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Efficient, Safe and Sustainable Traffic at Sea

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Table of Contents

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1 Introduction

1.1 Scope

To define a distinction between dynamic and static risks in vessel traffic and routing from a shore based surveillance perspective. This includes defining the static and dynamic risks.

When this is done a discussion around possibilities to transform dynamic risks into static risks have to be performed in order to make it easier to handle.

A discussion on managing these risks will be carried out as well.

Finally an effort to adopt the above to work done in the EfficienSea project will be performed.

1.2 Background

Shipping is of great importance for trade and prosperity around the world and thus also the Baltic Sea region benefits from shipping. Moreover, shipping in itself is a complex system with many actors and components displaying variations in space and time. Manoeuvrability, crew competence and navigational equipment are different from vessel to vessel. The vessels themselves vary in length, draught and width as well as directions and speed. Waterways and aids to navigations are crucial for shipping and are adjusted to the natural settings and the maritime traffic. Due to the array of maritime accidents experienced worldwide throughout the years and up to present date, it is clear that shipping, although relatively safe in general, never takes place without some risk. Different safety measures are aimed to reduce these risks but often come with a cost. In order to invest in safety in an appropriate and efficient way, safety and economical risks have to be balanced in a risk management context meaning that an optimization is aimed for; the sum of safety measure costs and accident costs are to be kept at a minimum as is given by the figure below.

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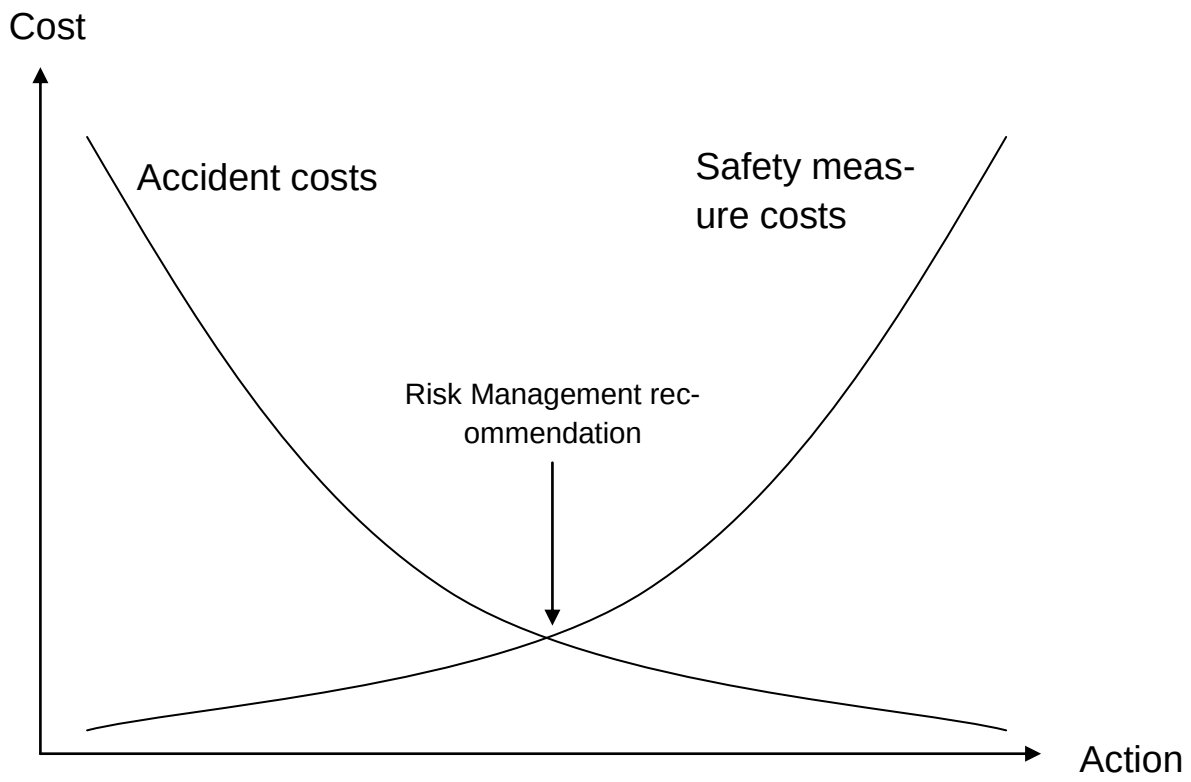

Figure 1 Simplified generalisation of the risk management procedure leading to recommendation on balancing costs for accidents and safety measures.

Except the economic limitations for safety measures, political and technical constraints have to be kept in mind.

Accidental risks are evidently present in **the Baltic Sea**. With a strong increase in transported oil volumes and a vulnerable ecosystem it is easy to assume pronounced and increasing risks for and with accidental oil spills. Recent accidents in the Baltic Sea with oil spills, as the ones with Baltic Carrier and Fu Shan Hai, obviously show that there is risk.

The by HELCOM recently adopted **Baltic Sea Action Plan** presents the agreement for strengthening of sub-regional cooperation in the oil-spill response field:

- by 2008 to develop and agree upon common methodology for the assessment of risk and sufficiency of emergency and response capacity, to be used with "Guidance for the subregional plans to quantify needed emergency/response resources"

- by 2009 to finalise the assessments by the Contracting States of the risks of oil and chemical pollution and to finalise the quantification of the emergency and response resources at the sub-regional level (emergency towing, fire-fighting and emergency lightering, hardware, human resources) needed to meet these risks;

- by 2010, based upon risk assessments, to identify the gaps in emergency and response resources at the sub-regional level and to prepare concrete plans/programmes for fulfilling them by 2013

- by 2010, based upon sensitivity mapping, to identify the need for and to finalise the quantification of countermeasures for shoreline response, and to prepare concrete plans/programmes for fulfilling them by 2013.

Due to the high maritime risk the Baltic Sea has been appointed a **Particular Sensitive Sea Area** (PSSA) by the International Maritime Organization (IMO) which means that it needs special protection as is expressed in the revised Guidelines for the Identification and Designation of Particularly Sensitive Sea Areas (resolution A.982(24)):

A PSSA is an area that needs special protection through action by IMO because of its significance for recognized ecological, socio-economic, or scientific attributes where such attributes may be vulnerable to damage by international shipping activities. An application for PSSA designation should contain a proposal for an associated protective measure or measures aimed at preventing, reducing or eliminating the threat or identified vulnerability. Associated protective measures for PSSAs are limited to actions that are to be, or have been, approved and adopted by IMO, for example, a routeing system such as an area to be avoided.

The guidelines provide advice to IMO Member Governments in the formulation and submission of applications for the designation of PSSAs to ensure that in the process, all interests - those of the coastal State, flag State, and the environmental and shipping communities - are thoroughly considered on the basis of relevant scientific, technical, economic, and environmental information regarding the area at risk of damage from international shipping activities.

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The **Baltic Sea Region Programme** has in one of their four priorities called for sustainable management of the Baltic Sea resources, thereby including the prevention and the response of oil pollution stemming from maritime accidents. The here proposed tasks are mainly aimed at meeting priority 3:

The third priority concentrates on environmental pollution of the Baltic Sea in broader framework of a sustainable management of the sea resources. It supports operations aiming at limiting pollution inputs into and pollution impacts on the marine environment. Special emphasis is put on enhanced maritime safety. The priority also promotes economic management of open sea areas by means of best available technologies and practices. Attention is given to an integrated development of offshore and coastal areas in the Baltic Sea Region in the context of climate change tendencies.

The risk management approach by balancing safety and costs is found in the **Formal Safety Assessment** (FSA) procedure, which has been introduced by the International Maritime Organisation (IMO) to be used when new regulations are to be proposed, implemented and enforced. Changes in accidental risk after a new regulation are screened by a risk assessment and a cost-benefit assessment of the measure in order to assess its suitability. However, in many FSAs the used accident cost data is based on rough estimations of a limited number of parameters, thus leading to significant uncertainty in the FSA. For instance, due to difficulties the ecological impact is seldom quantified in monetary terms. Further, the FSA is a ship-based approach without a dynamic component giving the distribution of risk levels, costs and benefits in a geographical context.

1.3 Aim

The overall aim of this Work Package is to **develop and demonstrate different approaches of dynamic risk management**[1] in order to optimise the investments for a safe and clean Baltic Sea. This means that the developed dynamic risk management in an efficient way shall reduce the number and the severity of foremost accidents leading to pollution of the marine environment, but also leading to losses of human lives and hampering of welfare development.

[1] Dynamic risk management is here defined as the continuous work on identification of among others, accident and economic risks, assessing risk levels, propose and perform risk treatment and communication of risks. Risks are here defined as the combination of probabilities and consequences of adverse effects as accidents and thereby indicating the expected accumulation of negative consequences with a given activity within predefined areas and periods.

The Work Package **does not aim** to investigate and propose absolute acceptability levels of accident risks since these are to be decided nationally by politicians.

The problem to be solved is to reduce risk levels in spite of increased ship traffic in sensitive waterways. Due to new possibilities with the wide spread use of AIS the interesting coverage area increases and manual survey together with frequent analysis of big areas is not realistic.

The overall aim of activity 6.3 is hence to create an automatic tool identifying potential dangerous situations and facilitate the traffic control work. More specific the aim is to develop a collision and grounding warning as well as risk assessment tool for VTS-control.

2 Dynamic and static risks

The aim in this section is to define a distinction between dynamic and static risks in vessel traffic and routing from a shore based surveillance perspective. This includes defining the static and dynamic risks.

2.1 Projects definition

As per definition in Page 66; Partnership agreement annex II & IV, Dynamic Risk Management Project plan, EfficienSea, Introduction

"Dynamic risk management is here defined as the continuous work on identification of among others, accident and economic risks, assessing risk levels, propose and perform risk treatment and communication of risks. Dynamic risk management aims the risk to be visible in terms of parameters identified by people who are related to maritime traffic. Risks are here defined as the combination of probabilities and consequences of adverse effects as accidents and thereby indicating the expected accumulation of negative consequences with a given activity within predefined areas and periods."

2.2 Interpretation of the Project definition

Dynamic risk management is handled from ashore by a VTS or other authority managing marine traffic.

This VTS/Authority should:

- Identify risks
  - Accidents
  - Economic risks
- These identified risks should be mitigated and/or minimized by VTS/Authority by all means possible.

2.3 Definitions of risk

2.3.1 Risk

Definition of a risk: A risk is something that may happen and if it does, will have an adverse impact on whatever. A few points here, "that may happen" implies a probability of less than 100%. If it has a probability of 100%, in other words it **will** happen - it is an issue that needs to be controlled or mitigated. A risk must also have a probability something above 0%. It must be a chance to happen or it is not a risk. The second thing to consider from the definition is "will have an adverse impact". If it will not have an adverse impact, it is not a risk.

2.3.2 Dynamic risk assessment

In an article by Lucie Ponting named Moving targets: dynamic risk assessment a discussion, with Duncan Spencer is held. Some parts of that discussion are shown below. The main topic is on risks in a workplace such as for example a fire brigade. However the discussion on Dynamic Risks applies here as well when it comes to it identify and make a definition on what a dynamic risk is.

"Risk is what it is," "The situation may be dynamic but the risks, while transitory, are predictable from experience. Risk is an evaluation of hazard and likelihood. The only thing that changes is whether you are carrying out the assessment in advance or at the time.

Dynamic Risk Assessment Method sets out five stages.

- Evaluate the situation: consider issues such as what operational intelligence is available, what tasks need to be carried out, what are the hazards, where are the risks, who is likely to be affected, what resources are available?
- Select systems of work: consider the possible systems of work and choose the most appropriate. The starting point must be procedures that have been agreed in pre-planning and training. Ensure that personnel are competent to carry out the tasks they've been allocated.
- Assess the chosen systems of work: are the risks proportional to the benefits? If yes, proceed with the tasks after ensuring that goals, both individual and team, are understood; responsibilities have been clearly allocated; and safety measures and procedures are understood. If no, continue as below.

- Introduce additional controls: reduce residual risks to an acceptable level; if possible, by introducing additional control measures, such as specialist equipment or personal protective equipment.
- Reassess systems of work and additional control measures: if risks remain, do the benefits from carrying out the task outweigh the costs if the risks are realised? If the benefits outweigh the risks, proceed with the task. If the risks outweigh the benefits, do not proceed with the task, but consider safe, viable alternatives.

Spencer is convinced that when people will talk about dynamic risk, they mean a dynamic situation where predictable hazards may or may not be present, or may be transitory.

If they see dynamic risk as the process of "**managing predictable risk in a dynamic situation**", this may help provide a better focus, he believes.

He says the elements of a good management system for dynamic risk are:

- high-quality predictive risk assessments
- a process for developing risk control strategies
- training to ensure operatives can identify the risk and know how to manage these risks
- a positive safety culture to empower operatives to act and ensure they apply controls consistently and behave safely
- an effective feedback system so that managers and other operatives can learn from experiences and develop further the risk control strategies.

Spencer has found that 99.9% of the risks clients consider at first to be dynamic turn out to be entirely predictable when they apply the idea of "reasonable foresee ability". In this context, controlling risk in dynamic situations is essentially about good management.

Ultimately, he argues, "It's about developing an effective safety risk management process rather than trying to wrestle with a new, separate and distinct type of risk."

2.3.3 Definition of dynamic and static risks

The foresee ability, you could argue that:

- A static risk is a known risk that we can foresee and hence mitigate or avoid.
- A dynamic risk is known risk that we chose to mitigate at the time because of the dynamic situation. Used where it can't be easily to foresee and hence mitigate or avoid

in advance but rather have to act and mitigate when it occurs. Dynamic risks can be treated as static risks with a less efficient mitigation process.

Meaning, dynamic risks can be described as, managing predictable risks in a dynamic situation.

The difference between the static or dynamic risk is whether you are carrying out the assessment in advance or at the time.

Finally I would define dynamic risks as:

Managing predictable risks in a dynamic situation

2.3.4 Can a dynamic risk be transformed to a static risk?

An example of a static risk from a shore based perspective is cargo onboard. This is a static risk from the ships perspective. However, since it is not always known to the shore side, we have to treat it as a dynamic risk.

Then, the question: Can the dynamic risk be transformed to a static risk. YES, the shore based side must be made aware about it.

This shift from dynamic risks to static risks is being addressed, at least to some extent, in the MONA LISA project. A part of the MONA LISA project is to build up such IT system to enable ship routes to be transferred, both to shore but the intention is also to transmit ship to ship.

If the protocol used by the new MONA LISA routes application is open, ships will probably be able to transmit other data ship to shore to enable more dynamic risks to be static.

2.4 Risk assessment and risk management

2.4.1 Organizing risk management

Risk regime is a way of organizing risk management. The starting point is that various parties around the risk must act and deal with the risk in different ways. Usually it's impossible for one party to manage risk on their own. How many that is involved is based on the nature of the risk. This flexible organization of risk management depends on four factors:

- Institutional Geography
  Institutional geography refers to how the organization around the risk looks like. This can be the expertise required, or at what level of risk should be treated. Examples of levels can be local, regional, national and international level. The institutional geography can vary much depending on the risk at hand. Some risks require considerable expertise and collaboration between different parties, while other risks require only general knowledge and fewer people involved.
- Laws and regulations
  Laws and regulations affect the organization of risk management directly because they create a clear distinction of what is allowed and not. This distinction may be real but may although in some cases be more abstract. There may also be informal rules difficult to describe, but which nonetheless affect the organization of risk management significantly.
- Ideas and practical implementation
  there may be obstacles in spreading ideas and practical implementations. Attitudes in the organization, this can be the attitude on various policy documents, cultural factors, attitudes to the risk involved, and more.

The risk management of vessels sailing in international waters requires much thought on each risk, and as can be read above the organization of the vessel routing risk management, institutional geography can be considered essential. Many parties are involved in risk management, mitigation of risk and not the least preparedness for accidents. This will make risk management of the vessel sailing from A to B more delicate, at least from a shore side perspective.

I will continue this chapter in managing risks and mitigation by narrowing down the perspective and owner of risk management to a VTS or other shore side vessel traffic surveillance central.

2.4.2 Dynamic Risk Assessment Method

With basis of the Home Office's 1998 Dynamic Risk Assessment Method in five steps, as laid out above, a method that looks at maritime traffic is outlined below:

With the definition above in mind you could:

- Look at risks from a shore side perspective
- Use a time perspective that is approximately 20 minutes to two hours ahead of real time.

Dynamic Risk Assessment Method in five steps, for maritime traffic:

- **Evaluate the situation**: consider issues such as what operational intelligence is available, what tasks need to be carried out, what are the hazards, where are the risks, which are likely to be affected, what resources are available?
- **Select possible solutions**: consider the different approaches to the problem and choose the most appropriate. The starting point must be procedures that have been agreed in pre-planning and training. Ensure that personnel are competent to carry out the tasks they've been allocated.
- **Assess the chosen solution**: Follow up, are the risks acceptable? If yes, proceed ensuring that goals are understood; responsibilities have been clearly allocated; and safety measures and procedures are understood. If no, continue as below.
- **Introduce additional controls**: reduce residual risks to an acceptable level; if possible, by introducing additional control measures, such as environmental protection ships or fairway restrictions.
- **Reassess chosen solution and additional control measures**: if risks remain, is that risk acceptable? If the risk has been reduced and mitigated to an acceptable level, proceed. If the risks are considered too high, do not proceed, but consider safe, viable alternatives.

To be able to work according to the method above you must perform :

- Risk identification
- Risk assessment

2.5 Risks from a shore based perspective on a specific vessel

The Efficiesea project is aiming towards a shore side VTS or even higher government overlook of the shipping traffic. Focus from here will be on risks from that perspective.

Above we saw a discussion on identifying dynamic risks; Spencer concluded that it is not a dynamic risk if the risk has a **"reasonable foresee-ability"**. This has been adopted below.

- Risk onboard the ship
  Static
- Weather
  Dynamic risks, but we have very good predictions and actual status readily available.
- Traffic situations/congestions in fairways,
  Dynamic,
- Threat/warfare/terrorism/piracy,
  Static/Dynamic
- Port congestion (ships may have to slow down or increase speed to berth occupancy)
  Dynamic
- Temporary and permanent changes in water ways and hazards. Anything today reported as a navigational warning.(this is planned changes)
  Static.
- Aids to Navigation (AtoN) status.(referring to changes and breakdown that is not planned)
  Dynamic
- Route
  Dynamic, no means today of knowing a ships route. Inside a VTS area this may be a static risk with ship reports. With the Mona Lisa project, this can probably be considered a static risk.
- Position, speed and course
  Dynamic, Not a risk in itself. But in the future it may be.
- Ship type
  Static/Dynamic, depend on how IT systems are connected
- Type of cargo/cargoes
  Static/Dynamic in Europe we have SafeSeaNet, but not all ships are known
- Loaded/ballast
  Static/Dynamic in Europe we have SafeSea Net, but not all ships are known
- Dimensions (Length, Beam, Current draught)
  Static/Dynamic in Europe we have SafeSea Net, AIS input data are unreliable as ships tend not to add these correct or not at all.
- Fairway design and shipping lanes
  Static

- Crew; knowledge and experience of the intended route, number of officers etc. **Static/Dynamic**

3 Dynamic risks in the marine environment from a shore side/VTS perspective, Examples

Above an overview of Dynamic risks in the marine environment has been laid out. In this part some examples are chosen, not aiming to cover the whole area but rather point at certain specific risks and how they can influence or possibly be mitigated.

This part will not deal with accident preparedness. This could for example be SAR operations or pollution at sea recovery.

3.1 Ship type, type of cargo/cargoes, dimension of the ship

Ship type identifies that different ship types possess risks that comes with how the ship is constructed. The Ship type risk is related to the type of cargo risk. However, for example dynamite may be shipped with various types of ships. LPG may be shipped as small containers or as a large LPG carrier.

Ship type may be a risk in itself; a high-speed catamaran may impose as risk in itself.

Mitigation of this risk from our perspective (VTS/shore side) will be connected to type of cargo, and dimension of the ship.

There is no reason to mitigate only for ship type. Type of cargo is self-describing. A loaded petroleum tanker is a risk. If you add to that a passenger ship you get various possible alternatives on heightened risk.

Mitigation of these risks usually includes fairway layout and AtoN layout.

VTS could also be a solution if we in that include separation of various cargo types SOPs.

The dimension of the ship heavily influences ship type and type of cargo. The dimensions will not by itself have any mitigation, but combined with ship type and type of cargo it will heavily influence the mitigation of those risks.

3.2 Route with waypoints

3.2.1 What is a route

What is a route and how is it defined? It is considered most important that it is agreed upon a common definition of a route in order to avoid interpretation conflicts. The definition of a route will most probably differ depending on requirements from the different applications in which routes are to be used, e.g.in an Autopilot, fuel economy algorithm etc. It is therefore proposed that the definition of a route is divided into a basic part consisting of a set of minimum common denominators and that additional route attributes are defined in different layers, based individual application requirements, by origin, or other belonging.

3.2.2 Way forward

It is not commonly known where a ship will go and/or what rout the ship will take to get to its destination. It has been evaluated within the EFFICIENSEA project on how to share routes or waypoints over AIS messages. This is a good start idea but however it is not fully satisfactory. This solution gives an indication where a ship is going the next few waypoints. A shore based authority would like to interact with a vessel on what route to choose and to make an extra check of the route for mistakes. This is now targeted partly in the Mona Lisa project where a green route system will be developed and distributed. There is furthermore another project aiming at distributing port information to all involve parties. If Mona Lisa and the port initiative could cooperate or make a continuation of these project aiming at connecting the whole logistic chain with vessels sailing and operating in ports a large gap would be bridged in terms of mitigation of risks.

3.2.3 Traffic situations/congestions in fairways

Evolving traffic situations in for example ports and densely trafficked fairways are dynamic risks situations to be handled both on the ships and from shore organisations.

A question to discuss is then the possibility to advise the ships to slow down in order to facilitate a more suitable meeting point.

3.3 Risks on-board the ship

The risks on-board the ship would normally be considered as static. They are mitigated to the extent as far as possible on-board. This however does not mean that no accidents occur. Examples of risks on-board are:

- Engine failure
- Steering failure
- Breakdown of equipment on-board

- proficiency of the crew
- Fire or leakage on-board
- Human factor (Not to be mistaken with the proficiency of the crew). This involves factors as:
  - Fatigue
  - Drugs and alcohol
  - Misjudgement
  - Lack of cooperation on the bridge

Actions can be taken from a shore side perspective. Examples are the grounding/collision avoidance concept using a grid where historical AIS data is analysed and compared with the present ship AIS parameters. The system is developed by SSPA/Huffmeier within the EFFICIENSEA project. A kind of normal/standard way to pass a certain grid system is developed/defined and enhanced over time. Once a normal behaviour is defined (within certain limits with respect to several AIS parameters) the system is able to identify situations out of the normal.

This way of identifying a normal safe way to help and identify actions and events that is out of the normal would most probably be a wise way to develop methods to mitigate against unwanted risks.

3.4 Weather

The weather situation is ever changing and thus must be treated as a dynamic risk. Most (all?) vessels do have access to weather forecasts. However, if there was a way to find the best route based on vessels data and weather/tide/ice status forecast these kinds of risks could be reduced. The following weather related elements have to be treated out of a risk perspective:

- Current
- Tide and water level
- Wind and waves
- Visibility
- Ice
- High/low temperature

Weather based routing is something where dynamic risk assessment must be used. There are also initiatives inside the MONA LISA project to mitigate these risks by introducing a route planning that includes weather.

3.5 Temporary and permanent changes in water ways and hazards

Aids to Navigation (AtoN) status includes, but are not limited to

- Boys
- Lighthouses
- VTS
- GPS
- AIS

Today anything can be reported as a navigational warning. These are warnings on a medium term time scale that may not have reached the vessel or may have impact on the vessels route as soon as they will be known. But sometimes information get lost.

One way to mitigate these risks, especially on a short notice is to introduce virtual Aids to Navigation on a broader scale. Other risk control options include the MONA LiSA route planning where new routes can be proposed to vessels.

3.6 Standard/status of ship

It is not possible, at least not today from a VTS point of view, to know the status of a vessel and what standard it has. The Paris MOU list is available in many VTS but this list only includes the list of the worst of the worst.

Examples on how to know and possibly act on sub-standard vessels includes:

- Ship Inspection reports that are generalised and searchable by data network and thus possible for a computer to evaluate for example the latest vetting´s of a tanker
- Make available all port state control checklists and findings
- Make a record of vessels sailing in an area/Europe. Do the vessels following their routes, do they have a good safety record?

To act on sub-standard vessels or low performance vessels could include open sea pilotage and routes that goes far away from other traffic and land.

4 Conclusions

The dynamic risk methodology can and should be introduced to shore based facilities such as VTS centres. The main thing is to make available information to these VTS centres and enabling VTS centres to act on the gathered information.

The EfficienSea project and other EU projects are taking steps in the right direction regarding methodologies and understanding of dynamic risk treatment. It is recommended to continue these efforts in order to reduce risk as far as practically possible.

5 References

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