Analysis of the Impact of Exemption from Pilotage for 75m and 90m Long Vessels on the Fairway Świnoujście-Szczecin

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ABSTRACT: The aim of the study is to analyze the impact of exemption from pilotage for 75m and 90m long vessels entering Szczecin on navigation safety on the waterway Świnoujście-Szczecin. Available sources concerning the influence of maritime pilotage on the safety of navigation have been analysed. Such data have been collected and made available only for the Danish Straits, the Great Barrier Reef Area of Australia, the Bosporus Straits and the Tokyo Bay. The study also included an analysis of economic effectiveness of pilotage exemption in this area.

1 INTRODUCTION

This study contains an assessment of the impact of exempting ships from compulsory pilotage and the benefits and costs of pilotage services on the Szczecin - Świnoujście waterway.

Safe maritime transport in limited port channels and waterways is the main objective of the pilot scheme and safe waterways contribute significantly to the efficiency and effectiveness of maritime transport. Ship accidents have a significant environmental impact and are associated with high accident related costs (compensation, pollution control costs, costs of temporary port closures, etc.) Only part of these costs can be quantified in financial terms, but even these easily identifiable costs are very high.

This paper focuses on the analysis of data on the impact of pilot presence on the safety of navigation. The research was carried out on the basis of available world literature. Available sources concerning the influence of maritime pilotage on the safety of navigation have been analysed. The main problem in collecting data on this problem is that there are few waters in the world where parallel navigation with and without pilots is allowed. Such data have been collected and made available only for the Danish Straits, the Great Barrier Reef Area of Australia, the Bosporus Straits and the Tokyo Bay.

2 METHOD USED IN THE STUDY

The following multistage method was used in the analysis:
1 Determination, on the basis of available literature, of the impact of pilotage on the safety of navigation, and in particular on the reduction of the risk of accidents such as collision, grounding and impact on fixed objects.
2 Determination of traffic on the waterway Świnoujście - Szczecin.
3 Determining the accident rate on the waterway Świnoujście - Szczecin.
4 Determination of the proportions of ships planned to be exempted from the pilotage obligation.

5 Determination of the reduction in the level of navigation safety as a result of the proposed changes in the form of exemption from the obligatory pilotage.
6 Analysis of the economic effectiveness of the proposed solutions.

3 IMPACT OF PILOTAGE ON NAVIGATION SAFETY

3.1 Definition of accident risk reduction

In the most of studies on the subject under consideration, the so-called factor of reducing the number of accidents due to the presence of the pilot on board is used. These may be percentage values (as used in this study) or fractional values in the form of risk reduction (R_p), e.g. R_p=1/3, which means that the presence of a pilot reduces around 67% of accidents [Lentz and Kroon, 2010].

$$n_{bp}=n_p/(1-R_P)$$

where:
n_{bp} – number of accidents without pilot onboard;
|n_p – number of accidents with pilot onboard;
R_p – percentage risk reduction due to pilotage.

Available sources concerning the impact of maritime pilotage on the safety of navigation were analysed. The main problem in collecting data on this problem is the fact that there are few areas in the world where sailing with and without pilots is allowed. The literature review indicates the following areas where such data has been collected and analysed:
1 the Danish Straits, including the Great (between 2004-2012), the Little Belt and the Sound (between 1982-1994).
2 The Great Barrier Reef area in Australia, including the Strait of Torres (between 1985-2003).
3 Bosporus Strait (between 1982-2003).
4 Tokyo Bay, 1970s research.

Navigation accidents are divided into types. The study covers only three most important of them - occurring mainly in piloted areas, that is:
1 grounding,
2 collision,
3 impact on the fixed objects.

Available literature sources determine risk reduction as a result of maritime pilotage provocation. In general, the sources are consistent and state that:
1 the pilot on board contributes more to reducing the risk of stranding than the risk of collision;
2 the reduction of shoal entry is in the range of 50% to 80%,
3 collision reduction averages between 25% and 60%.

3.2 Conditions of the Świnoujście - Szczecin waterway in terms of pilotage

The Świnoujście - Szczecin waterway has special navigational conditions, which differ from those mentioned in Chapter 3 of the area where pilot studies were conducted on the impact of pilotage on navigation safety. These include, among others:
1 very small width of the waterway, the ratio of which to the width of ships is 3 to 5 times the width of the ship, which requires considerable skills in maneuvering in limited areas, including passing techniques,
2 high complexity of the track and navigational signage, which requires a high level of navigational knowledge,
3 lack of the navigation assistance service provided by VTS resulting mainly from the design of the route (this service is not possible with the current state of the technology),
4 high interaction with other vessel traffic regarding passing and overtaking restrictions,
5 complexity of port regulations covering about 100 pages,
6 the complexity of the port structure and infrastructure in the form of turning place, basins, etc., which makes it difficult to determine manoeuvring tactics or interactions with other participants and berths.

As a follow-up step, the average values of the coefficient of reduction in the number of accidents (based on Ozsoysal R. & Ozsoysal A. O. (2006), Lentz A. & Kroon I. B. (2010), White M. (2000)) caused by pilotage were determined for particular types of accidents and are presented in Table 1.

Table 1. Average percentage values of the impact of pilotage on the safety of navigation, as adopted in the study

Type of accident	Average reduction of accident risk as a result of pilotage Rp% [%]	Relative accident reduction expressed as Rp
Grounding	**60**	0.60
Collision	**55**	0.55
Impact	**82**	0.82
Average	**65**	0.65

4 TRAFFIC ON THE ŚWINOUJŚCIE - SZCZECIN WATERWAY

Vessel traffic is the most important accident factor. Vessel traffic in 2003-2016 was analysed on the basis of data from the Central Statistical Office [Statistical Yearbooks of Maritime Economy 2010-2017] and the Maritime Office in Szczecin. It shows a slight variation of several percent without a clear upward trend (Tab. 2.).

The waterway is dominated by small units with an overall length of up to 90m. Figure 1 on the basis of Maritime Office data for 2017 (3162 entries of ships) shows the percentage share of vessels in size groups in intervals of 5m. It can be noted that the vessels currently excluded from pilotage, i.e. with a length of less than 60m, are about 250 vessels (8% of the traffic). Units from 60m to 75m are 300 units, which is 10% of the total traffic, and units from 75m to 90m are about 250 units (8% of the traffic). 1580 units per year is approx. 50% of all ships traffic in Szczecin.
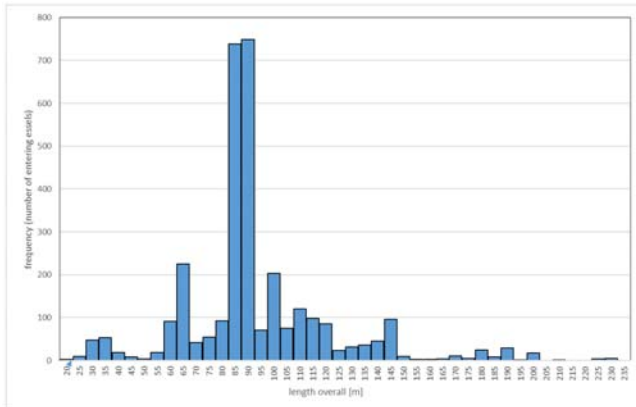
Figure 1. The histogram of the length of units entering Szczecin in 2017.

5 RISK RESULTING FROM THE EXEMPTION FROM PILOTAGE TO SZCZECIN

As a further step, the annual average accident figures for the period 2004-2014 were determined. In order to estimate the probability per occurrence for each type of accident, the number of operations (events) in the form was first calculated:

1 for grounding - one operation is a single track crossing,
2 in the case of a collision, one operation is one passing by with another ship (stoppages and passing bans are not included),
3 for hitting an object, one operation is one ship's entry or exit.

The above operations (events) are used in the next step as a divisor to estimate the probability of accidents (Tab. 3). Comparison with world results shows a high share of collisions in accidents. This is due to the specific navigation characteristics of the fairway and its significant reduction.

5.1 Exemption from pilotage of units up to 90m in length

The values of navigational risk reduction from pilotage (chapter 3), vessel traffic (chapter 4) and accidents (chapter 5) and the assumed number of vessels exempted from pilotage (60% of vessels) were used in the next step to estimate the expected number of accidents in the group of vessels from 60m to 90m and the expected increase in accidents in this group due to not being manned with a pilot. It was calculated

The values are presented in Table 4. It can be seen that the expected increase of accidents in the group of collisions with solid objects is 25.3 accidents/year (540%), in the group of collisions is 3.2 accidents/year (220%) and in the group of grounding - 3.9 accidents/year (248%). Assuming that the latter two are the most important for safety, it can be noticed that on the basis of the adopted assumptions, the accident rate on the waterway and in Szczecin will increase by 7.1 accident per year, i.e. by about 230%.

Table 2. Vessel traffic in Szczecin

Traffic / Year	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Entrances to Szczecin	3288	2943	3106	2971	2895	2718	2775	3185	3084	2822	2872	2619	2823	2939
Operations (2* entrances)	6576	5886	6212	5942	5790	5436	5550	6370	6168	5644	5744	5238	5646	5878
Hourly intensity 1 direction of movement [vessels/h]	0.38	0.34	0.35	0.34	0.33	0.31	0.32	0.36	0.35	0.32	0.33	0.30	0.32	0.34
Average time of transition to the Baltic Sea [h]	4.25	4.25	4.25	4.25	4.25	4.25	4.25	4.25	4.25	4.25	4.25	4.25	4.25	4.25
Average number of encounter situation during passage	1.60	1.43	1.51	1.44	1.40	1.32	1.35	1.55	1.50	1.37	1.39	1.27	1.37	1.43

Table 3. Probabilities and average number of accidents on the Świnoujście - Szczecin fairway

Type / Year	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	Average Year
Impacts	11	12	13	7	10	3	15	19	7	3	5	**9.55**
Probability of impact per operation.	1.87E-03	1.93E-03	2.19E-03	1.21E-03	1.84E-03	6.16E-04	2.72E-03	3.58E-03	1.36E-03	5.22E-04	9.55E-04	**1.71E-03**
Collisions	1	2	7	11	6	3	7	3	4	2	3	**4.45**
Probability of collision per 1 passage	2.43E-04	4.85E-04	1.70E-03	2.67E-03	1.46E-03	7.28E-04	1.70E-03	7.28E-04	9.70E-04	4.85E-04	7.28E-04	**1.08E-03**
Grounding entrances	8	4	3	3	8	8	3	7	2	1	1	**4.36**
Probability of grounding for operation	1.36E-03	6.44E-04	5.05E-04	5.18E-04	1.47E-03	1.64E-03	5.43E-04	1.32E-03	3.89E-04	1.74E-04	1.91E-04	**7.96E-04**

Table 4. Expected increase in accident rate in the group of ships 60m-90m as a result of exemption from pilotage on the Świnoujście - Szczecin waterway

Type	Average number of ship accidents per year	Percentage of vessels 60m - 90m [%]	Number of accidents for ships between 60m and 90m (np)	Pilotage accident reduction (Rp)	Number of accidents in the group 60-90m after pilotage exemption per year (nbp)	Additional number of accidents in the group of 60-90m due to pilotage exemption per year (delta)	Increase in accident rate (ww%= nbp/np*100%) [%]
Impacts	9.55	60.1	5.7	0.82	**31.0**	**25.3**	**541**
Collisions	4.45	60.1	2.7	0.55	**5.9**	**3.2**	**220**
Groundings	4.36	60.1	2.6	0.60	**6.5**	**3.9**	**248**

6 ANALYSIS OF ECONOMIC EFFICIENCY

Following the example of other countries with a developed maritime safety culture (e.g. Canada, UK, Denmark or Australia), it is proposed to carry out a standard Cost Benefit Analysis (CBA), which is also part of the FSA [IMO FSA 2011] methodology, which is required by the IMO to adopt any type of binding legal solutions, before introducing changes relevant to maritime safety.

In the case of pilotage, the CBA procedure takes the form of minimising the total costs of expected accidents and pilotage in a given area. The dependence on the determination of costs is as follows:

$T_C = P_{AR} + P_C \rightarrow \min$

where:
T_C - Total Costs
P_{AR} - Profit from accident reduction through pilotage
P_C - Pilotage costs

The cost of accidents is taken to mean the total cost of maritime accidents, including the cost of port downtime, the cost of expected human casualties and the cost of environmental pollution.

The cost of pilotage is understood as the cost of conducting pilotage activities and the cost of exposing the pilot to health and death as a result of conducting such activities.

The standard CBA procedure for pilotage was performed for Canadian pilots [MPC 2017]. In this analysis, the economic profit resulting from pilotage activity was even estimated at 300:1.

6.1 *Costs of navigational accidents*

The average cost of a cargo ship accident is in the order of USD 2.5 million [MPC 2017] for the US Coast Guard [1997], not including environmental losses. The average cost of an insurance claim determined by the Swedish Club over 10 years (2000-2010) is USD 1.4 million for collision and USD 0.9 million for shoal entry [Collisions and Groundinds, 2011]. The Swedish Club insures and reinsures more than 5,000 ships every year and operates in the marine insurance market from 1872.

On the basis of Cefor data from 2017 [Hull Claims 2017] associating 26% of the world fleet above 1,000 GRT and 46% above 10,000 GRT for hull insurance claims alone (collisions, strikes and strikes), the average cost of such a fall was determined as 1.27 million Euro (Fig. 2.).
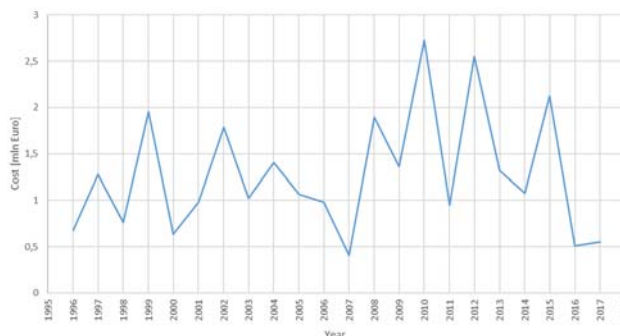

Figure 2. Costs of collision, shoal and strikes insurance claims between 1996 and 2017 [Cefor 2017].

Fig. 3 presents the average cost of accidents on the Świnoujście-Szczecin fairway, divided into size groups, as adopted in the study.

It should be noted that they cover the insurance claim itself without taking into account the true costs of pollution and loss of human life.
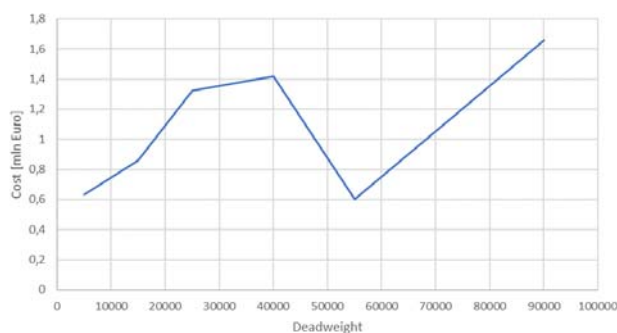

Figure 3. Average accident costs as a function of ship size based on Swedish Club data for the period 2001-2011.

7 CONCLUSIONS

The analysis carried out in this study concerning the issue of exemption from compulsory pilotage of various size groups of vessels on the Świnoujście - Szczecin waterway leads to the following conclusions:

1 Any additional exemption from compulsory pilotage will reduce the safety of navigation compared to the status quo.
2 The average values of the increase in navigational safety defined as the percentage reduction of accidents caused by pilotage for global data are:
   − 60% for grounding,
   − 55% for collisions,
   − 82% for impact.
   − These values will be higher for the waterway Świnoujście - Szczecin due to its specificity, as they have been defined in the areas much easier to navigate.
3 In the case of accepting the exemption from pilotage of compulsory units with a length of 60m to 90m, an increase in the number of annual accidents should be expected:
   − 3.9 grounding per year,
   − 3.2 collisions per year,
   − 25.3 impacts per year.

4 In the case of accepting the exemption from pilotage of compulsory units with a length of 60m to 75m, the number of annual accidents should be expected to increase by:
   – 0.7 grounding per year,
   – 0.5 collisions per year,
   – 4.3 impacts per year.
5 A preliminary, simplified economic efficiency analysis carried out only for shoal entry and collision accidents shows that pilotage for all groups of ships has positive economic values with a total annual effect of more than €6 million.
6 Before introducing legal changes in the field of pilotage, a thorough analysis of economic efficiency (CBA) should be carried out, which will indicate which solutions are optimal in terms of cost, taking into account also environmental losses, port downtime, accurate estimation of pilotage impact, taking into account the characteristics of the region, etc.
7 The analysis does not take into account the impact of the factors proposed in the solutions exacerbating the mandatory pilotage requirements, such as jet rudders, wind or visibility, as these are factors which do not influence the results of this analysis (most small units have thrusters, poorer visibility or wind above 12.5 m/s occur with a frequency of several days per year).

ACKNOWLEDGMENTS

REFERENCES

[1] Collisions and Groundings (2011), The Swedish Club 2011.
[2] DNV (2001), Great Barrier Reef pilotage Fatigue Risk Assessment, Prepared for the Australian Maritime Safety Authority (AMSA).
[3] DNV (2011). Ship Oil Spill Risk Models: Report for Australian Maritime Safety Authority.
[4] DNV (2013). North East Shipping Risk Assessment: Australian Maritime Safety Authority. DNV (2013). Safety and Navigational Risk Assessment for LNG fuelled Passenger Ferry Vessels: Washington State Ferries.
[5] DNV, (1999). Risk Assessment of Pollution from Oil and Chemical Spills in Australian Ports and Waters, NDV Project 9330-3972.
[6] GBR (2002). Great Barrier Reef Shipping Review (GBR) Steering Committee, Review of Ship Safety and Pollution Prevention Measures in the Great Barrier Reef.
[7] Gucma L. (2005) Modelowanie czynników ryzyka zderzenia jednostek pływających z konstrukcjami portowymi i pełnomorskimi. AM w Szczecinie 2005.
[8] Gucma L. (2009) Zarządzanie ryzykiem morskim. AM w Szczecinie 2009.
[9] Gucma L. (2012) Zarządzanie ryzykiem w rejonie mostów usytuowanych nad drogami wodnymi w aspekcie uderzenia jednostek pływających. AM w Szczecinie 2012.
[10] Huffmeier J., i Raggl K.J. (2011). Uppdatering av Riskanalysen "Navigationssakerhet I Milskarsleden. Góteborg: SSPA rapport RE 201.
[11] Hull Claims 2017. CEFOR. The Nordic Association of Marine Insurance 2017.
[12] Istikbal, C. (2006), Turkish Straits: Difficulties and the Importance of Pilotage, In: Oral N. i Öztürk B.: The Turkish Straits. Maritime Safety, Legal and Environmental Aspects, Turkish Marine Research Foundation, Publication No. 25.
[13] Kacalak P. (2018), Wypadkowość statków na torze wodnym Świnoujście-Szczecin. Praca inżynierska. AM Szczecin 2018.
[14] Larsen, O.D. et al. (1993). Ship Collision with Bridges: The Interaction between Vessel Traffic and Bridge Structures. IABSE – AIPC –IVBH, Switzerland.
[15] Lentz, A. i Kroon, I.B. (2010), Oil spill risk and the socioeconomic effect of mandatory pilotage. Accepted for publication by International Journal of Engineering Under Uncertainty: Hazards, Assessment and Mitigation. 2010.
[16] MPC 2017. Marine Pilotage Canada. A Cost Benefit Analysis. TransportationEconomics & Managem Systems, Inc. Canadian Marine Pilots' Association.
[17] Ozsoysal, R. & Ozsoysal, A. O. (2006), Maritime Casualties through the Bosporus, Naval Engineers Journal vol. 118.
[18] PIANC (2014). Harbour Approach Channels Design Guidelines. PIANC report no 121. Maritime Navigation Commission. PIANC 2014.
[19] ROM 11-99 (2000). Recommendations for the Design of the Maritime Configuration of Ports, Approach.
[20] Taryfa (2015). Taryfa za usługi pilotowe w portach Szczecin, Świnoujście, Trzebież, Stepnica, Police i pozostałych portach Zalewu Szczecińskiego ważna od 01.12.2015.
[21] White, M. (2000) Navigational Rights in Sensitive Marine Environments: The Great Barrier Reef, in Navigational Rights and Freedoms and the New Law of the Sea, D. Rothwell & S. Bateman (eds). The Hague: Kluwer Law International.