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Protection Measures for Merchant Ships

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SEC-2013.2.4-2 - Protection Measures for Merchant Ships

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Project partners:
1 – MARSS – MARSS Limited - EN
2 – CMRE – Nato Science and Technology Organisation - BE
3 – WMU – World Maritime University - SE
4 – UoA – University of the Aegean-Research Unit - GR
5 – SAMI – Security Association for the Maritime Industry Limited – UK (no longer existing)
6 – UNR – Uniresearch B.V. - NL
7 – TNO – Nederlandse Organisatie voor Toegepast Natuurwetenschappelijk Onderzoek - NL
8 – EII – Engineering – Ignegeria Informatica Spa - IT
9 – Oldendorff – Oldendorff Carriers GMBH & Co KG - DE

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Contents

1 Publishable summary

1.1 Project context and the main objectives

Piracy has re-emerged as a global security threat. The Suez Canal and Gulf of Aden provide Europe's key trade route to the Middle East, India and the Far East. Unhindered passage for the 30,000 ships that use it annually is essential to the economic well-being and energy security of the continent. There are a number of options available to shipping companies to mitigate the risk of piracy and to deter pirates. Many advisable options are summarised in Best Management Practice. They include passive protection measures to discourage attacks, and defensive measures to counter the pirates in the event of an attack. There has been a rapid growth in the use of private contracted armed security personnel to provide ship-board protection and some flag states permit the use of lethal force in order to protect their ships. There is evidence that this militarization of the industry has been effective, however there remains deep unease regarding the broader industrial, political, ethical, economic, social, legal and environmental implications which are poorly understood.

Based on shipping industry concerns, it is clear that there are a bewildering number of options available to shipping companies to mitigate the risk of piracy and to deter pirates. However there is scant information regarding their operational effectiveness or the cost benefits of their use, particularly when employed in combination as part of a holistic approach addressing: the particular vulnerabilities of each vessel, non-lethal response measures and armed security guards, crew training and abilities, shipping business practices and pressures, pirate tactics and the impact of environmental factors (visibility, currents, waves and wind speed) on all. It is currently difficult for stakeholders to evaluate and compare the cost benefits, and operational effectiveness of different counter measures.

The PROMERC project applied advanced geospatial analysis and intelligence techniques to provide the shipping industry with a layered approach to planning, routeing and threat reduction that goes beyond current state of the art. PROMERC organised and consolidated the many dimensions of risk reduction by delivering a knowledge base, manuals and tools to assess the available counter-measures, the current and future threat situations, to identify and quantify the risks and to aid decisions before and during voyages. The system will provide situation and ship specific counter-measures and best practice guidance prior to and during the voyage, as well as interactive route planning tools to develop the counter-measures and sail plan to an acceptable level of risk and cost.

To this end, the PROMERC consortium brought together end-users, commercial, political, academic, and military entities along with leading research companies and agencies. The consortium's broad commercial and military security experience was supported by active stakeholder engagement throughout. This ensured synergy with key players and ongoing activities, both military and non-military. The project was build on extensive background knowledge and data that ensured rapid development and completion of the project in 2 years. The deliverables were reviewed by end-users and the prototype system was used by end-users under realistic, operational conditions.

1.2 Work performed since the beginning of the project and the main results achieved

The Promerc project was running well and no major issues appeared in the second period of the project. The activities on Current and Future non-military Counter measures (WP1) and PEESLE constraints (WP2) have been completed with good results in the first period. These results feeds into Evaluation options (WP3) for inclusion into a database and manual. An early prototype web portal to access the manual was fielded in early July 2014 and was updated to receive the completed databases, end 2014.

The approach to evaluating counter measures has been amended from a measure of 'operational effectiveness' to one of 'utility'. This adaptation followed the engagements with our stakeholders and is considered to be more reliable due to the scarcity of data for some counter measures.

Similarly, WP2 has adapted the measures of PEESLE weightings to create a flexible framework. This will enable changes to be made as legal and social factors change and will also provide end users with the ability to enter their own weights which reflect their company posture.

Although D2.2 was delayed in submission (the report on the PEESLE database) and was not on the critical path. The PEESLE database is required by WP3 and this has been delivered on time.

The Cost benefit studies have been finalized and the manual setup is completed, digital and hard copy.

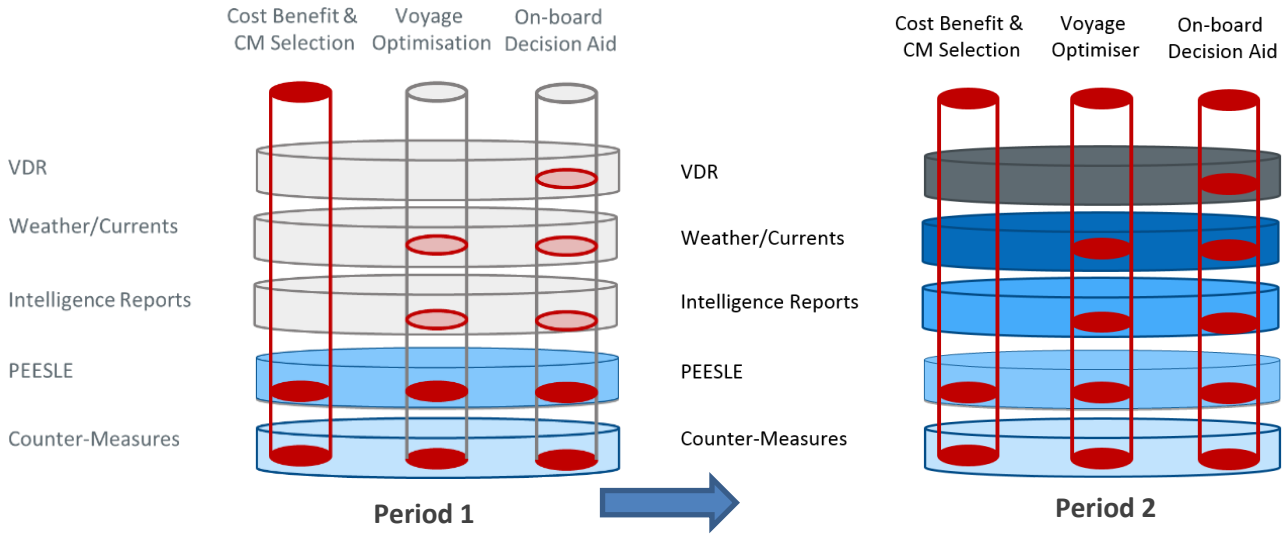
Activities in WP4 have been started and first results are presented during the review meeting.

Overall, the activities in WP5 have been executed according plan, however the overall timing was slightly delayed without out knock on effects, D5.1 has been submitted.

Headlines of achievements:

- 27 Deliverables completed to plan
- Counter Measures Manual available as online tool
- Route Planner and optimiser available as online tool
- Dissemination activities performed according plan
- Exploitation path under development in line with expectations
- Key material available to public via website

Current status on technical developments are plotted in figure below, where the red "filled" dots means completed and the "open" means that activities have started.



1.3 Expected final results and their potential impacts and use

The main goal of PROMERC is to reduce the vulnerability of EU merchant fleets and maritime supply lines to criminal abduction and extortion. The challenge will be to create the optimal mix of security measures, based on an all risk approach. This will be delivered through the provision of following research outputs:

1. A Counter Piracy Measures Manual (D 3.3) to aid in the selection and use of appropriate active and passive counter piracy measures in a layered holistic defence. The manual will also be available as a user Counter Measures database and Planning Tool (configurable by End-Users) which will be produced as D 3.2. The end-users will be able to filter Counter Measure to achieve the desired level of protection, cost and compliance.
2. A prototype Onboard Counter Measures Decision Aid (D 4.1 – a software application) will provide sea farers with real time threat assessment, evaluation of possible courses of action and a recommended course of action.
3. A Prototype Pre-voyage planning and routing tool (D4.2 – a software application) to aid shore based authorities, which will balance routeing to mitigate risk against incurring additional fuel costs due to re-routeing and increased speed.
4. Recommendations on the further development of Counter Piracy Measures (D. 5.2 - including the Counter Piracy Measures Manual, Voyage Planning Tool, Counter Measure Tactical Decision Aid)

The PROMERC proposal addresses the main objectives – improved security for the European citizens by protecting the merchant fleet and enhancing competitiveness for industry. In more detail the proposed research addresses the adverse impact of piracy on:

- The liberty, health and life
- The competitiveness of the shipping industry
- The global trade
- The international community

Impact of on liberty, health and life – addressing the human costs of piracy

Piracy impacts multiple stakeholders, none more so than the seafarers attacked, held hostage, or killed. In 2011, at least 3,863 seafarers were assaulted by armed pirates seeking to hijack their vessel and kidnap them[1]. In 2011 alone, 1,118 seafarers were held hostage by Somali pirates, of which 24 were killed[2]. Seafarers face increased stress and risk associated with transiting through pirated waters, with extreme psychological pressures for those unfortunate victims held hostage on hijacked vessels. They are subjected to assaults with automatic gunfire and RPGs, beatings, and extended confinement as hostages. In some cases, hostages are even used as human shields to protect pirates from navy vessels or are forced to crew "motherships" that are used to lure and attack other merchant vessels

Impact on the competitiveness of the shipping industry – addressing the economic cost of piracy

European shipping industry is a global leader controlling 40% of the global merchant fleet and is active in all kinds of maritime services within Europe, between Europe and third countries and in so called cross trades between non EU continents[3]. PROMERC proposes to strengthen the competitiveness of this significant European shipping trade by minimizing the most important direct cost piracy inflicts on the shipping industry:

Minimising the number of hijackings, payments of ransoms and associate costs
Minimising additional fuel and time costs
Minimising insurance costs

[1] Ship-technology.com, 28 Jun 12
[2] One Earth Foundation, 'The Economic Cost of Somali Piracy, Jan 12
[3] The European Community Shipowners Association

2 Project context and main objectives

2.1 Project context

Largely as a consequence of failed states, piracy has re-emerged as a global security threat, most recently in the waters off the Horn of Africa, but also in West Africa, the waters off India, the South China Sea and the Strait of Malacca, and the Caribbean. Pirates tend to operate in regions with large coastal areas, high levels of commercial activity, small national naval forces, and weak regional security co-operation mechanisms. According to International Maritime Bureau statistics worldwide rates of piracy began to increase in the early 1990s, peaking at roughly 350 to 450 reported attacks per year during the period 2000-2004, then declining by almost half by 2005. In 2007, almost half of the world's reported pirate attacks took place in African waters, mainly near Nigeria and Somalia. There have been 70 attacks in Somali waters reported to the International Maritime Bureau in the first 9 months of 2012 representing over one third of attacks worldwide.

The long term solution to piracy requires building stable states and tackling poverty. This has been recognised by the international community being active in the support and development of these countries and regions. This is a complex process with many political issues and implications that will take many years. In the short term, adequate, cost effective solutions are needed to protect seafarers and merchant shipping and to secure Europe's maritime supply lines.

2.2 Main objectives

The overall goal of the PROMERC project is to reduce the vulnerability of European Union (EU) merchant fleets and maritime supply lines to criminal abduction and extortion and thereby reduce risk to mariners, shipping, and the environment, while also reducing costs and remaining cognizant of legal and social constraints. This will be delivered through the provision of the following tangible project results:

- Independent review and recommendations about non-lethal technologies for pirate avoidance and opposing the boarding of vessels by pirates.
- A Knowledge base and manual to aid in the selection and use of appropriate counter piracy measures in a layered holistic defence. This will provide a powerful planning tool, which will also provide a practical guide to the active and passive counter measures to counter pirate threats, their operational effectiveness, cost-benefits and their legal, economic and societal implications.
- An automated voyage planning support tool to aid shore based authorities, which will balance routeing to mitigate risk against incurring additional fuel costs due to re-routeing and increased speed. (A prototype will be available for use by end-users).
- An automated decision support tool to provide seafarers with real time threat assessment, evaluation of possible courses of action and a recommended course of action and for use by shore based authorities as a training aid. (A prototype will be available for training of capabilities and use by end-users). Recommendations on the further development of counter piracy measures.

PROMERC has the following scientific and technical objectives:

1. To optimize the use of different countermeasures in concert. To develop predictive algorithms that accurately forecast the risk of attack and the probability of a successful attack on specific ships.
2. To develop a routing algorithm that successfully balances the risk/costs of boarding avoidance and re-routing, thereby minimising overall cost of counter piracy actions. To quickly bring existing technology to the merchant vessels in the fight against piracy.
3. To find effective and efficient ways to leverage military technology to rapidly provide high quality intelligence and surface picture information to vessels, without the need of expensive radar systems, command and control systems and highly trained officers.
4. To validate the Counter-Measures knowledge base and manual against the baseline scenarios and extensively evaluated by the stakeholder group and end-users partners.
5. To validate and fine-tune the cost-benefit algorithms so that they perform optimally over a large set of threat scenarios. They will then be integrated into the tools produced by PROMERC and tested in a simulation environment as part of the development process.

6. To validate the Decision Support tool against the baseline scenarios and the evaluation criteria of the stakeholder group and end-users partners in a bridge trainer. Bridge trainers are used to train deck officers and provide a life-size, fully equipped and functional bridge which will be used to develop 'real' pirate threat scenarios. The Decision Support tool will receive data feeds from the bridge Voyage Data Recorder (VDR) and will provide situation sensitive advice and guidance.
7. To validate the voyage planning support tool against the baseline scenarios and against historical data prior to an extended period of use by end-users to support their daily operations.
8. To document, leverage and support, ongoing and completed research from related projects and actions e.g. VESCOSUR, PMAR, NAVTRONIC, SECTRONIC, PERSEUS and OP ATALANTA.

Main achievements on the PROMERC project

The PROMERC project achieved the following main results:

1. Manual
2. Voyage optimisation
3. On board decision aid
4. Cost Benefit
5. Counter measure manual

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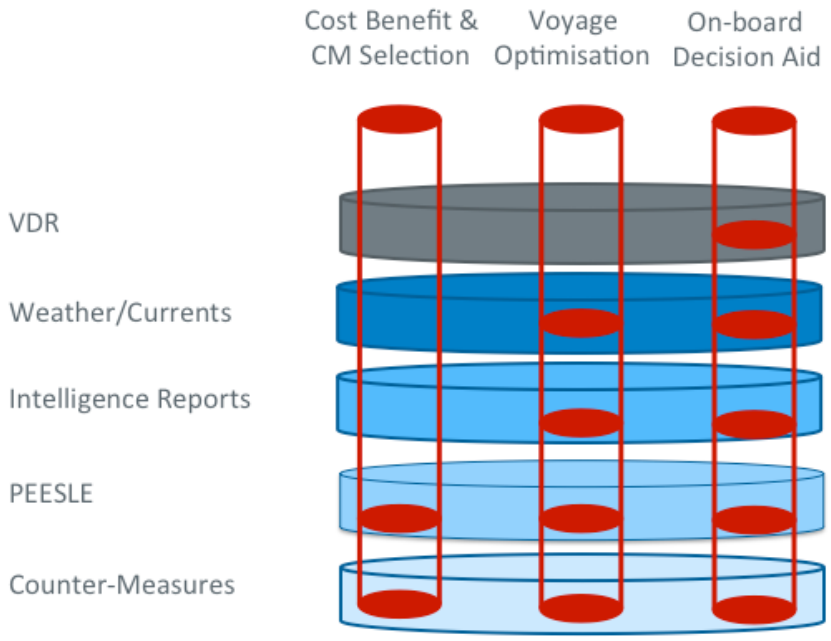

Figure 2-1 Promerc concept and main technical achievements

2.3 Expected final results and their potential impacts and use

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[4] Ship-technology.com, 28 Jun 12
[5] One Earth Foundation, ‘The Economic Cost of Somali Piracy, Jan 12
[6] The European Community Shipowners Association

3 Main scientific and technological results

The main project achievements are described in the below sections. Topics addressed are:

1. Counter piracy measure database and manual
2. Risk and vulnerability module
3. Voyage optimisation module
4. Graphical User Interface – GUI
5. On board decision aid - assessment

3.1 Counter piracy measure database and manual

A Knowledge base and manual to aid in the selection and use of appropriate counter piracy measures in a layered holistic defence. This will provide a powerful planning tool, which will also provide a practical guide to the active and passive counter measures to counter pirate threats, their operational effectiveness, cost-benefits and their legal, economic and societal implications.

Independent review and recommendations about non-lethal technologies for pirate avoidance and opposing the boarding of vessels by pirates.

The current state of the art in countering piracy is based on complying with advice from the International Maritime Organization (IMO) and other maritime authorities and the use of Counter-Measures (CMs). In fact, from the information made available by stakeholders, it appears that to mitigate the risk of piracy or deter pirates, decisions on-board ships appear to be largely based on manuals of best practice, such as the Best Management Practice 4[7] (BMP4), a document defined by the maritime community and disseminated by European Naval Force (EUNAVFOR), IMO and others. These documents list different solutions, which range from passive protection measures to discourage attacks to defensive measures to counter the pirates during an attack. Many of them are readily available, (e.g. barbed wire, fire hoses, maneuvering and increasing speed) and are claimed to have a positive effect on reducing ship and crew vulnerability, but there is little understanding of the CMs' effectiveness in quantitative terms. Moreover, there is not a decision support tool widely available, that could help taking into consideration elements such as the variability of the threat and vulnerability dependency on vessel characteristics, environmental conditions, location, pirate tactics and pirate numbers. Therefore, shipping companies could potentially incur large costs in the adoption of CMs without achieving a significant risk reduction.

One of the aims of PROMERC has been to identify and analyze the different existing and potential non-military protection measures available to shipping companies against piracy[8] and armed robbery[9] (from here on defined

[7] Best Management Practices for Protection against Somalia Based Piracy, Version 4, August 2011

[8] As stated in the Articles 101 to 103 of the United Nations Convention on the Law of the Sea (UNCLOS) (1982) :

Piracy consists of any of the following acts:

(a) any illegal acts of violence or detention, or any act of depredation, committed for private ends by the crew or the passengers of a private ship or a private aircraft, and directed—

(i) on the high seas, against another ship or aircraft, or against persons or property on board such ship or aircraft;

(ii) against a ship, aircraft, persons or property in a place outside the jurisdiction of any State;

(b) any act of voluntary participation in the operation of a ship or of an aircraft with knowledge of facts making it a pirate ship or aircraft;

(c) any act of inciting or of intentionally facilitating an act described in subparagraph (a) or (b)

[9] As defined in the Code of Practice for the Investigation of the Crimes of Piracy and Armed Robbery Against Ships (resolution A.1025(26), Annex, paragraph 2.2): "Armed robbery against ships" means any of the following acts:

(a) any illegal act of violence or detention or any act of depredation, or threat thereof, other than an act of piracy, committed for private ends and directed against a ship or against persons or property onboard such a ship, within a State's internal waters, archipelagic waters and territorial sea;

(b) any act of inciting or of intentionally facilitating an act described above".

simply as piracy). These information have been summarized in a CM Manual that has to be considered an integration document to the internationally recognized manuals of best practice.

The Counter-Measure (CM) manual is a user configurable tool developed with the intent to support end user in their decision process regarding the selection and use of CMs. To populate the CM Manual and underlying CM database a CM Catalogue was created.

The first stepping stone has been the definition of Counter-Measure. After an intense consultation of Subject Matter Experts (SMEs) the two following definitions were agreed:

- Counter-Measure (CM): high level functionalities that are unique, but not necessarily independent. Because of their nature they cannot be substituted one for the other, nor they are mutually exclusive;
- Counter-Measure Product (CMP): different type of products, both technical equipment and non-physical measures (e.g. Standard Operational Procedures - SOPs), that contribute to the functionality of a given CM.

To better understand those definitions a good example is given by the CM Anti-access that has different CMPs associated, such as electrified barriers and sandbags.
CMPs can be categorized in many different ways, therefore the Counter-Measure Catalogue contains for each CMP the following relevant data:

- Associated CM;
- CMP description;
- CMP Posture: expressing if it is a passive or active CMP;
- Information source;
- Legal references: the legal reference in case the CMP is mandatory under international legal regime[10] (e.g. International Maritime Organization - International Convention for the Safety of Life At Sea);
- Time of the day when CMP is effective (e.g. day, night, always, twilight);
- Defence Layer: an onion shaped sequence of progressively more defensive activities, designed to mutually support each other (Figure 3-1);
- Defence Phase: it is a complementary categorization to the Defence Layer, which shows when CMPs most likely apply (e.g. plan, avoid, detect, communicate, deter, defend);
- Time of decision: shows when decision must be made to obtain the CMP (e.g. before the voyage, before entering the area, while in the area or while under attack);
- Action to obtain CMP: which actions have to be taken to obtain the CMP (e.g. procure, install and train, company SOPs, master SOPs, crew training or no follow-up);
- Action to make CMP effective: which actions are required to make the CMP effective once the shipping company obtains it (e.g. install and train, company SOPs, master SOPs, crew training or no follow-up)[11];
- CMP Orientation: indicates if the CMP is ship specific (Ship CMP), that is a CMP which assessment can be conducted on a non-scenario base, or voyage specific CMP (Voyage CMP) for which the assessment is only possible on a scenario base;
- Category: shows the level of ship and crew protection readiness, which can range from the simple implementation of mandatory CMPs to the installation of citadels, through a progressive hardening process;

[10] The CM Manual includes only the 'international and worldwide' mandatory requirements. Single Flag States or regions of states (e.g. EU) can decide to adopt more rigid mandatory requirements that are not included in the manual.

[11] In fact, this information in conjunction with the Action to Obtain CMP and Time of Decision ensures that the CMPs are correctly integrated into the vessel's operations.

- Cost: a symbolic cost that allows the reader to understand the order of magnitude of the costs associated to the adoption of a given CMP. The expressed value is the incremental cost to normal operational cost of the counter-piracy measure. Therefore, to some of the CMPs there will be associated a zero cost although they are not free on the market, as the expenses incurred for their adoption can be accounted as ship's operational costs[12].

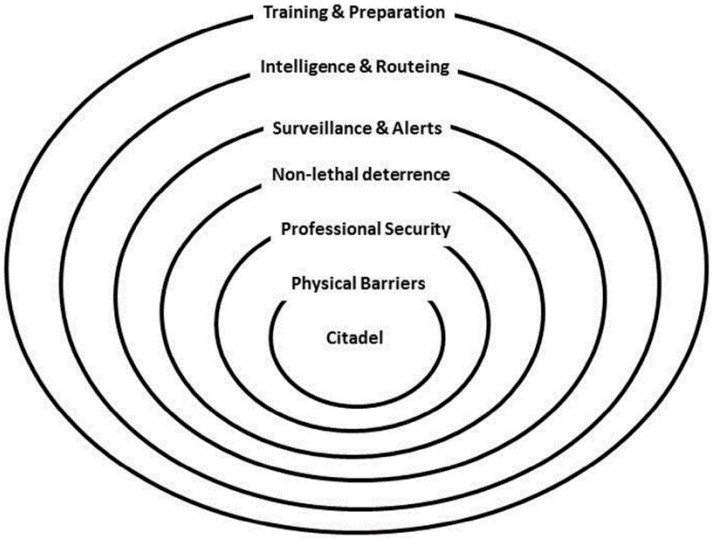

Figure 3-1 Defense layers

Moreover, the CM Catalogue contains information regarding the cost-benefit of the CMP use that are summarized in the following parameters:

- Technical Utility: an index that illustrates the utility of the adoption of a given CMP as a function of its operational effectiveness (more details in Paragraph 2.6);
- Political, Ethical, Economic, Societal, Legal & Environmental factors (see Paragraph 2.4);
- Overall Utility Weight: an index that illustrates the utility of the adoption of a given CMP as a function of its Technical Utility, PEESLE factors and cost (more details in Paragraph 2.6).

3.2 Voyage planning and route optimisation tool

PROMERC has created a prototype voyage planning and route optimisation tool that enables shore based authorities to select appropriate ship specific Counter-Measures and to balance routeing to mitigate risk, against incurring additional fuel costs due to re-routeing and increased speed.

Exposure of the costs and benefits of different options and to create ship and situation dependent risk assessments were key end-user requirements and these underpinned the development of this tool. The concept that was developed in response to this provided multiple possible optimal routes which the user dynamically selected by allocating weightings to risk, speed and cost. This was underpinned by ship specific vulnerability indices and risk surfaces.

The tool is underpinned by the Counter-Measures, PEESLE and piracy knowledge bases and incorporates algorithms developed during the project to:
- Assist the user to optimize the use of different countermeasures in concert.

[12] A practical example of this is the Ship Security Alert System (SSAS) on board ships to which the SOLAS Convention applies. In fact, those ships regardless of the geographical area where they sail need to have a SSAS installed on board. Therefore, the use of the SSAS in case of a piracy or armed robbery incident is free from a counter-piracy perspective.

- Accurately forecast the risk of attack and the probability of a successful attack on specific ships.
- Present options to the user that balance the risk/costs of boarding avoidance and re-routing, thereby minimising overall cost of counter piracy actions.

The PROMERC Pre-planning and routeing tool is shown schematically in Figure 3-2. It consists of 4 key components. Three on the server side comprising: databases, a risk and vulnerability module and an optimisation module and a GUI on the client side. The clients access the system using the GUI to provide inputs regarding the vessel, counter-measures and voyage and to view the optimised routes and risk profiles. The user inputs are used by a module to calculate the vulnerability of the specific vessel and voyage. Look up tables of fuel burn for the vessels are used to calculate cost matrices. The resulting vulnerability and cost matrices are used as by the evolutionary algorithm in the optimiser module to optimise cost, risk and time.

The key components are shown schematically in Figure 3-2 and are described in the following sections.

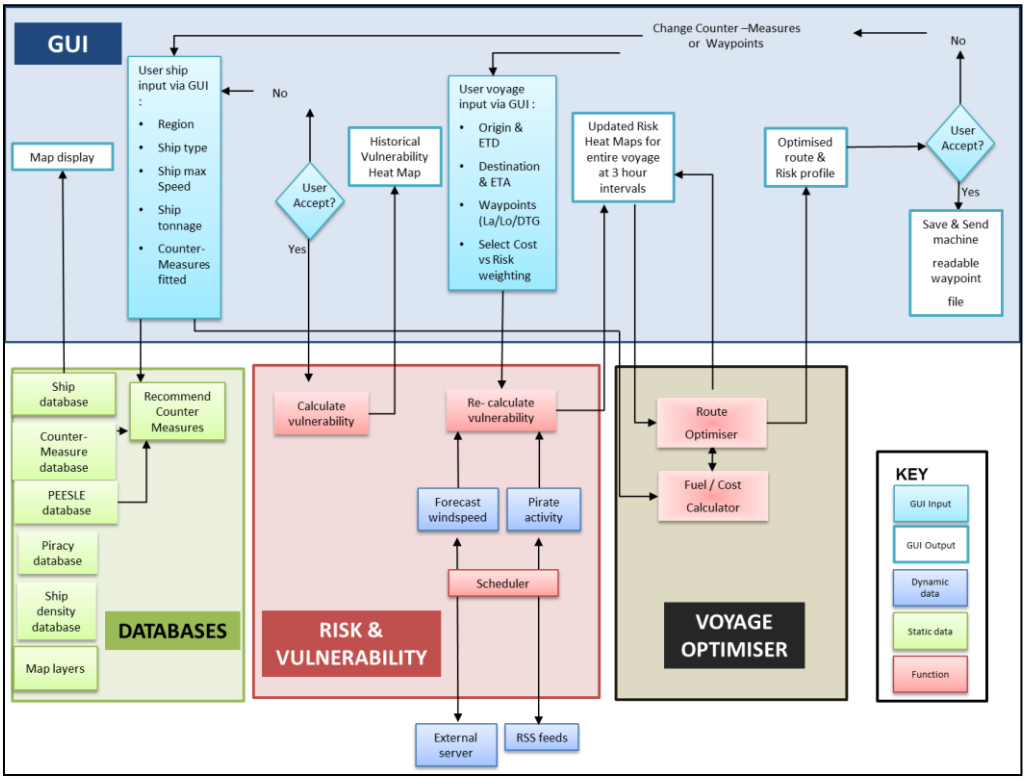

Figure 3-2 Key components of the Route planning and optimization tool

3.2.1 Databases

The static databases are shown in green in Figure 3-2. A piracy event database has been analysed to identify the parameters that contribute to the risk of a pirate attack and parameters that contribute to the risk of being successfully attacked once an attack is underway. Key parameters include: ship tonnage, type, speed and counter-measures, monsoon season, wind speed, day of the week, visibility and location of attack.

Some areas of the world concentrate most of the piracy attacks, so the historical attacks maps have been derived from the piracy database and are used as a background layer for risk assessment. These maps are available for each month of the year as there is often a strong seasonal effect.

For voyages that have already started, weather forecast maps provide wind speed and direction, wave height and direction, visibility and a few other parameters, every 3 hours, out to 10 days. For pre-voyage planning operations, weather forecast maps are not always available and weather information is then provided by a climatology

database. Monthly wind statistics maps are available at 0.25° resolution and form the basis for assessing the risk of being attacked and the risk of being successfully attacked.

3.2.2 Risk and Vulnerability Module

Although historical attacks provide the background for risk assessment, day-to-day pirate activity is monitored and integrated in near real time into the risk heat maps. The most important bits of information in a report are the exact time and location of the attack. This gives a datum that will be used to update pirates' position and uncertainty area over time, based on prior knowledge of pirates' tactics and / or additional information available in the report. A simple pirate tracking function has been developed and provides a means to optimise the pirates' position estimate over time. Current piracy risk is thus integrated into updated risk maps and broadcast as soon as a report is available.

3.2.3 Optimiser Module

Route optimisation is then carried out for the vessel and voyage on the bases of the estimated risk of piracy attack on the voyage and the vulnerability of the vessel and its associated Counter-Measure to a successful boarding if attacked. The risk of the vessel being pirated is traded-off with other objectives affecting the journey schedule. The algorithm is based on a multi-objective optimization approach, which has proven to be very effective as it permits different solutions representing optimal trade-offs among conflicting objectives from which the operator could select the most suitable to his needs.

The optimization starts from a baseline route that can be input by the operator or can be the result of an external service such as weather routeing.

The cumulated risk along the baseline route is then adopted as the reference risk value to be used in the definition of a relative risk metric associated to the candidate routes. The relative risk matrix is represented by the ratio between the risk along the new route and the risk along the reference route. This metric is finally optimized with respect to the waypoints and service speed in trade-off with relative fuel consumption and relative time of arrival providing a set of candidate optimized routes.

A state of the art evolutionary multi-objective algorithm carries out the optimization. The optimizer simultaneously minimizes (or maximizes) conflicting objectives by implementing the concept of Pareto dominance, providing a set of solutions, all of which represent the optimal trade-offs among the selected objectives (e.g. piracy risk, fuel consumption, time of arrival, etc.). Each solution is provided with the associated list of waypoints, service speed, relative piracy risk, relative fuel consumption and differential time of arrival. The end-user is able to select a single solution that corresponds to his/her needs, by assigning more weight to a given objective than the other.

3.2.4 GUI

The user interface is web based and implemented using HTML5/CSS3/JavaScript in combination.
Additional JavaScript libraries such as C3, D3 and OpenLayers have been used to short-cut development time and to enrich the user experience.
The end users have worked closely with the development team in order to ensure that the interface is clear and simple so that users could use it intuitively without in-depth knowledge or training.

The GUI consists of 3 pages that are described in the following paragraphs.

Home page: a map view showing Near Real Time information on pirate activity along with voyages that are underway and the latest ship positions. The map is interactive and users can access additional information through the map.

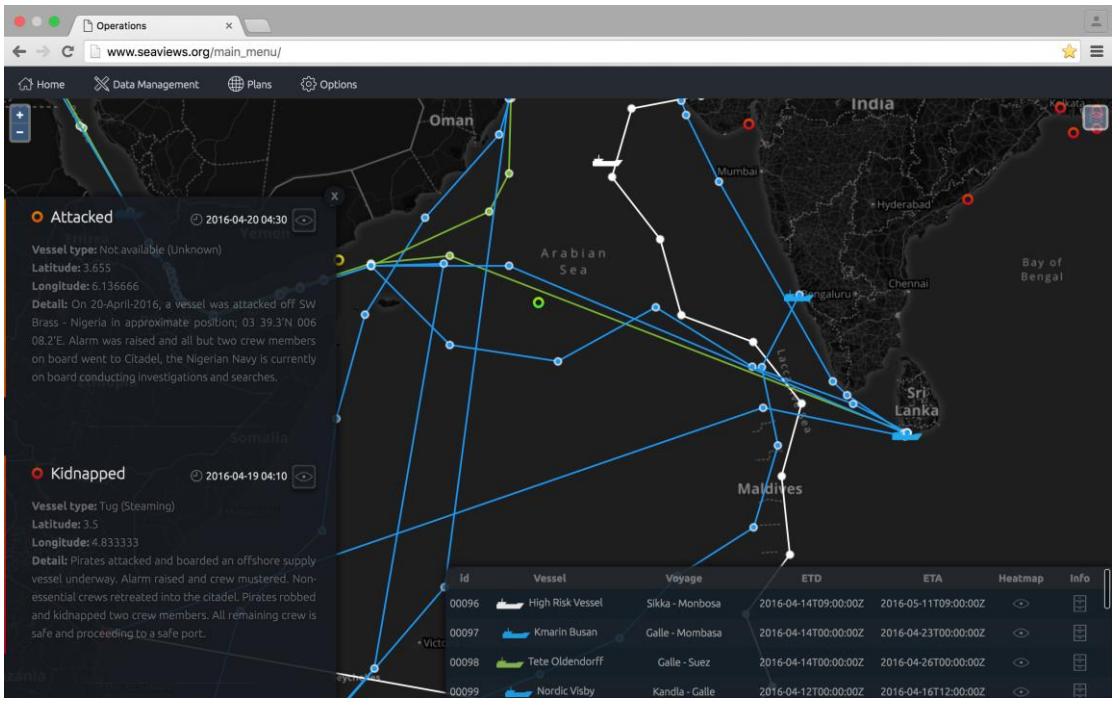

Figure 3-3 GUI Home page

Data management page: consisting of the ship library and providing tools to assess the vulnerability of each vessel and the impact of Counter-Measures on the vessel's vulnerability.

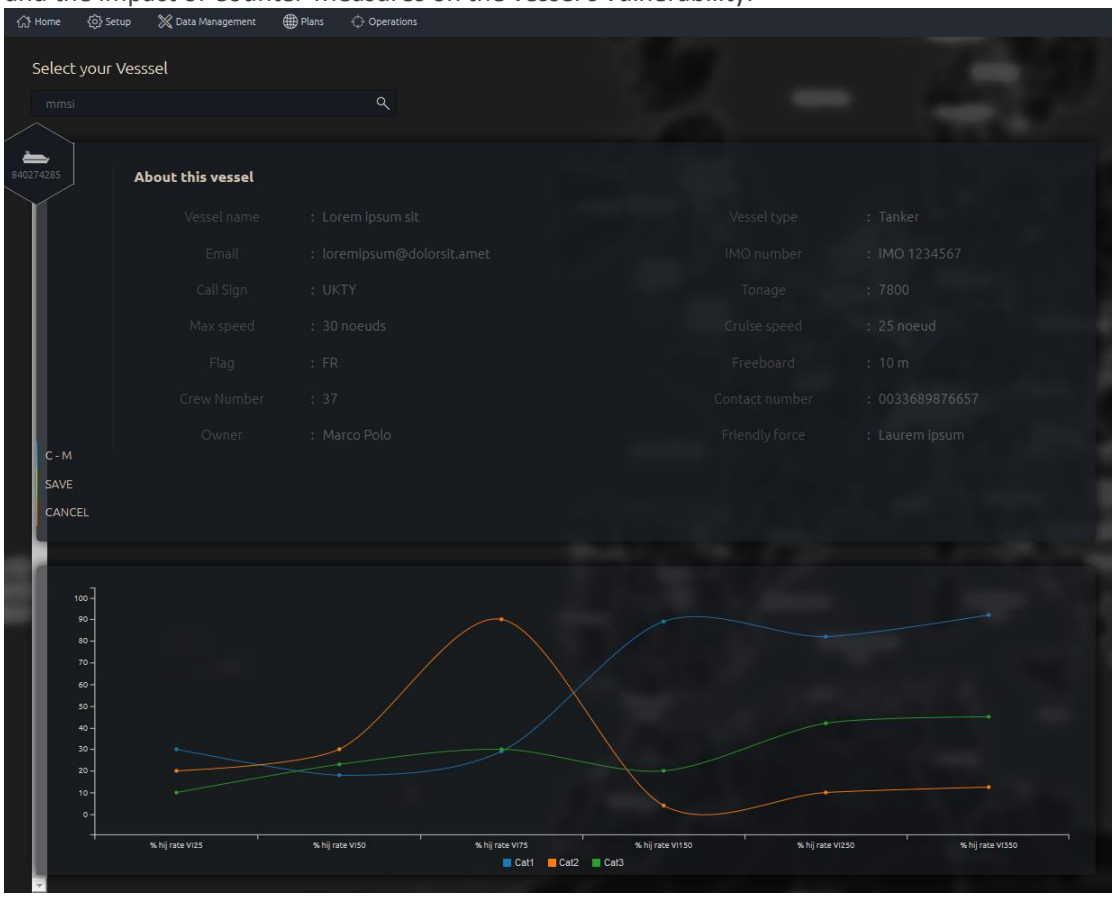

Figure 3-4 Data management page

Plans page: the library of planned and current voyages and route optimisation and selection

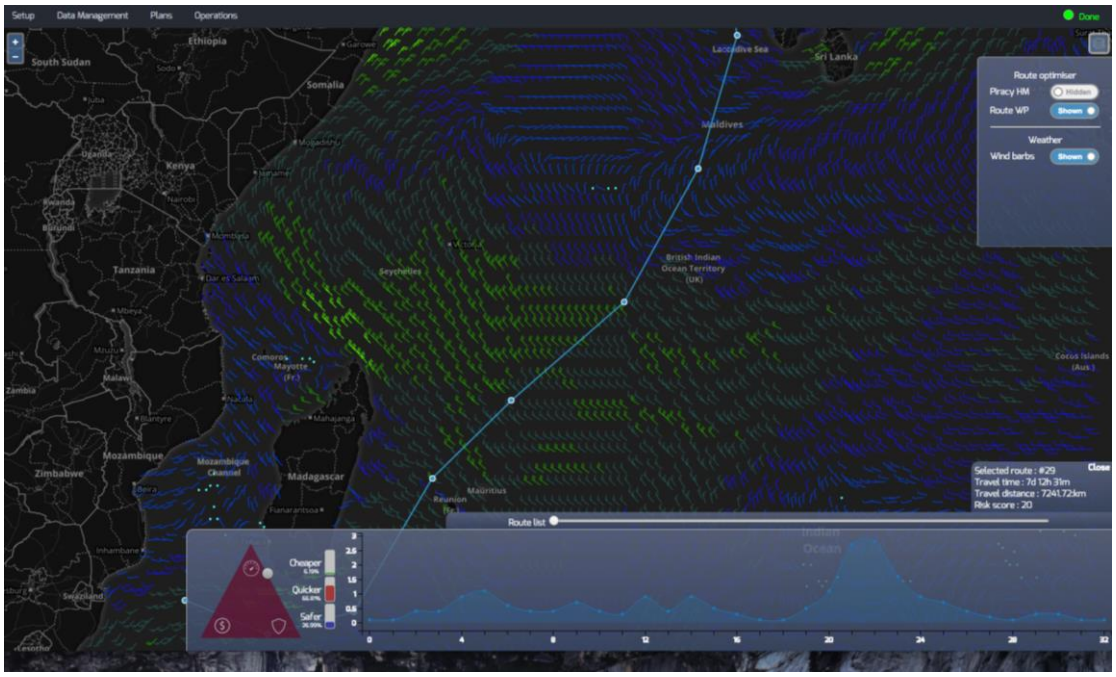

Figure 3-5 Plans page

The user can select a voyage to view or analyse through a table of all planned and underway voyages. The user can then use the triangle to select his preferred balance between risk, time and cost. The optimal route corresponding to the selection is displayed. The selection is overlain on layers showing the risk or selected weather parameters that correspond to the position and time along the route which are indicated both on the map and on the 'hill' chart indicating risk along the selected route. Once the user has made his section the route is saved and available as a machine readable waypoint file which can be sent to the ship.

3.2.5 Assessment

The end-users have been an integral part of the development of the tool and feedback and assessment has been a continual process shaping the concept, system development and leading to suggestions for improvements to facilitate operational usage as well as further development.

An assessment of the predictive skill of the risk algorithms for the Indian Ocean was made using historic data. However no assessment of skill in operational use has been possible to date as there have been no reported piracy incidents in the Indian Ocean during the period of assessment.

3.2.6 Further development

Work is underway to create piracy weighting and forecast risk maps for two additional areas that have become piracy hotspots, namely the Gulf of Guinea and the waters off Indonesia. Consideration is being given to incorporating Satellite-AIS reports in order to update ship positions.

An automated voyage planning support tool to aid shore based authorities, which will balance routeing to mitigate risk against incurring additional fuel costs due to re-routeing and increased speed. (A prototype will be available for use by end-users).

3.3 Automated decision support tool

An automated decision support tool to provide seafarers with real time threat assessment, evaluation of possible courses of action and a recommended course of action and for use by shore based authorities as a training aid. (A prototype will be available for training of capabilities and use by end-users).

3.3.1 Onboard Counter Measures Tactical Decision Aid

The onboard CM-TDA provides the bridge team with two types of counter measure advices; BMP4 advices and manoeuvre advices.

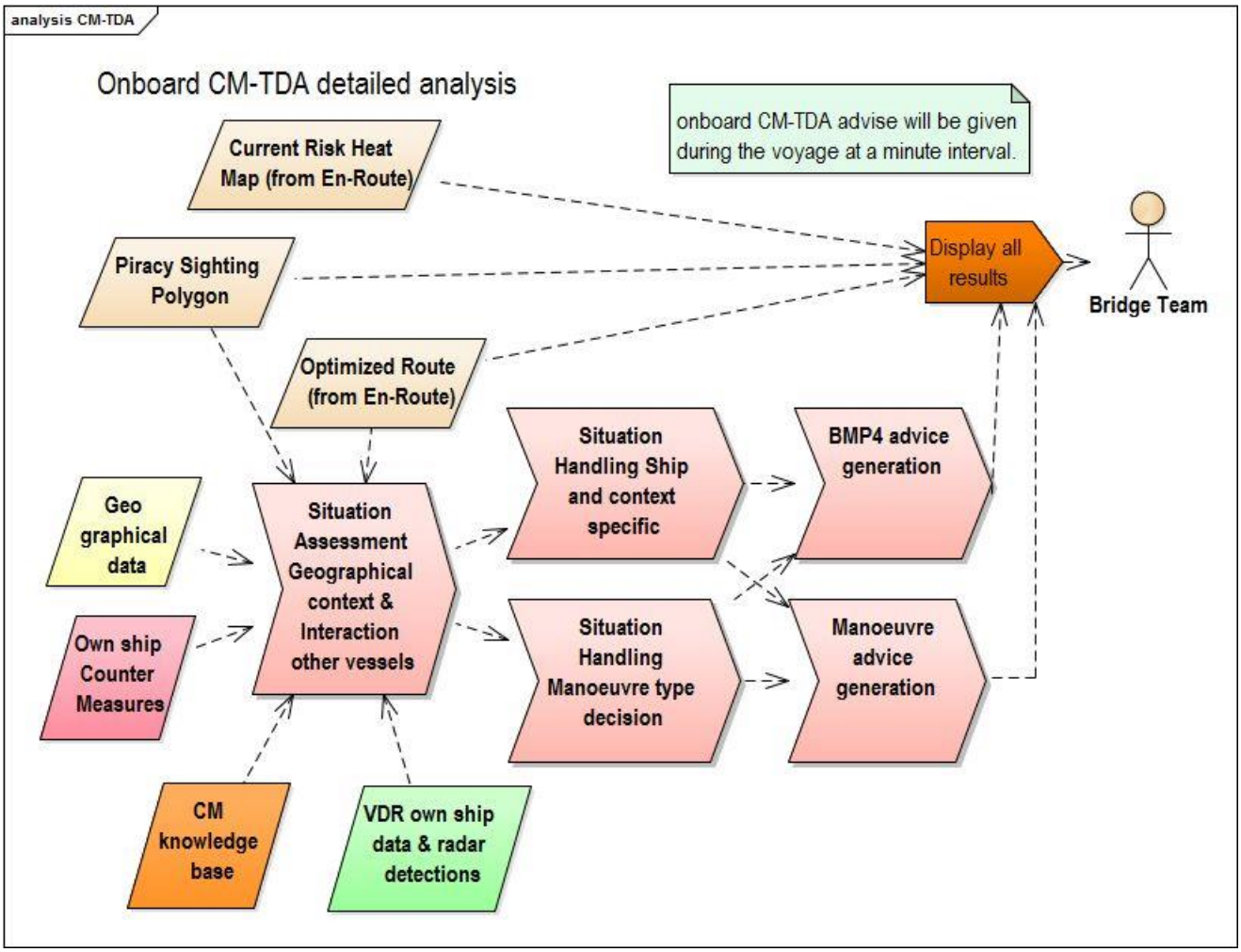

Figure 3-6 Detailed onboard CM-TDA process and data description

The situation assessment components has the links with the information sources for the onboard CM TDA. The databases contain geographical context data, information of the onboard counter measures. The onboard CM TDA receives regular risk map and route updates from the VPST (Voyage Planning Support Tool) and when an incident is reported an immediate piracy sighting report. The onboard CM TDA will immediately generate manoeuvre advice when required. The VDR (Voyage Data Recorder) provides the live stream of information for the onboard CM TDA generating dynamic counter measure advices.

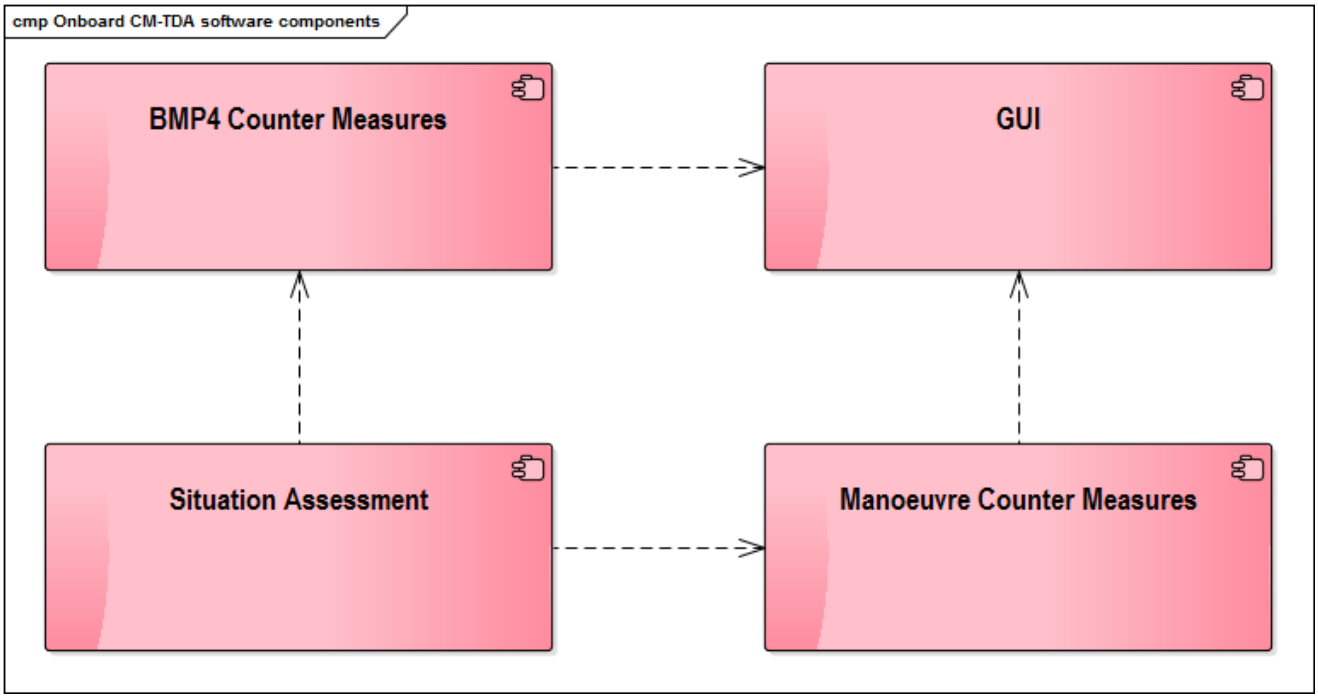

Figure 3-7 The main onboard CM-TDA software components

3.3.2 BMP4 counter measure advice generation

The onboard CM TDA generates BMP4 counter measure advices based on the information received from the situation assessment component. The regular BMP4 reminder advices use the dynamic information as the time of the day, the time to sail into geographical zones e.g HRA (High Risk Area), territorial waters to generate the BMP4 reminder counter measure advice. The counter measures in the defence layers categories; training & preparation and surveillance & alerts are part of the regular BMP4 reminder advice.
The VPST provides the onboard CM TDA with the advices in the defence layer category Intelligence & Routing, with the regular updates of risk maps and route advice.
In case of an encounter with suspect vessel both CM advice components, manoeuvre and BMP4 will generate counter measure advice in parallel. The BMP4 advice on counter measure activation is based on the information from the VDR with relative position of the detected suspect vessel in the neighborhood of the own vessel. The BMP4 CM component considers the activation range and the availability of the available onboard counter measures in the BMP CM activation advice.
The BMP4 counter measure component has counter measure knowledge base which contains two knowledge base tables; Dynamic CM activation advice (22) and Regular BMP4 advice (29).
The PROMERC CM Manual contains 105 counter measures from the different defence layer categories. Of the 105 counter measures 29 were categorized as pre-voyage. The 29 counter measures in the counter measures classes; guards, projectiles and CM's used during attack phase that the pirates are onboard the own vessel were not considered for advice generation as there is not enough information available for system to create reliable advice.
The counter measures were grouped into messages as the screen in the GUI could not deal with the high number of individual counter measure advices. For the dynamic CM activation advice knowledge table with 22 counter measures, 9 messages were created. This knowledge base table stores information for each message on; effective range and activation range. For the regular BMP4 advice knowledge table with 29 counter measures, 14 messages were created. This knowledge base table stores context information; geographical, time of day and preparation time for CM.

Figure 3-8 PROMERC defence layers for piracy counter measures

3.3.3 Manoeuvre counter measure advice generation

The manoeuvre decision aid provides manoeuvre advice when a suspect contact (potential hostile pirate) is detected by the merchant vessel. The three manoeuvres that have been identified in the PROMERC project are ‘avoid being detected’, ‘step aside’, and ‘high-speed escape’.

3.3.3.1 Avoid being detected

If a suspect contact is detected, the merchant vessel should change its course in such a way that it ‘sails around’ the contact and thus stays outside the expected detection range of the contact.

The manoeuvre used for this is called ‘avoid being detected’, and it is calculated by the manoeuvre decision aid such that:
the distance between the merchant vessel and the suspect contact does not become less than the specified ‘avoid being detected safety range’ (i.e. the expected detection range of the contact);
the maximum turn rates of the merchant vessel are taken into account.

An example of an‘avoid being detected manoeuvre’ is shown in Figure 3-9. The merchant vessel is sailing northwards and a suspicious contact is sailing west-south-west. The solid blue circle denotes the merchant vessel’s (radar) detection range, and the dotted circle the assumed contact’s detection range, which must be avoided.

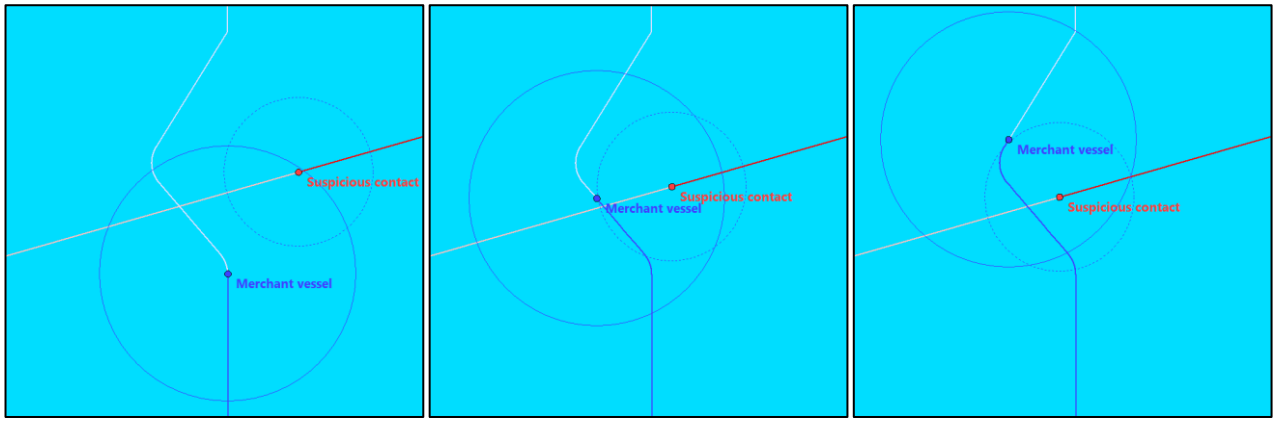

Figure 3-9 Example of an avoid being detected manoeuvre, at various moments in time.

3.3.3.2 Step a side

If a suspect contact is on an intercept course with the merchant vessel, the merchant vessel must change its course in order to determine the contact's intention. This course change must be such that no intercept takes place within a certain range. If the suspect contact changes its course such that it can again intercept the merchant vessel, the contact's intention is assumed hostile.

The manoeuvre used for this is called step aside, and it is calculated by the manoeuvre decision aid such that:

- the distance between the merchant vessel and the suspect contact does not become less than the specified 'step aside safety range';
- the maximum turn rates of the merchant vessel are taken into account.

3.3.3.3 High speed escape

If a pirate starts to attack the merchant vessel, i.e. it changes its course to intercept the merchant vessel or starts to follow it, an 'escape manoeuvre' must be sailed by the merchant vessel.

This 'escape manoeuvre' is called high-speed escape, and it is calculated by the manoeuvre decision aid such that:

- the time needed for the suspect contact to intercept the merchant vessel is maximized (given the constraints);
- the maximum acceleration, deceleration and turn rates of the merchant vessel are taken into account.

3.3.4 Onboard CM TDA GUI

The Graphical User Interface (GUI) of the onboard counter measures tactical decision aid has two map screens and three textual screens. The main map screen can zoom into local map levels and displays all vessels reported on VDR. The second map screen om the bottom right shows overview of the voyage, with actualised information received from VPST on route advice and the current risk map. The three textual screens are for the status information screen at top, the BMP4 advice screen in the middle and the counter measure manoeuvre advice screen at the bottom. In the scenario for the GUI in Figure 3-10 there is no suspect vessel reported so there is no counter measure manoeuvre advice generated.

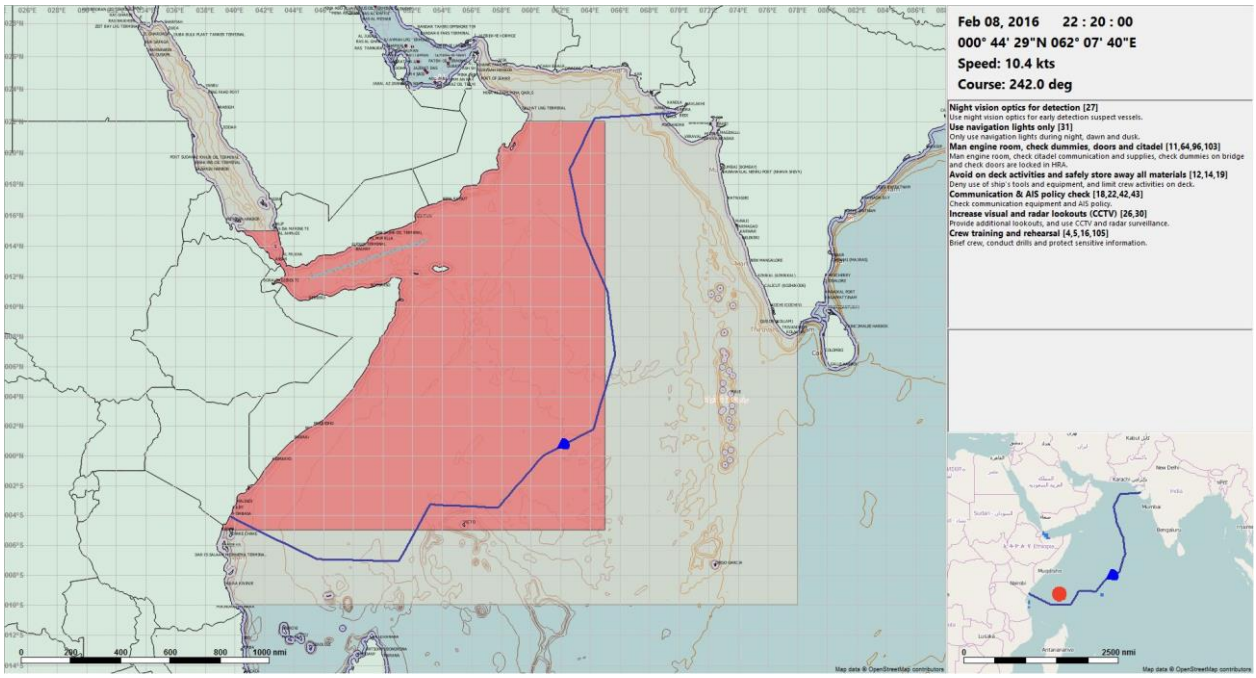

Figure 3-10 Onboard CM TDA GUI during voyage on Indian Ocean. The overview screen on bottom right show the actualised piracy sighting report and risk map

3.4 PEESLE constraints

The Political, Ethical, Economic, Societal, Legal and Environmental (PEESLE) matrix has been a mandated requirement of the project. From the early stages of the work, partners worked with stakeholders on sourcing and assessing factors in each of the disciplines carried by the matrix that could affect the response of seafarers to threats of maritime violence. The project's research and tools development have thus been carried out in no vacuum of contextual considerations.

Working on PEESLE saw a broadly based stakeholders' meeting identify and discuss the relevant factors. The meeting was broken up into smaller groups. The work of the various groups was then brought together to form a collected view of the findings.

This output was then put under study by dedicated researchers, who analysed the factors as against the best available literature. This included laws and regulations operating in the context of the European Union.

Researchers resorted to a necessary scoring assessment of the factors *as against each countermeasure*, in order to meet the varying and relative importance of the underlying considerations. This translated in the form of numeric values on a unitary scale from -3 to +3. A negative value pointed to a countervailing PEESLE factor, meaning that the given factor weighed against the use of the specific countermeasure at hand. On the contrary, a positive score meant that use of the countermeasure was favourable from the point of view of the PEESLE factor under consideration. In the case of a nil score, the individual PEESLE factor was viewed as neutral to the use of the countermeasure.

Scoring was ultimately amalgamated for all factors across the panoply of countermeasures compiled as part of the project.

PEESLE factors and scorings were submitted to a second stakeholders meeting for further examination and corroboration. The meeting undertook the review by using a series of exercises. The discussions were frank and open, and initial scores were in several cases readjusted. In a few cases, PEESLE factors were set aside for their limited impact on countermeasures.

In the process, selectivity was unavoidable given both the wide ramifications of the exercise and the project's limitations.

3.5 Evaluation by stakeholders

The end-users have been intimately involved with the project since inception and have steered the development of the tools through a series of workshops and through assessment of prototypes. Following 2 years of research a stakeholder workshop was held in Portsmouth to disseminate the results of the research and to provide end-users with a chance to use the PROMERC tools.

End-users and stakeholders evaluated 5 elements of PROMERC, the 3 software tools the Ethics Advisory Board and the project as a whole.

The end-users have been an integral part of the development of the tool and feedback and assessment has been a continual process shaping the concept, system development and leading to suggestions for improvements to facilitate operational usage as well as further development.

3.6 End User assessment

PROMERC has benefited immensely from active End-User involvement from the inception of the project both as partners and within the broad stakeholder group and an independent ethical advisory board. Commercial shipping has been represented by Oldendorff Carriers and Moller-Maersk, naval forces by the NATO Maritime Interdiction Training Centre and NATO Shipping Centre, PMSCs by the Security Association fro the Maritime Industry. Their guidance has steered the development of the project and has ensure the relevance of the tools.

3.6.1 Counter Measure Manual

The online Counter Measures manual provides the knowledge base and the ability to filter the information for constraints, cost, and effectiveness to make informed decisions regarding counter measures. The analysis includes ethical and legal constraints on the use of counter-measures, ship specific vulnerability, response time to military intervention and environmental parameters.

This tool is described in detail in Deliverable 3.2 Counter Piracy Measure database.

Details of how to access the Counter Measures Manual as an online tool were given to stakeholders in the Counter Measure Manual Deliverable 3.3. The content of the manual has been revised to incorporate feedback and information arising from subsequent work packages. Login information was also promulgated to the Project Office and assessors prior to the Period 1 review.

During the stakeholder demonstration and dissemination event the manual was presented by Engineering – Ingegneria Informatica (EII) who led the development of this tool in WP3, supported by the NATO Centre for Maritime Research and Experimentation (CMRE) who led the development of the cost benefit analysis and assessment of Counter Measures utility.

The overwhelming response was positive with 50% of stakeholders stating that the stated had been 'Fully Achieved' and 50% 'Mostly achieved'.

3.6.2 Route Planning and voyage optimistion

The exposure of the costs and benefits of different options and to create ship and situation dependant risk assessments were the end-user requirements underpinning the development of this tool. The concept that was developed in response to this provided multiple possible optimal routes which the user dynamically selected by

allocating weightings to risk, speed and cost. This was underpinned by ship specific vulnerability indices and risk surfaces.
Oldendorff were introduced to the tool in an interactive online demonstration on 21 October 2015. The initial feedback was very positive:

> "Very much impressed by the simplicity of the software"
>
> "Like the weather availability – that is a plus"
>
> "Impressed by this product even though it is not fully complete"

This feedback validated the design which was to keep the GUI clean and simple so that users could use it intuitively without in-depth knowledge or training. The Work Package leader responded by making additional weather parameters (wave height and direction and current strength and direction) available for display.

The initial user's manual was produced and distributed in November 2015 and system assessment began. This resulted in a number of changes being made, namely:

Further simplification
The GUI was further simplified by combining the operations and home pages.
Support of longer voyages
The capability was extended to support voyages in excess of 10 days (the limit of the available Numerical Weather Prediction forecasts). After assessment of various climatological and numerical options it was decided to assume persistence for the weather factors adjusted for light levels. STATUS: Complete

Display of Vulnerability Index
The display of Counter Measures was refined to better display the impact of the selected level of protection on the vulnerability of the vessel. STATUS: Complete

Baseline route
The end-user is required to upload a set of waypoints comprising the 'normal' or master's route for the voyage. This is used by the route optimiser as the baseline route which is then optimised. Several issues have been identified and addressed following feedback:

- The format of the latitude and longitude of the waypoints was initially expected to be sexagessimal. However it was discovered that decimal latitude and longitude were readily available within Oldendorff and so the format was adjusted. The capability to create a waypoint file in both decimal and sexagessimal was added to the 'Plans' section. STATUS: Complete

- Initially waypoints files consisted of latitude, longitude and the date and time associated with each waypoint. Oldendorff do not associate date and time with each waypoint and so the route GUI inputs were amended to provide the inputs required by the route optimiser by calculating the speed required between waypoints. STATUS: Complete.

- The format of voyage waypoints files created outside the PROMERC system was initially Comma Separated Variables (CSV). It was found the different operating systems (Microsoft/Apple) and different programs (Wordpad/Excel) add unseen characters to the files which were unexpected by the route planner. The software has been made mode robust to cope with this and plan text (.TXT) format files added as a recommended format. STATUS: Complete.

The difference between the resolution of the navigational charts and the computational grid led to problems with the optimisation if the waypoints were too close to land. STATUS: Complete

Once the issues identified during the initial testing were identified the prototype system was considered to be ready for assessment during operational usage.

The tool was well received with 50% of stakeholders agreeing that the aims had been 'Fully' achieved and all stakeholders agreeing that the aims had been 'Fully' or 'Mostly' achieved. Several suggestions for improvements noted from end-users that would facilitate operational are outlined in the following sections.

3.6.3 Onboard Tactical Decision Aid

The centre-piece of the dissemination and demonstration event was the onboard decision aid which was demonstrated in the bridge trainer. The voyage which was planned using the route-planning tool was then conducted in a mix of real time and time travel in order to demonstrate the full capability of the system in the available time.

The attendees played the role of the bridge team and all enjoyed the experience. Many commented that the experience really made the scourge of piracy real and aided their understanding of the purpose and utility of the tools created in PROMERC.

3.7 Cost Benefit

When considering counter-piracy investments, generally the attention is concentrate at the ship survivability level, looking at the reduction of probability of a piracy attack, which is defined as threat reduction, or at reducing the probability that given an attack is underway it could be successful, which is defined as vulnerability reduction. Rarely the attention is drawn on the fact that shipping companies have to base their business decisions on maximizing the profit of each voyage. Therefore, the investment in CMPs should be analysed not in the light of maximizing the benefit to a single ship, but inasmuch as reducing the cumulative expected cost of piracy for the company.

A Cost-Benefit (C-B) analysis method was set up in order to aid shipping companies to take informed decision with regard to the adoption of CMPs, which would allow to emphasize the need of maximizing the profits of a route. It is important to highlight that the Cost-Benefit analysis aim is to provide support to the end-users, whose professional judgment still remains the main tool to select the most appropriate CMP for circumstances at hand.

A CMP operational effectiveness analysis laid the foundation for the C-B analysis. The result of this analysis has been the calculation for each CMP of the Technical Utility. This parameter is an index, summarizing the CMP's operational effectiveness, taking into consideration only the technical implications of using a certain CMP. In fact, after an in-depth analysis of the past piracy events reported in the International Maritime Bureau (IMB) and in the International Maritime Organization (IMO) databases, it was concluded that it was not possible to conduct a rigorous statistical analysis to calculate the single CMP operational effectiveness due to incompleteness and inconsistency of data. Therefore, a Multi-Criteria Decision Analysis (MCDA) to quantify the operational effectiveness, based on the inputs of Subject Matter Experts with different background (e.g. scientific, merchant mariner, navy, legal, maritime security, etc.), was adopted.

The CMP Technical Utility is then corrected by a PEESLE correction factor, to account for the different PEESLE implications of the CMP use, both positive and negative. This new parameter has been defined as CMP Overall Utility. Figure 3-11 shows how the Overall Utility could be compared to the CMP cost, to easily define trade-offs between the benefit and the cost of adopting a given CMP. In fact, CMPs in the green zone would be the first recommended, with those in the red one not recommended. CMPs in the yellow region should be subject of further discussion to determine when to recommend them. CMPs need to be re-assessed periodically as costs, Technical Utility, and PEESLE factors are able to shift over time.

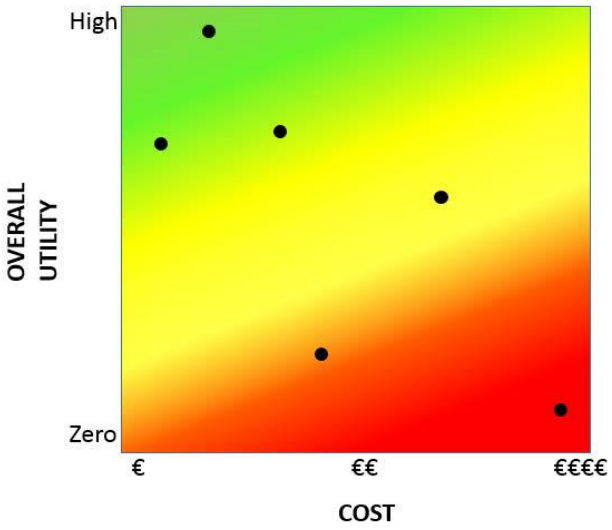

Figure 3-11 Overall utility vs Cost

As mentioned previously CMPs can have two distinct orientations, as they can be ship specific or voyage specific. Currently most CMPs are ship specific with the exception of nine Voyage CMPs, three of which are the most relevant, namely re-routeing, a team of 3 armed guards and a team of 4 armed guards. The other Voyage CMPs are of minor importance as they can be factored in the re-routeing CMP (e.g. region avoidance and coalition assistance) or are reported by the stakeholders to be ineffective (e.g. unarmed guards) or too expensive (e.g. commercial protection vessels).

Given that the cost estimate method for Ship CMPs and Voyage CMPs differs, the C-B analysis had to take into account the different nature of CMPs, allowing for two different CMP assessment methods (Figure 3-12).

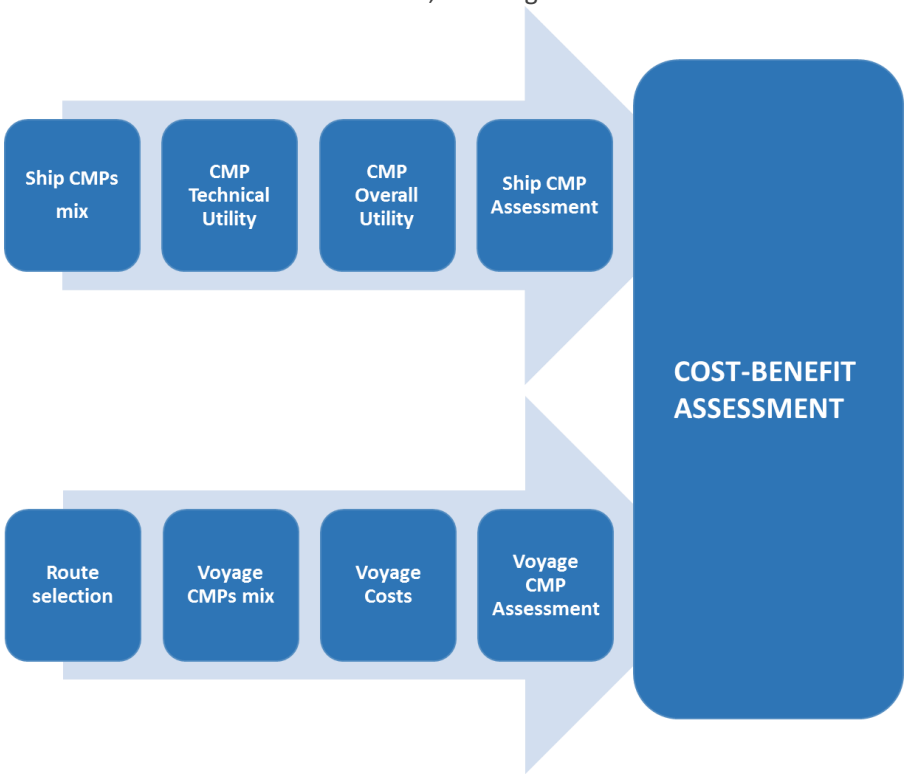

Figure 3-12 illustrates the complete C-B process

A practical limitation of the C-B analysis approach is the inability to consider all the permutations that might occur for each CMP. Therefore, the assessment is conducted on a CMP category level, limiting the number of ship preparedness levels that the user needs to consider to four.

The C-B analysis has been conducted with a dynamic and integrated tool that, starting from the data of the CM Catalogue, can automatically calculate the quantitative C-B elements and the impact of changes made to the available data.

For Ship CMPs the CMP Overall Utility is straightforward weighted against the CMP costs to derive the CMP Overall Utility Weight. This parameter and the selected mix of Ship CMPs, enable a Ship CMP assessment, in which Ship CMP shortfalls to reach a given category are analysed. Moreover, the cost to address these shortfalls is reported, assuming as prioritization parameter the CMP Overall Utility.

The Voyage CMPs assessment needs to be performed in relation to a specific voyage. Therefore, examples of C-B analysis have been provided on the base of representative scenarios, which were selected as the result of the analysis of past piracy events and stakeholder engagement. The adoption of scenarios allowed to calculate the single voyage costs along different routes (e.g. cost of fuel consumption for the reference ship at specific speeds, insurance costs, CMP costs, ship operating costs, return of anti-piracy investment per trip, etc.).

The Voyage CMPs assessment and Ship CMPs assessment results are merged in the final C-B assessment that provides to shipping companies a way of capturing the trade-offs between the cost of different CMPs mixes and the profitability of the route.

4 Potential impact

The overall goal of the PROMERC project is to reduce the vulnerability of EU merchant fleets and maritime supply lines to criminal abduction and extortion and thereby reduce risk to mariners, shipping, and the environment, while also reducing costs. PROMERC therefore fits perfectly as a Capability Project under Area 10.2 “Security of Infrastructures and Utilities” Topic SEC-2013.2.4-2 Non-military protection measures for merchant shipping against piracy.

The PROMERC project addresses the main objectives – improved security for the European citizens by protecting the merchant fleet and enhancing competitiveness for industry. In more detail the proposed research addresses the adverse impact of piracy on:

- The liberty, health and life
- The competitiveness of the shipping industry
- The global trade
- The international community

4.1.1 Impact of on liberty, health and life – addressing the human costs of piracy

Piracy impacts multiple stakeholders, none more so than the seafarers attacked, held hostage, or killed. In 2011, at least 3,863 seafarers were assaulted by armed pirates seeking to hijack their vessel and kidnap them[13]. In 2011 alone, 1,118 seafarers were held hostage by Somali pirates, of which 24 were killed[14]. Seafarers face increased stress and risk associated with transiting through pirated waters, with extreme psychological pressures for those unfortunate victims held hostage on hijacked vessels. They are subjected to assaults with automatic gunfire and RPGs, beatings, and extended confinement as hostages. In some cases, hostages are even used as human shields to protect pirates from navy vessels or are forced to crew “motherships” that are used to lure and attack other merchant vessels

Early 2011 witnessed an increase in pirate activity with more than 700 hostages held aboard vessels off the coast of Somalia. Throughout 2011, however, pirates captured fewer seafarers, reflecting a significant drop in the success rate of pirate attacks. While the decrease is good, the International Maritime Bureau report titled 'The Human Cost of Piracy 2011' released in June 2012 reveals a disconcerting trend. While the number of attacks went down, the severity of attacks has actually become worse and civilian suffering has increased. According to Major General Buster Howes, the British commander of the European Union Naval Force, there are now "regular manifestations of systematic torture" by pirate gangs[15].

The seafarers’ families are an important group of victims that is often overlooked. Families and others who depend on seafarers are faced with stress and fear while a seafarer transits high risk areas. In the case of a hijacking, families live in constant fear and uncertainty of the wellbeing of their loved ones and may be subjected to psychological manipulation from pirates to ensure that ransoms are paid.

PROMERC aimed to reduce the vulnerability of EU merchant fleets to such criminal abduction and extortion, reducing the overall number of hostages and the human cost of piracy by providing seafarers with tools which will enable informed decisions and an improved choice of counter measures in order to avoid, deter and defeat piracy. The tools will support a layered approach employing a mix of active and passive measures which are appropriate to the situation and the threat.

4.1.2 Impact on the competitiveness of the shipping industry – addressing the economic cost of piracy

European shipping industry is a global leader controlling 40% of the global merchant fleet and is active in all kinds of maritime services within Europe, between Europe and third countries and in so called cross trades between non

[13] Ship-technology.com, 28 Jun 12
[14] One Earth Foundation, ‘The Economic Cost of Somali Piracy, Jan 12
[15] Freeman, Colin, “Somali Pirates Raise Ransom Stakes,” The Telegraph, 10 Apr 11

EU continents[16]. PROMERC proposes to strengthen the competitiveness of this significant European shipping trade by minimizing the most important direct cost piracy inflicts on the shipping industry:

Minimising the number of hijackings, payments of ransoms and associate costs

According to the recent report titled 'The Economic Cost of Somali Piracy 2011' by Oceans Beyond Piracy (OBP), total ransom payments collected by pirates in 2011 amounted to $160 million. However, the ransom payment is just one element to consider. The cost of associated services of securing the release of those hijacked – including payments for lawyers, professional negotiators and for the security team making the physical delivery of a ransom also impose significant costs on the shipping industry. Further, there is a high cost of having ships held and out of service. For example, at charter hire rates of perhaps $17,500 per day, a bulk carrier held hostage for six months could cost as much as $3.15 million in unrealized charter hire rates alone. Indeed, according to Stephen Askins of Ince & Co., the excess costs of having ships held hostage for months on end is potentially as large as $20 million for a $4 million ransom[17]. By reducing the risks of having a vessel hijacked, the PROMERC consortium's ambition is therefore to bring about considerable cost savings for the shipping industry.

Minimising additional fuel and time costs

Almost 50% of the total economic cost of piracy comes from increased fuel consumption[18] brought about either through maintaining higher speeds or re-routing around the high risk areas. PROMERC aims to provide end users with the means to minimise the cost of re-routing (in time & fuel) while maintaining a low risk level. This can be done based on an improved Situational Awareness: the improved accuracy and more recent information results in better route recommendations that give maximum protection at only marginal deviation from the most direct route.

Minimising insurance costs

Since 2008, the Gulf of Aden has been declared a "war-risk" zone subject to special insurance premiums; at the beginning of 2011 the "war risk" region was further expanded to include the larger Indian Ocean. Depending on the class of vessel the surcharges of sailing through this area can amount to up to USD 150,000 per ship, per voyage[19]. The two major forms of piracy-related insurance are war risk and in kidnap and ransom (K&R); 2011 the total cost of war risk and K&R insurance was approximately $635 million[20]. However many shipping companies received premium reductions for installing specific equipment (like citadels) or having private armed security on board ships. Maritime insurers are a clearly identified target audience of PROMERC's project result with the object to educate this stakeholder group about the efficiency of various non-military counter-measures. By doing so the consortium hopes to help reduce overall risks and associated insurance premiums for shipping companies that implement the recommended combination of such counter-measures.

4.1.3 Impact on global trade – addressing the risk to maritime supply lines

The Suez Canal and Gulf of Aden provide the key trade routes between the Far East, the Middle East, North America and Europe and unhindered passage for the 30,000 ships that use it annually is essential to global economic well-being and vital maritime supply lines.

The northern coastline of Somalia lying to the south of the Gulf of Aden is a key transit zone for ships passing to and from the Red Sea and the port of Djibouti and approximately 8 percent of the global seaborne oil trade traverses this maritime chokepoint annually[21].

More acutely piracy is hampering the delivery of international food aid to the Horn of Africa, where more than 12 million people are in need of emergency aid as a result of the worst draught in over sixty years. According to the African Development Bank's chief economist Mthuli Ncube piracy has both prevented and delayed vital food aid

[16] The European Community Shipowners Association
[17] One Earth Foundation, 'The Economic Cost of Somali Piracy, Jan 12
[18] Hooper, Eric. "The Shipping Industry and the Spiraling Costs of Maritime Piracy". June 12
[19] Pham; Peter J."Why Piracy Matters", 20 Mar 12
[20] One Earth Foundation, 'The Economic Cost of Somali Piracy, Jan 12
[21] Kunertova, Dominika. Patel, Faiyaz. Richter, Sascha. Trept, Sebastian L. "European Anti-piracy Strategy: Somalian Piracy: Today's Challenge Addressed by an EU Initiative" Apr 12

from being delivered to Somalia. It is forcing relief agencies to use aircraft, which significantly increases cost, or less convenient ports that lengthen delivery time.[22] A new report by the African Development Bank said piracy has been a longstanding problem for aid efforts to Somalia as 80%-90% of food aid arrives by sea. In 2007, the World Food Programme, the UN's food aid agency, reported that the number of ships willing to carry food aid had been cut by half because of the increased dangers faced by ships in Somali waters[23].
Commodore Abdul Aleem of the Pakistan Navy highlighted the impact of piracy on global trade earlier this year when stating that "Piracy has become a major threat in the world as it endangers supply of essential food and energy sources"[24]. Restoring security for the merchant fleet in the area is therefore an integral part of sustaining global trade volumes.
Should the world community fail in effectively tackling piracy and seafarers unions refuse to sail in the infested areas the cost of piracy could be further exacerbated to the point that it would seriously disrupt global trade and the security of the supply chain of goods and energy. PROMERC aims to prevent such a scenario by creating dynamic tools and link a counter-measures database to real time data feeds and create logic and algorithms to assist end users in making decisions that will reduce the vulnerability of global trade to the adverse effects of piracy. The ambition is to create tools that help secure maritime supply lines by aiding the merchant fleets to both avoid pirate attacks in the first place and to mitigate the potential consequences of an attack once they occur.

4.1.4 Impact on the international community – addressing the role of international military support

Somali pirates have so disrupted merchant shipping that over 30 countries contributed military forces, equipment, and vessels to counter piracy activities in 2011, at considerable expense for the international community, to try to prevent vessels in the Gulf of Aden and the Indian Ocean from being hijacked. One Earth Foundation estimates that the total cost of the having these naval forces protect the merchant fleet in the region to be around USD 1.27 billion in 2011. However, naval forces often lack efficiency due to the size of the endangered waters area and the quantity of possible individual targets in the large area of the Indian Ocean. On any given day there will be somewhere in the region of 12-15 naval ships and 3-5 Maritime Patrol Aircraft dedicated to Counter Piracy duties. Whereas the Chief of Staff to EUNAVFOR said that a minimum of 83 vessels would be required to guarantee a one hour response time from a naval ship to reach a merchant ship being attacked by pirates[25]. As it is highly unlikely that such a scale of naval resources ever could or would be deployed in the Gulf of Aden and the Indian Ocean it is therefore a need to further optimise the use of the military support actually on location. PROMERC hopes to shift the emphasis from intervention power to information power. Accurate and timely information on piracy behaviour and piracy intent will have to be provided either by already available "military" systems or by dedicated civil agencies to better protect the merchant fleet.

4.1.5 Impact on the Marine Environment – addressing the risk of an environmental disaster

Keeping in mind the increasing level of violence observed during the recent pirate attacks (the use of heavier weaponry, like Rocket Propelled Grenades), pirate attacks pose a serious threat to the marine environment. Large oil tankers pass through the Gulf of Aden and the danger exists that a pirate attack could cause a major oil spill in what is a very sensitive and important ecosystem. During the attack on the Takayama in 2008 the ship's fuel tanks were penetrated and oil spilled into the sea[26]. The consequences of a more sustained attack could be much worse. As pirates become bolder and use ever more powerful weaponry a tanker could be set on fire, sunk or forced ashore, any of which could result in an environmental catastrophe that would devastate marine and bird life for years to come.

The research aimed to develop and demonstrate the technologies and knowledge for building capabilities needed to ensure the security of the European merchant fleet from threats such as piracy, terrorism and other crime. The below table summarise how PROMERC contributes towards the expected impacts listed in the work programme and the call text and what steps that will be taken by the consortium to bring about these impacts:

[22] Curnow, Robyn. CNN . "Piracy delaying vital food aid from reaching Somalia" 3 Nov 11
[23] Tran, Mark. The Guardian, "Piracy hampers delivery of aid to Somalia" 11 Aug 11
[24] Maritime Sun "Piracy a major threat to food and energy supply" Jun 12
[25] Colonel Richard Spencer RM, Chief of Staff EUNAVFOR 14 Sep 10.
[26] Middleton, Roger. Chatham House "Piracy in Somalia - Threatening global trade, feeding local wars" Oct 08

Expected impact of Topic SEC-2013.2.4-2 Non-military protection measures for merchant shipping against piracy	PROMERC Compliance	Comment
Relevant civil stakeholders / end-users should be provided with an exhaustive practical guide on active and passive contemporary measures to counter pirate threats and their legal, economic and societal implications	Yes	A Counter Piracy Measures Manual (D 3.3) to aid in the selection and use of appropriate active and passive counter piracy measures in a layered holistic defence will be produced in WP 3.5. It will include all inputs, results, conclusions and recommendations from cost benefits and operational effectiveness analyses, as well as legal limits/necessities and the level of societal acceptance of the various measures. The manual will also be available as a user Counter Measures database and Planning Tool (configurable by End-Users) which will be produced as D 3.2. The end-users will be able to filter Counter Measure to achieve the desired level of protection, cost and compliance.
Advantages and disadvantages of active and passive contemporary measures should be highlighted and realistic improvements proposed	Yes	These will be included in the D 3.3 Counter Piracy Measures Manual, D 3.2 the Counter Measures database and Planning Tool (configurable by End-Users) and further developed in the logic underpinning the prototype Onboard Counter Measures Decision Aid produced in D 4.1 and in the Recommendations on the further development of Counter Piracy Measures Recommendations D 5.2.
Results should be presented in a well structured and functional way (e.g. in form of a manual) to aid in the usage and further development of counter piracy measures	Yes	The Decision Support Tools and Manual produced in WP 4 will be evaluated by our Reference Group of end users in WP5. They will produce recommendations on the further development of the manual, decision Support tools and other counter piracy measures to aid in the usage and future development.
An automated decision support tool can aid the operator with real time threat assessment and help him determine the best course of action in case of a threat. Such a tool could also provide training and planning capability	Yes	D 4.1 the prototype Onboard Counter Measures Decision Aid will provide sea farers with real time threat assessment, evaluation of potential evasion measures that could be employed and the recommended combination of such. This tool will be evaluated by our stakeholder group which includes the NATO Maritime Interdiction Operations Training Centre who will assess the utility of the tool to assist in training. Re-routing and recommended actions are based on a low risk – low cost optimisation.

4.2 How did the research address these threats?

As discussed under point two of this Societal Impact Checklist PROMERC will produce 4 important tools with the ambition to reduce the vulnerability of EU merchant fleet:

1. A Counter Piracy Measures Manual (D 3.3), also available as a user Counter Measures database and Planning Tool configurable by End-Users (D3.2)
2. A prototype Onboard Counter Measures Decision Aid (D 4.1 – a software application)
3. A Prototype Pre-voyage planning and routing tool (D4.2 – a software application)
4. Recommendations on the further development of Counter Piracy Measures (D. 5.2)

The consortium strongly believes that these tools are an important step in the right direction to systematically address the threat of piracy to merchant shipping. By providing a ship master planning a voyage or currently

underway in a piracy prone area with all the information relevant to the situation of his ship in a clear and effective way PROMERC will maximise the probability that the ship will not come under attack and if so, that the attack fails by means of a simple guide that takes into account as many current inputs as possible and provides recommendations on best possible actions.

Essential information, such as sea state and wind speed, that impacts the probability of a successful attack on a ship varies significantly in time and space. As time to make a decision is critical when under attack, this consortium believes that an automated decision tool is extremely important to helping reduce the hijack success rate. The proposed research will develop such a tool that includes real time information and provides the operator with the fastest and most accurate way to assess threat, to evaluate possible courses of action and make the best decision.
The tool will also have a planning and training capability for shore based operation. The specific aspect of this capability is to balance routeing to minimize piracy risk against additional costs due to increased fuel consumption and time delay. All available information at run time, including wind and sea state high resolution forecast maps will be included in the tool.

Quantification of counter measure effectiveness by combination of expert stakeholders and advanced modelling tools will bring significant improvement in the selection process and usage of individual and combined components of a defence system and thus on the overall capability of a ship to prevent, deter or repel an attack.
The consortium will bring its experience in a decision support modelling tool that will identify the dominant features of many diverse and complex scenarios. Morphological analysis has for instance been used by CMRE in the development of maritime security scenarios for serious gaming.

5 Dissemination activities

5.1 Major dissemination activities

5.1.1 Movie

To explain the major achievements and the overall approach of the PROMERC project there is a movie created within the project and placed on the website and at YouTube.

Figure 5-1 Promerc Movie

5.1.2 Website

The PROMERC website (www.promerc.eu) was created at the start of the project and displays all major achievements and the approach of the project. Further, all public results are available for download.

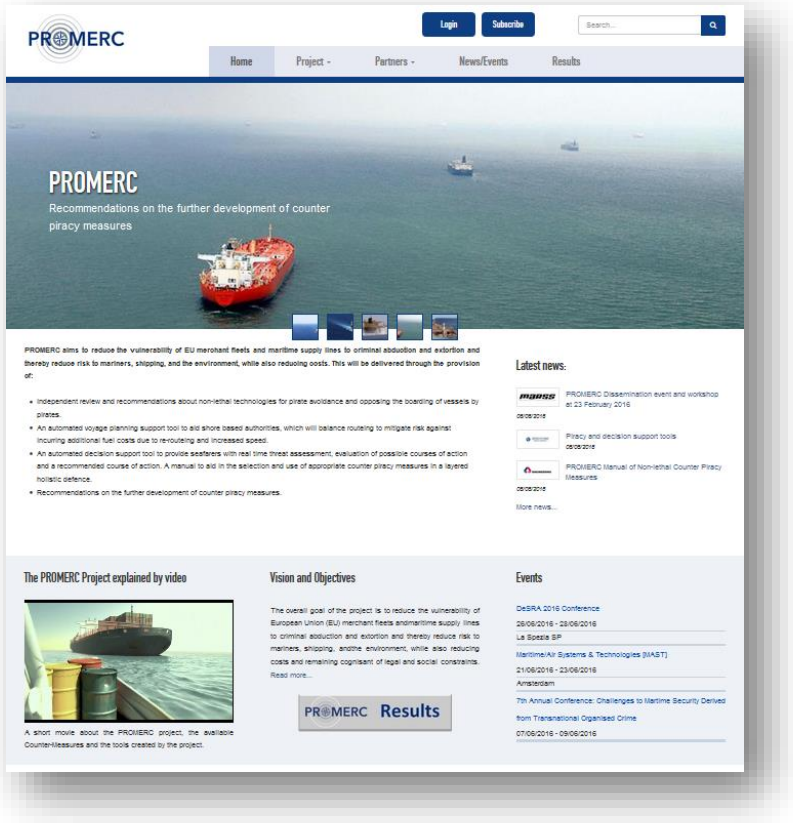

Figure 5-2 Project Publci website – www.promerc.eu

5.1.3 Workshop

The PROEMRC project organised a final workshop in Portsmouth to show and demonstrate the major achievements on the project to invited stakeholders, including the Commission Project Officer.

Figure 5-3 End user workshop Portsmouth

6 Website and relevant contact details

PROMERC Protection Measures for Merchant Ships	www.promerc.eu	EU-project
marss Marine & Remote Sensing Solutions	Coordinator www.marss.co.uk	United Kingdom
S&T organization	www.cmre.nato.int	Belgium
WMU WORLD MARITIME UNIVERSITY	www.wmu.se	Sweden
University of the Aegean DEPARTMENT OF SHIPPING, TRADE & TRANSPORT	www.stt.aegean.gr	Greece
UNIRESEARCH	Project management www.uniresearch.com	The Netherlands
TNO innovation for life	www.tno.nl	The Netherlands
ENGINEERING	www.eng.it	Italy
oldendorff	www.oldendorff.com	Germany

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http://cordis.europa.eu/fp7/cooperation/home_en.html

http://ec.europa.eu