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Summary Report on Evaluating VTS and Pilotage as Risk Reduction Measures

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Content

1 Introduction

1.1 Background

Pilotage and Vessel Traffic Services (VTS) are risk reduction measures aimed at improving navigational safety and reducing the risk of collision, grounding, and contact accidents and incidents. Within the EfficienSea project, three studies investigated the risk reduction effects of these measures in specific areas of the Baltic Sea. This report summarises the results of these studies with respect to conclusions on the contributions of these measures to safety.

1.2 Aims of the activity

The main objective of activity 6.5, "Risk reduction of pilotage and Vessel Traffic Service (VTS)", is as follows:

> "*The services provided by VTS centre differ and so do covered areas and required education and experience of VTS operators. It is believed that provided services, area coverage, routines, operator qualifications and operator training etc. can be more risk- oriented than currently the case, and that there is much existing knowledge to be exchanged between different VTS-centres in order to increase maritime safety. Both pilotage and VTS provide information to navigators and their risk-control measures show similarities. Therefore, exchange might be possible. Navigators, pilots and VTS operators are all capable of human error and this is essential to consider. The result of this activity is a decision supporting framework for establishing pilot and VTS services.*"
>
> (From the EfficienSea Project Data Form 04/02/2009)

1.3 Aim of report

This report is part of activity 5 within work package 6 Dynamic Risk Management. The aim of this report is to summarise the three main studies reported within this task, which are focussed on evaluating VTS and pilotage as risk reduction measures, and present their findings with respect to decision support.

1.4 Scope

The study covers the following areas:

- The sea **areas** of the Baltic Sea, primarily Swedish and Finnish territorial waters.
- The risk reduction measures VTS and pilotage.
- The **accident types** groundings, collisions, and contacts.
- **Merchant ships** and **fishing vessels** with a size of at least 100 or 300 GT.

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1.5 Data sources

This report summarises the findings of the following three studies:

- Westerlund, K. 2011. The Risk Reducing Effect of VTS in Finnish Waters. EfficienSea Deliverable D_WP6_5_01.
- Anbring, A., and P. Grundevik. 2012. How Pilotage Contributes to Maritime Safety. EfficienSea Deliverable WP_6_5_02
- Lundkvist, M. 2012. Risk Assessment of VTS in Swedish Waters. EfficienSea Deliverable W_WP6_5_03.

The study by Lundvist was a detailed risk assessment of VTS, with the view to providing a basis for decision making. The other study of VTS, by Westerlund, investigated the types of interventions carried out by VTS operators, and compared the duties in an open water period with those carried out during an ice period. The study on pilotage investigated how pilots contributed to maritime safety through a literature review, interviews, participant observations, accident statistics and accident reports. The interviews, observations, statistics, and accident reports all concerned pilotage in Swedish waters. The study also to some extent investigated whether the pilotage criteria could become more risk-based.

In addition to the three studies mentioned above, recent literature, including some relevant accident reports, was reviewed and discussed.

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2 Risk Reduction from VTS Services

Vessel traffic services (VTS) are defined by the IMO as "shore-side systems which range from the provision of simple information messages to ships, such as position of other traffic or meterological hazard warnings, to extensive management of traffic within a port or waterway." (IMO, 2011).

IALA (2008) defines three types of vessel traffic services as follows:

- Information Services (INS): this provides "essential and timely information to assist the on-board decision-making process". The service is not a participant in on-board decision-making.
- Navigational Assistance Service (NAS): This service "provides essential and timely information to assist the on-board decision-making process and may inform, advise and/or instruct vessels accordingly."
- Traffic Organisation Service (TOS): This service "provides essential and timely information to assist the on-board decision-making process and may advise, instruct or exercise the authority to direct movements."

IALA (2009) states that the purpose of VTS is "to improve the safety and efficiency of navigation, safety of life at sea and the protection of the marine environment and/or the adjacent shore area, worksites and offshore installations from possible adverse effects of maritime traffic". IALA (2009) recommends that a formal risk assessment be carried out when implementing a VTS. They state that the navigational risks of the baseline situation should be assessed for the types of accidents that may be managed by VTS – collisions and groundings. They state that one of the main difficulties with respect to conducting an assessment is that "the true financial consequences of recorded casualties are not available". They also state that the future is not necessarily an extension of the past and foreseeable trends should be taken into account.

Within the Baltic Sea area, studies on risk reduction potential of VTS services have been carried out within the framework of FSAs and navigational risk assessment. Some of the more comprehensive studies are as follows:

- Risk Analysis of Navigational Safety in Danish Waters: This study by COWI (2002) was carried out on behalf of the Danish Maritime Authority and the Royal Danish Administration of Navigation and Hydrography. The objective of the study was to estimate present navigational safety in Danish waters and calculate the risk reduction potential of various risk control options. Two of the risk control options considered involved expansion of VTS in the area: one involved incorporating the Hatter area into the VTS Great Belt surveillance area and the other involved introducing a VTS centre for the area around the Drogden channel. A risk reduction factor effect of 0.45 was used in the study for all accident types. It was based on literature studies.

- Implementation of a VTMIS system for the Gulf of Finland: The purpose of this study, carried out by VTT (2002) was to assess the potential effectiveness of two proposed options for a VTMIS system for the Gulf of Finland. The first option included a new routeing system combined with a mandatory reporting system. The second option, consisted of the first option combined with a radar-based traffic monitoring system. These options were compared to the 'Baseline' option which consisted of no additional

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investments to vessel traffic control for the Gulf area. The study concluded that the likelihood of collisions was reduced by 80% with a radar based reporting system. Without radar surveillance the risk reduction would be limited to 3-11%. It should be noted that the study was produced before AIS became mandatory on vessels over 300 GT.

Two studies on risk reduction from VTS services were reported within the EfficienSea project activity 6.5:

- Risk Assessment of VTS in Swedish Waters (Lundkvist, 2012)
- The risk reducing effect of VTS in Finnish Waters (Westerlund, 2011).

The main findings of the studies are summarised in the following sections.

2.1 Risk assessment of VTS in Swedish Waters

The study "Risk Assessment of VTS in Swedish Waters" (Lundkvist, 2012) was a risk assessment carried out on a national level to analyse the costs and benefits of VTS in Sweden. The main aim was to provide a decision making basis regarding whether VTS was cost efficient in specific waterways. The study was limited to Swedish territorial analyses and to vessels over 300 GT. The accident types considered were collision, contact, and grounding. The risk assessment was conducted using the Formal Safety Assessment (FSA) methodology (IMO, 2007) recommended by the International Maritime Organizations (IMO). A summary of the main steps of FSA as carried out within the study are as follows:

- Hazard identification: Accident scenarios were identified based on a review of historical data – specifically the information included in the analysis of data included in the Swedish Sea Accident Database, SOS (Sjöolyckssytemet). This includes accidents and incidents occurring on vessels of all flags in national territorial waters, and Swedish flagged vessels in all waters. Only the data for accidents and incidents occurring in national territorial waters was used.

- Risk analysis: The probability assessment phase of the risk analysis was also based on an analysis of data from the SOS system. Data for two periods was considered, and an accident frequency (number of accidents per year) was estimated. This was then used as the accident probability for the risk assessment study. In terms of accident consequences, literature studies and Swedish national recommended values for socioeconomic analysis of transport (SIKA, 2009) were used as the basis for calculation, along with compensation data obtained from the Swedish Club for the study. Consequence categories included damage to ships, environmental damage, human consequences, delay costs for industries, impact on the ship owner's income, and damage to other property. Risks were quantified for each of the accident types (collision, contact, and grounding) for each waterway considered in the study.

- Risk control options: Risk control options considered in the study included VTS and general call reporting. The main function of VTS addressed in the assessment was the information service function. Navigational assistance and traffic organisation functions of VTS were also discussed. The risk reduction value of VTS was estimated based on literature studies and an assessment of accident investigations. For each accident investigation a number of questions were put to accident investigators and VTS operators on whether the information service could have prevented the accident. Risk

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reduction for information services was estimated at 30% for groundings, 30% of collisions and 20% for contacts. Similar reduction factors were found for a developed port information service as well as for navigational assistance.

- Cost benefit assessment: Costs of information service for each of the waterways considered in the study were based on current costs for information services in two existing VTS areas in Sweden. These costs were estimated based on two basic units – number of vessel calls, and the distance covered by the ships within the VTS area (ship distance monitored by the VTS). The benefit of VTS was considered to be a reduction in accident costs. These were obtained using the estimated accident probability reduction expected from VTS and applying this to the annual expected accident costs for each of the waterways considered. A net present value ratio for each proposed VTS area was estimated using the estimated costs and benefits. As a sensitivity analysis probabilities calculated on the basis of accident frequencies for the periods 2000-2009 and 1985-2009 were compared. The effect of these different frequencies on the overall Net Present Value (NPV) were presented.

- Recommendations for decision making: Uncertainties present in the risk assessment were laid out clearly as background for consideration in the decision-making process. Uncertainties in input data, methodology and assumptions were described, along with possible effects on the outcome of the analysis. The recommendations were specific regarding whether there was a benefit to implementing the information service function of VTS in each of the specific waterways examined.

Further recommendations came out the study with regards to how a better basis for assessing the need for VTS could be developed. Some of these recommendations were directed towards improving available information for carrying out risk assessments, and included the following:

- Within the frame of accident investigation, assess whether collision and grounding accidents could have been prevented with vessel traffic information. This would help to develop a better basis for determining an overall risk reduction factor for each accident type.

- Estimate accident costs in connection with the documentation of accidents in SOS. This would provide a better basis for cost estimates of accidents in Swedish shipping lanes as well as give an indication of local and ship related cost variations.

- Better documentation and collation of information on incidents observed and experienced at VTS centres.

- Carry out follow-up analysis of accidents and incidents that occur within VTS areas.

- Regarding estimations of cost of VTS services, documentation and quantification of the VTS operators' workload and work time used according to job duties (function) and section of fairways would be helpful for improving estimates of costs of future services.

In summary, the formal safety assessment methodology functioned as an effective framework for the study and for providing recommendations for decision-making.

2.2 Risk reducing effect of VTS in Finnish Waters

The study on the risk reducing effect of VTS in Finnish waters (Westerlund, 2011) considered the effect in open water and the effect in winter navigation. The study collected detailed reports from VTS operators during two periods: a fall period without ice ("open water") and a winter period with heavy ice conditions. The reports were analysed to draw conclusions about the type of interventions carried out by VTS operators, and demonstrate the type of work carried out by the VTS centre.

Both study components involved collected reports from three VTS centres in Finland. These were the Archipelago VTS, the West Coast VTS, and the Gulf of Finland VTS. All three centres provide information, traffic organisation and navigational assistance services in the VTS areas they supervise. The centres reported all events that required their intervention during the two study time periods. Violation reports were also collected and analyzed for the periods.

Open Water:

The open water study covered the period from October 25 to November 8, 2010. A total of 141 reports were gathered from the operators over this time, of which two were not included in the analysis as they were not considered to be safety-related. The ratio of reports to number of port calls in the three VTS areas were estimated. The ratios were all quite close – ranging from 11.5 to 13.3%.

The most common reasons reported for intervening with the ship's navigation were considered to be traffic organisation. These included information sharing, reminding about close quarter situations and making remarks about TSS violations. Examples of traffic organisation included asking ships to use alternative fairways or to slow speed when meeting another ship in narrow or restricted areas. There was also a large range of other types of cases, such as providing information about pilot boarding and disembarking areas, and asking ships about abnormal behaviour.

The study gave examples of the types of cases dealt with by VTS operators and identified specific locations within the VTS areas where interventions were most frequent. It was noted that the study only covered a limited period of time, and that it was not possible to predict whether there would have been an accident or not without VTS intervention. It was recommended that additional data collection during other periods, on an ongoing basis, would be useful.

Winter navigation:

The study on winter navigation covered the time period 28 February to 14 March 2011. February was an exceptionally cold month and ice conditions at the end of the month were considered harsh. The traffic separation schemes could not be used during the period, as the ships were forced to proceed through areas with easier ice conditions. The conditions deviated considerably from the open water situation, and VTS duties of a different nature were required. During ice conditions, icebreakers are responsible for assistance of ships and coordination of traffic in ice fields. The icebreaker coordination sets the order for assisting vessels, based on safety issues. It provides navigational instructions, waypoints, position of the icebreaker, name and VHF working channel, to the VTS, which is then forwarded by the VTS to vessels.

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Very tight restrictions on navigation were in place during the study period, regarding ice class and minimum tonnage. A total of 104 reports were reviewed as part of the analysis, reduced from the previous open water study. Many of the reports from VTS centres were regarding warning ships about harder ice conditions ahead and guiding ships towards easier routes with less ice. Information about where it was safest to wait for icebreaker assistance and/or for a pilot was also provided. Compared to the previous reporting period, i.e. for open water, there were no ship to ship close quarter situations reported. During ice conditions it is normal for ships to navigate in close proximity to each other because otherwise the ice channel starts to close quickly after a ship has passed through. There were a few minor rear-end collisions during the period, but it was not considered the type of collision that VTS could prevent. The role of VTS during the ice period was seen to be very much as a contact point and information exchange – informing icebreakers about vessels requiring assistance and informing vessels about the movements of icebreakers.

The study on risk reducing effect of VTS in Finnish waters provided a good indication of the types of interventions carried out by VTS operators. It also provided very good qualitative descriptions of the work done, and an interesting comparison on duties during open water and ice conditions.

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3 Risk Reduction from Pilotage

Maritime pilots are recognized as playing an important role in promoting maritime safety and protecting the marine environment. The pilot's responsibility is to assist with navigation and manoeuvring. A study on the contribution of pilotage to safety reported within EfficienSea is described below.

3.1 Swedish pilotage study

The study, "How pilotage contributes to maritime safety" (Anbring and Grundevik, 2012), focused on pilotage in Swedish territorial waters, primarily on the pilot's role and work on board the vessel. The study was an investigation based on literature review, interviews, participant observations, accident statistics and accident reports. Interviews, participant observation and accident reports were limited geographically to Malmö and Södertälje. Nine interviews were conducted and the respondents included pilots, VTS operators, and masters with pilot exemption certificates. Accident statistics were obtained from the Swedish Sea Accident Database, SOS (Sjöolyckssytemet) for the period 1985-2009 and were limited to navigation-related accidents in all Swedish waters. They included the accident categories collision, contact, and grounding.

Maritime safety was defined and described in the study as having and maintaining control over a situation, but also to being flexible and adaptive and to adapt the system to a changing world. It was considered that to understand accidents it is important to understand the human behavior in the context it was performed.

Several aspects of how pilots contribute to maritime safety were identified within the literature and empirical studies. The pilots' expertise, experience and local knowledge of the waters and the pilots' ability to make risk assessments based on these were identified as important contributions to maritime safety. Local language skills were mentioned as another contribution. The pilots' advisory role and role as a resource were also identified. These factors were also discussed in the context of Resilience Engineering, which gave another dimension to how pilots contribute to maritime safety. All these factors were considered to represent the contributions that are offered by pilotage and were definitely seen as contributing to increased safety. The opposite, that these factors would decrease safety, was not considered plausible.

Pilots not only increase safety on board the vessel which they are on – they also make conditions safer for other vessels in the fairway compared to the situation of not having a pilot on board any of the vessels. This seemed to be the general opinion among the interview respondents, who claimed that the vessels for which it is mandatory to have a pilot according to the criteria also represent a higher risk and thus it was more likely that these would be involved in accidents.

Pilotage was considered a safety-enhancing measure for the shipping industry. According to the Swedish Maritime Safety Inspectorate there would have been more maritime accidents if the vessels that currently fall under mandatory pilotage requirements would not have had a pilot. This was also suggested during the interviews. Although the accident statistics do not fully capture the complexity of accidents, the statistics show that the number of accidents have decreased since mandatory pilotage criteria were introduced. This was also the objective for introducing mandatory pilotage for specific ship categories. The number of accidents decreased

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for the first ten years, especially for vessels without a pilot on board. The question is whether this was due to the pilotage criteria which resulted in many more vessels that sailed with a pilot onboard and therefore there were fewer vessels without a pilot onboard. However, the number of accidents increased again in the late 1990s to about the same level as in 1985, and then decreased again. Another explanation could be that there has been a reduced number of vessel port calls and subsequently fewer vessels requiring pilotage. The number of cargo vessels has decreased due to the use of increasingly larger vessels. Improved technology may be another reason for the decline, or it could be a combination of fewer calls and improved technology. The respondents gave AIS as an example of technology that has improved maritime safety. Another explanation could be that the reporting method, or the propensity to report accidents, has changed over this time period, leading to the variation in number of accidents. It is only possible to speculate on the reasons and it is difficult to make causal relationships in complex systems. Furthermore, most accidents were classified as less serious, and only a few were serious accidents. Since accidents are relatively rare events, the statistics are considered a blunt tool.

Nevertheless, the statistics gave no clear indication that pilotage has reduced the number of accidents and thus made the shipping industry more safe. To draw conclusions from the accident numbers it requires more information such as the number of calls with and without a pilot and much more. This information was not available**.** However, safety is more than just the absence of accidents and therefore it is not as simple as stating that shipping has become safer just because the accidents have been reduced. That's because safety can also be manifested in the form of so-called non-events and can then be seen as the sum of events that did not happen. This means that there are several other aspects of how piloting can contribute to maritime safety.

According to this limited study the conclusion is that based on the theory of resilience engineering, the pilot is well placed to contribute to maritime safety as the pilot can adapt the system to new conditions. The pilot must therefore be flexible and adaptive to be able to have and maintain control over the system. The pilot should also be seen as an artifact of the overall maritime safety system and thus the pilot affects the performance of the overall system.

Based on the interview results and the literature study, the current criteria for mandatory pilotage were considered reasonable and there was no apparent need for more risk-based pilotage criteria identified among the respondents. However this issue ought to be investigated further.

The criteria presented can be used as a basis for further discussion of risk-based pilotage criteria and include the following:

- Vessel dimensions, design and maneuverability in relation to the fairway and port
- Ship and especially the bridge equipment
- Ship design in agreement with cargo load
- Crew and watch schedule on the ship
- The bridge team competence/s
- The bridge team experience in the Swedish coastal waters as master and watchkeeping officer
- The bridge team ability to communicate in English or Swedish and English.

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3.2 Other studies and references on the effect of pilotage

Although pilotage is generally considered to contribution to maritime safety, some recent accidents have highlighted some aspects of pilotage that are of concern. The issues relate to pilots boarding and disembarking and to problems with the pilots functioning as a team with other officers on the bridge. Within Finland, there have been three accidents related to pilots disembarking, as follows:

- grounding of the M/S ANNE SIBUM on 2 April 2008 (Finland Accident Investigation Board, 2011)
- grounding of the M/S TALI on 29 January 2008 in Norwegian Waters (Finland Accident Investigation Board, 2009a)
- grounding of the M/S OOCL NEVSKIY on 27 February 2008, south of Helsinki Pilot Station Harmaja (Finland Accident Investigation Board, 2009b).

The Finland Accident Investigation Board (2011) did not consider that weather conditions were so exceptional for the above three accidents that the pilot should have remained on board until the next port. Further, they stated that prevailing winds can often play an important role with regard to a pilot's safe boarding or disembarking, and vessels may turn sideways in the fairway to provide lee to the pilot boat. Recognizing the inherent risks in this, the accident investigators recommended the following:

> *"The State Pilotage Enterprise amend their pilotage instructions so that the pilot, after disembarking, remains at the site and ensures that the vessel assumes the correct heading in time if it has been necessary to turn the vessel into a heading that deviates significantly from the course of the fairway so as to guarantee the pilot's safe landing. If the pilot disembarks well before the designated boarding/disembarking area the pilot boat should escort the vessel to the designated boarding/disembarking area." (Finland Accident Investigation Board, 2011).*

There have also been recent accidents reported by the Norwegian Accident Investigation Board where actions of pilots on board were contributing factors. These were as follows:

- Grounding of the bulk carrier FEDERAL KIVALINA off Årsundøya Island east of Kristiansund on 6 October 2008: The report (Accident Investigation Board Norway, 2010a) stated that the pilot and ship's crew did not work as a team, and this contributed to the accident. It was noted that the manning of the bridge was not functioning during the period before the vessel ran aground, and there had been a gradual loss of control over navigation. One recommendation of the report was that the Norwegian Coastal Administration "*consider changes in the training of pilots and procedures, along with other measures, so that the pilots can more efficiently be part of a well-functioning bridge team."*
- Grounding of the CRETE CEMENT at Aspon Island in the Oslo Fjord on 16 November 2008: The accident report (Joint Accident Investigation Board Norway & Bahamas Maritime Authority Marine Accident Report, 2010) cited the pilot's strenuous duty period the week before the accident as a contributing factor. Limited communication on the bridge was also mentioned. The Norwegian Coastal Administration, was recommended to implement measures to ensure that pilots have sufficient sleep and rest.

Despite that there are some issues associated with some aspects of pilotage, pilots are considered to prevent far more accidents than they cause (Gard News, 2011). Bridge team management operation with a pilot on board, however, is considered an important area to consider.

Huffmeier (2011) states that determining the degree to which safety will improve with a pilot on board is difficult, and can vary depending on the physical characteristics of the waterway and traffic patterns in the area. References to various literature studies include an estimated accident frequency reduction by a factor of 4 for groundings and 5 for collisions at the Bosporus Strait in Turkey, reduction by a factor of 2 for the Great Barrier Reef, and as high as 30 for Danish data (summarised in Huffmeier, 2011). He further reports that the consulting company COWI uses risk reduction factor of 0.5 for groundings if a pilot is on board, and 0.75 for collisions.

4 Summary

Each of the studies contributed new information in the Baltic Sea area that is useful for consideration during decision-making processes. Lundkvist (2012), as part of his risk assessment of VTS in Swedish waters, put forth a number of recommendations for decision making regarding the establishment of new VTS areas. The FSA approach he employed, and rationale behind risk reduction estimates, can serve as a useful framework for similar studies regarding decision-making in other areas of the Baltic Sea. The work by Westerlund (2011) on the risk reducing effect of VTS in Finnish waters provided good background information on the types of duties carried out by VTS operators during both open water and ice conditions. This contributes knowledge useful for estimating manpower requirements for similar areas and also potentially for estimating the distribution of time allocated to various types of duties (information, coordination, etc.). Studies conducted for additional time periods and areas, as recommended by Westerlund are required to ensure a more representative basis. Regarding pilotage, good qualitative information on the benefits of pilotage and views of those involved in pilotage was put forth in the report by Anbring and Grundevik. The need for additional statistical basis for quantifying risk reduction potential was identified.

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