above 10 m) meet, only one ship can be a bulk carrier (these ships have inferior maneuverability).

Attention should be paid to the need to adjust the port regulations to facilitate new infrastructure elements maintenance within the fairway. Considering the results of presented analysis, the following recommendations could be provided:

- it would be reasonable to introduce the records in the new port regulations about, i.e.:
 - a) limited weather conditions that allow ships to pass each other safely;
 - b) detailed definition of passing places "Mijanka Zalew" and "Mijanka Police".
- it would be advisable to collect data on the parameters of maximum-sized vessels traffic and mooring and deliver them to VTSOs.

Based on the results of conducted research, it was possible to identify several key factors affecting the uncertainty of decision-making process related to the planning of two-way traffic on the dredged fairway, considering the usage of passing places (Figure 8). Recommendations have been proposed to facilitate the decisions made by VTSOs (Table 2).

Table 2. Factors affecting VTSOs' decision-making process and recommendations

Factors affecting decision-making process	Recommendation
Unclear, overly general port regulations	Training of operators based on introduced new traffic rules and guidelines resulting from the safe navigation analysis developed for the modernized fairway
Concerns about cooperation with pilots	Developing the framework for cooperation with pilots. Operators' training on the new traffic rules and guidelines resulting from the navigation safety analysis developed for dredged fairway. Supporting operators with application of specific tools, e.g., compliance group calculator
Lack of mutual agreements between pilots, port authority and VTSOs on the way to implement new passing rules	Scheduling the meeting of VTSOs, pilots and port management representatives to set the agreements (e.g., brainstorming) and carrying out the joint training
Lack of data necessary to plan the passage	Acquiring data needed to plan future vessel traffic. Providing obtained data to VTSOs
Lack of specified weather conditions for the maximum-sized ships passages in port regulations	Acquiring specific data on required weather conditions. Providing collected data to VTSOs

Source: Own elaboration.

It should be highlighted that the questionnaire survey was conducted one month after the dredged fairway was commissioned that could impact the research results. Therefore, it would be reasonable to repeat the research 6-12 months after the introduction of new port regulations.

The research results may be of interest to seaports and institutions planning vessel traffic on the fairway. Future directions of the authors' research will focus on further investigation of vessel traffic planning problems occurring within Świnoujście-Szczecin fairway.

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