End-users Co-create Shared Information for a More Complete Real-time Maritime Picture

Harri Ruoslahti[1] and Ilkka Tikanmäki[2]
[1]Laurea University of Applied Sciences, Vanha maantie 9, 02650 Espoo, Finland & University of Jyväskylä, Seminaarinkatu 15, 40014 Jyväskylän yliopisto, Finland
[2]Department of Warfare, National Defence University, Kadettikouluntie 7, FI-00861 Helsinki, Finland

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Abstract: European Union Member States are working towards an integrated maritime surveillance and deeper information sharing and implementation of Common Information Sharing Environment. Value networks aiming at co-creation, need active facilitation, and relevant platforms for open cooperation. This study analysed scenario analytics, and narrative documents from projects CoopP, CISE, and MARISA by using a Data Extraction Table to classify both objects and phenomenon relevant to European maritime information sharing systems. The object and phenomenon rows are grouped under a European Coast Guard Functions, CGFs framework, to better understand their occurrence and interdependencies. This paper finds that objects and phenomena need to be continuously evaluated against evolving risk and treat scenarios and end-user needs. Shared maritime information systems need to include tools for continuous self-revaluation. Added complexity may greatly reduce the time to value creation and innovation, which in this context is the ability to create greater common knowledge, learning, and value. Thus, faster and more widely shared information on objects and phenomena result in an accurate Recognized Maritime Picture, which supports threat assessment, asset and operations planning, and sharing of resources for added safety and security on the European maritime domain.

1 INTRODUCTION

"The overall objective of the Cooperation Project is to support further cross-border and cross-sectoral operational cooperation between public authorities (including EU Agencies) in the execution of the defined maritime functionalities, with a focus on information sharing across sea-basins. The project is one step towards the Common Information Sharing Environment, or CISE" (HELCOM, 2017).

The European Union with its Member States work towards an integrated non-military maritime surveillance and deeper coordination in information sharing. This development is demonstrated in putting wide European resources in the development and implementation of wider cooperation processes and platforms and a Common Information Sharing Environment – CISE (PERSEUS, 2017; EUCISE2020, 2017; European Commission, 2015). EUCISE2020 aims to achieve pre-operational information sharing between maritime authorities in different European States (EUCISE2020, 2017); the Cooperation Project, CoopP, is an integral part of this development; as is project MARISA, which seeks to strengthen the information exchange needed to optimize the surveillance of the EU maritime area and borders (Laurea, 2017). Together these EU-wide projects show that European authorities on the maritime domain can and need to cooperate.

The main contribution of this paper is that it raises the issue that technical systems, such as CISE, require shared, frameworks of content, on which human processes of operation can be based on. This practical case study aims to serve its part in filling some of this research gap. This study contributes, as a relevant part of project MARISA, by, in a rigorous way, identifying what objects and phenomena information systems and platforms used to share data between authorities on the maritime domain should contain.

Theoretically this paper draws from co-creation theory and the collaboration framework by Ruoslahti, (2017). Active stakeholder participation can be achieved through defining common aims, and the foundation of cooperation is openly shared

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information. This will require both open cooperative and co-creative processes, and tools, such as information systems to share the needed data. Any value network that aims at co-creation, needs not only active facilitation, but also relevant platforms and tools for open cooperation (Figure 1) (Ruoslahti, 2017, p. 15). This paper sees that CISE is a cooperation platform for open cooperation between and active participation by authorities as in figure 1.

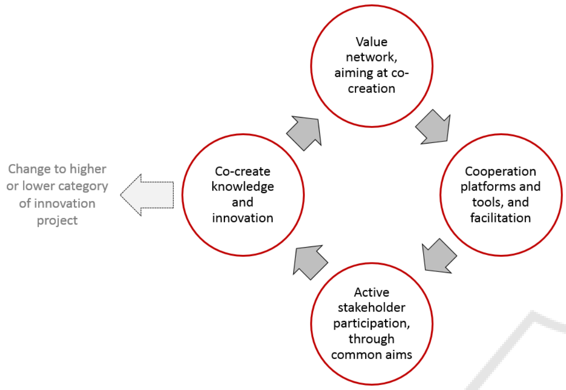

Figure 1: Cyclical connections in co-creation projects (Ruoslahti, 2017, p. 15).

This cycle of co-creation is completed when knowledge and innovation becomes co-created. Depending on the outcome and evolution of the co-creative cooperation, the network may continue on the level of a similar co-creation cycle, regress, or evolve to a more complex level of cooperation.

Based on defined use cases the EUCISE2020 based CoopP project identified and classified, in its WP3 (Scaroni, 2014), seven main groups of risk: (1) Illegal, unreported and unregulated fishing; (2) Illegal oil discharges or Environmental destruction and degradation; (3) Counterfeit goods; (4) Irregular immigration; (5) Trafficking in human beings; (6) Trafficking of drugs; and (7) Piracy. This paper combines this classification with that of a framework of European Coast Guard Functions, CGFs, as its basis of analysis to answer the research question of this study:

RQ: What objects and phenomenon should modern common use maritime information systems produce for its users to gain a more complete real-time maritime picture?

The structure of this paper is (2) Authorities on the Maritime Domain, (3) Method, (4) Results, (5) Discussion and Conclusions.

2 AUTHORITIES ON THE MARITIME DOMAIN

"Situational awareness is one of the starting points for feeling safe and secure. Maritime surveillance is the cornerstone of situational awareness at sea. It is also written in integrated Maritime Policy in EU which aims among other objectives to ensure the safe and secure use of European maritime area and protection of European Sea Borders" (de Arruda Camara, et. al., 2012, p. 5).

European Maritime Policy has adopted an integrated and cross sectorial approach to respond to the various challenges that the authorities serving the European maritime domain face. These authorities, which are responsible for safety and security at sea are many, and member states are organized very differently in their ways of organizing the responsible authorities covering the various tasks needed on the maritime domain.

Frontex, which recently became the European Border and Coast Guard Agency, facilitates cooperation between national law enforcement, customs and other authorities operating in the maritime domain. (Frontex, 2017). Joint multi-purpose operations, may include personnel, vessels and aircraft from different authorities from various Member States.

To ensure continuous improvement in safety and security on the maritime domain, the European Union has classified the activities promoting safety and security on European waters as European Coast Guard Functions, CGFs, which aid coordinate the work of the different authorities. The European Coast Guard Functions Forum, ECGFF (2014) categorized ten CGFs (Ruoslahti & Hyttinen, 2017), and the results of this study are structured be these CGFs.

On the European level there are four more major Coast Guard Cooperation Networks as frameworks for sharing best practices and relevant information between coast guard authorities. They all have a similar regional maritime focus in maritime safety and security, environmental protection, combat of cross-border crime, and enhancement of information exchange (de Arruda Camara, et. al., 2012; Ruoslahti, 2013).

The Baltic Sea Region Border Control Cooperation, BSRBCC, for example, is "a flexible regional tool for daily inter-agency interaction in the field of environmental protection and to combat cross-border crime in the Baltic Sea region, with a maritime focus. Cooperation Partners are Police, Border Guards, Coast Guards and Customs Authorities." (BSRBCC, 2013).

There are also other frameworks that bring together the dispersed authorities on other European maritime fields, and they all exchange information directly within each other. Multinational military maritime surveillance cooperation began between Sweden and Finland as the Sea Surveillance Co-Operation Finland Sweden cooperation, and has broadened to include eight Baltic Sea countries as Sea Surveillance Cooperation Baltic Sea. "Today Maritime Situational Awareness is continuously shared between the participating parties benefitting at the same time maritime safety, maritime rescue, maritime assistance, VTS, maritime environmental protection, maritime security and law enforcement in the Baltic Sea region" (SUCBAS, 2013). Other cooperation networks on the Baltic maritime domain include the European Maritime Safety Agency, EMSA (EMSA, 2013); the Baltic Sea Task Force on Organised Crime (CBSS, 2017), and the Helsinki Commission – HELCOM (HELCOM, 2017). These examples of various frameworks show the complexity of cooperation regarding safety and security on the maritime domain – across Europe.

2.1 Authorities and Co-creation

Ruoslahti and Knuuttila (2011) note that listening to different types of end user representatives is important to successfully communicate the total range of end user opinions and needs. Networks of co-creation "can demonstrate new knowledge on how a cooperation should work in the future (e.g. in SAR) – not only technically, but also as a process to change the current mind-sets to cooperate more and share information to benefit the security and safety…" (Ruoslahti & Hyttinen, 2017, p. 104).

Safety and security on the maritime domain begins from the vessel level. Empowering a ship's crew is important in creating a self-regulating culture, as managing safety on board is "leadership and management of the people living and working in the ship. The execution of safety measures lies within the seafarers and their masters working at sea" (Salokannel, et. al., 2015, p. 12). Managing crisis on board prevents harm and damage, and the goals in managing communication in crisis are: (1) empowerment, (2) understanding, and (3) cooperation.

Ruoslahti and Knuuttila (2016) apply the concept of issue arenas (Luoma-aho and Vos, 2010) to the interaction between stakeholders in cooperation networks. Through the life-cycle of a project, the number of stakeholders – end users, industry, NGOs, authorities, and academia – that participate in the communication should grow, as the project progresses. (Henriksson, Ruoslahti, & Hyttinen, 2017, p. 11).

Ruoslahti (2017) notes that as networks become structured based on different aims. Complexity is greatest in multiple-stakeholder co-creation projects that benefit innovation network stakeholders, where roles between stakeholders are in fluid and constant change, and open innovation environments – such as a CISE –facilitates communication and interaction.

2.2 Applying a Business Point of View on Co-creation on Authority Networks

From a business point of view, mapping end-user processes and practices can identify opportunities for encounters to support the co-creation of value (Payne, Storbacka & Frow, 2008). Co-creation allows companies, communities, and customers to create value through interaction (Dawe & Sankar 2016). Multi-stakeholder networks, as an organizational structure, allow collective actions over national boundaries, participation is voluntary and both objectives and actions can be negotiated among participants (Roloff, 2008). Value networks that aim at co-creation require active stakeholder participation, and this is best achieved through common aims. Innovation networks need these to promise benefits for every concerned stakeholder (Ruoslahti, 2017).

Saarinen (2012) points out that developing services cannot be totally user-based, but that a design process includes several actors' problems, goals, and actions, which may differ in preference. Co-production with customers supports organizational innovativeness (Luoma-aho, et.al., 2012), knowledge is value, and stakeholder services and systems depend on the resources of others to survive, and to co-create this value (Pirinen, 2015; Ruoslahti, et. al, 2011). True co-creation is an interactive and complex learning process, where information as a key resource and trust a key component (Ruoslahti, 2017).

2.3 Co-creation of Knowledge through a Common Information Sharing Environment

Change and development require new thinking from organizations, and end-user participation is an activity, strategically structured by the organization coordinating the innovation project. Networks and learning within them only become constructed by interaction. Tools that promote information sharing, cooperation, and open innovation can bring advantages (Ruoslahti, 2017), and networking is very important in developing services (Tikanmäki, Tuohimaa, & Ruoslahti, 2012), as well as for smooth cooperation in technical development projects, where it is important that developers and potential end users work closely together (Ruoslahti, et. al., 2010).

Project MARISA is working towards the common use of existing and future on-line platforms to serve as a cooperation tool for European-wide maritime authorities. The project "seeks to address the need to strengthen the information exchange to optimize the surveillance of the EU maritime area and its maritime borders" (Laurea, 2017).

Active co-creation processes require tools and environments for cooperation to foster knowledge sharing and long-term relationships (Ruoslahti, 2017), as truly co-creative cooperation is cyclical and on-going. To achieve innovative outcomes, co-creation requires a strategy, and relationships require time and active management to develop, supported by the internal structures of all stakeholder organizations (Figure 1). Identifying key success factors helps facilitate and monitor these cooperation processes. In creating common aims, it is important "to understand the multiple points of view, different values and individual aims that the multiple stakeholders in the innovation network may have" (Ruoslahti, 2017, p. 7).

3 METHOD

The aim of this study is to identify the objects and phenomenon that modern common use maritime information systems should produce for a more complete real-time maritime picture. Users of the system can make better informed decisions when they have a comprehensive picture of what objects and phenomenon are out there, how they might evolve in time, and what effects these developments may have. This paper identifies relevant objects and phenomena needed in common information sharing. A European wide CISE, will support this desired development, which this paper is in part promoting.

This study draws from use case and scenario narratives, and scenario analytics gathered and developed in projects CoopP, CISE, and MARISA. The data collected, was submitted to a structured desktop analysis, where objects and phenomena were first identified, then placed as rows on a Data Extraction Table, DET, which was developed in Excel as an analysis tool for this study. The objects and phenomena were further classified under one of the ten CGFs that this paper uses as part of its analysis framework (ECGFF, 2014; Ruoslahti & Hyttinen, 2017): (1) Maritime safety and vessel traffic management; (2) Fisheries control; (3) Maritime border control; (4) Maritime surveillance; (5) Maritime security; (6) Maritime customs activities; (7) Prevention of trafficking and smuggling; (8) Maritime environmental response; (9) Accident and disaster response; and (10) Search and rescue at sea.

The DET is structured so that each individual object or phenomenon is classified under a CGF (rows), and as an object or phenomenon (columns). Also the main category of risk (Scaroni, 2014) were listed under each CGF on the title row in red. Columns in the DET are *Category of Coast Guard Function*, *Object*, and *Phenomenon*. Also the DET makes a difference between *Observations* and *Actions*. Under Observations are listed all objects and phenomena that are produced by outside agents, and under Actions all objects and phenomena that pertain to the assets and resources that the authorities have to respond to the objects and phenomena produced by these outside agents.

Issues that were clearly common to all categories of CGFs appeared, and to avoid repeating them under each category, one additional class *General common to all* was added. The issues that are shared by all CGF classifications were listed here. Besides serving this study the DET is intended to serve as an individual tool in project MARISA to better understand what objects and phenomena level information end-users need shared for a more complete real-time maritime picture.

In the results section of this paper is structured by grouping the ten CGFs under five subtitles: 4.1 Maritime Safety and Vessel Traffic Management; and Maritime Surveillance; 4.2 Accident and Disaster Response; and Search and Rescue at Sea; 4.3 Maritime Border Control; Maritime Customs Activities and Prevention of Trafficking and Smuggling; 4.4 Maritime Security; and 4.5 Maritime Environmental Response; and Fisheries Control.

4 RESULTS

There are six issues identified that are common to all categories and functions of EU-CGF. (1) Anomaly detection, classification and threat assessment; (2) Prediction of the operational maritime picture; (3) Threat assessment; (4) Intervention plans; (5) Address underlying problem that stimulated the threat; and (6) Mission Planning and Decision Support. All these six topics generate needs to identify objects and phenomenon on the maritime domain.

Anomaly detection, classification, threat assessment, and alert operators is key. To gain a Common Operational Picture from different contributors will aid to classify the threats, evaluate their seriousness, and predict possible impacts. All this information are needed to protect potential victims of any potential incident. Accurate real-time information will help support rapid decision making, planning operations, and operations asset planning for the most accurate and rapid response possible.

4.1 Maritime Safety and Vessel Traffic Management; and Maritime Surveillance

Maritime accidents are the main risks in maritime safety and vessel traffic management (Scaroni, 2014). Objects that are needed to know are vessel, its type, characteristics, identification, and preferably its port history, travel plan, crew and when applicable passenger list, and cargo manifest. Thus accuracy and validation of the automated vessel identification system AIS-signals is also very important.

Maritime safety and vessel traffic management are concerned with a wide variety of issues ranging from commercial shipping to leisure boats, and from vessel safety inspections, through personnel qualification issues, to active traffic control and VTS-monitoring. Thus the objects and phenomenon that it is interested in are concerned with information related vessels, their seaworthiness, manning, and movements. Predicting maritime traffic evolution is important. It calls for predictions of vessel trajectories, understanding of the evolution of events and circumstances over a potential areas of interest, potential threats, aided by density and risk maps that picture maritime activities over areas of interest, heavily used traffic routes and points of cross traffic, potentially risky routes, and deeper understanding of seasonal trends.

Anomaly detection, classification and threat assessment should include observing change of speed, direction, or vessel interactions, and possible vessels approaching the coast suspiciously far from ports or unauthorized access to areas of interest, prohibited anchoring.

Also metrological information, such as clouds, winds, waves, and storms, and oceanographic information such as currents and topography are of interest. Sea metrological conditions information and evolution predictions aid in the assessment of abnormal weather conditions and support route and asset planning and when needed in Search and Rescue, SAR operations.

4.2 Accident and Disaster Response; and Search and Rescue at Sea

When maritime accidents occur, the main alerts are SOS / Mayday calls, or vessels or aircraft disappearing from maritime surveillance and traffic control radar screens. The operational IT-systems should be capable of aiding to identify which vessels are concerned, and where. Also, where are potential places of refuge and what accident response capabilities are at disposal, and how quickly. The main focus is in the prevention of accidents and their impacts. Knowing what operational assets and search and rescue teams are available guide rational decision making.

If vessels and people are lost at sea, must the SAR operations begin swiftly after receiving an SOS or Mayday call, and with enough resources. The last known location, intended port or travel route, persons on board (at least number of), and if possible their nationalities and names are needed information. Also if persons are in vessel, lifeboat, or in water (overboard)? In case of accident response, to make the right decisions on the spot, an on-scene coordinator (OSC) will need information that is as accurate and real-time as possible.

4.3 Maritime Border Control; Maritime Customs Activities and Prevention of Trafficking and Smuggling

The main risks for maritime border control are irregular immigration and trafficking in human beings (Scaroni, 2014). Objects that need to be recognized are vessels and persons of interest, both EU residents and non-residents, their travel documents, and biometric information. Suspect travel patterns, detections of illegal border-crossing between BCPs, illegal or clandestine entries between BCPs, as well as persons using false identities or fraudulent documents are of high interest. Abnormal behaviour recognition, facilitator information, applications for asylum, refusals of entry, illegal stay, and return decisions issued should be included in the system for easy information sharing.

Victims and suspected traffickers of forced sexual exploitation, forced labour exploitation are important information in preventing trafficking. Knowing the common countries of origin and countries of destination of detected victims are also needed.

The main focus for maritime customs activities and prevention of trafficking and smuggling is in detecting and preventing the smuggling of goods and the export and import of counterfeit goods, narcotics, alcohol, tobacco, firearms, explosives, and stolen property (e.g. vehicles), as well as people. Following estimated worldwide production sites and main logistics sea routes to Europe, worldwide hot-spots of users, consumption patterns per drug category, and the modus operandi of traffickers aid in planning effective measures against trafficking. Some of the main tasks, to fight against the main risks counterfeit goods and trafficking of drugs, are sharing of intelligence information, ship inspections, and detected contraband modus operandi. Drugs, alcohol, cigarettes, and other goods, where customs or tax are unpaid are of interest.

Knowledge of available assets for interception and capacities of prevention are needed for effective response. The main risks, trafficking of firearms and explosives, and smuggling and counterfeit goods is closely tied to maritime customs activities, and trafficking of human beings to maritime border control.

4.4 Maritime Security

The main identified risks for maritime security are piracy and terrorist threats (Scaroni, 2014). The focus is in understanding phenomena, such as vessels transiting the area concerned and goods transported through these hot-spots of piracy (such as the Gulf of Aden), suspicious activity, pirate attacks, fishing vessels seized, possible seafarers and fishermen abducted, taken hostage, or killed by pirates.

Understanding one's assets is key in preventing and countering risks for maritime security. Knowledge of which military and other authority vessels are operating in the area concerned, which are protected, and which are not, also what re-routing possibilities are there and what could be achieved with increased speed.

Also information on ransoms and recovery, protection and counter (military) operations, counter-piracy organizations, and both security equipment and guards are needed to coordinate counter-piracy measures. All in all, detection of anomalies, firearms, possible bomb building, or vessel highjack, be it piracy or terrorism, may alert operators to successfully enforce criminal law on the maritime domain.

4.5 Maritime Environmental Response; and Fisheries Control

Some main risks are illegal oil discharges, formerly known as environmental destruction and degradation (Scaroni, 2014). The main task for authorities is to detect and prevent waste at sea. The main object to identify is pollution (of any kind). Oil unfortunately is still deliberately dumped into the sea in quantities. Detecting oil and chemical spills, illegal or accidental bilge, grey, and black water discharges and seepages are in the focus. Also ships' emissions are monitored. Polluters should be identified.

Oil transport routes by sea, the volumes transported, and potential risk areas help prioritize how to place assets. Aircraft observation, capacities of prevention, drift calculations, estimated volume of possible oil discharges (m^3), and assets of pollution response guide the planning of resources and possible operations.

For fisheries control the main risks (Scaroni, 2014) are illegal, unreported and unregulated fishing. The large problem are the commercial fishing groups that overfish and do not comply with EU fishing regulations and quota. The main problem is with third country vessels, so checking fishing vessels is an important deterrent against wrongdoings. Risk and blacklisted vessels are important to identify. Important objects to identify are vessel identification and position, amount and type of catch, as well as the fishing equipment used.

The phenomenon that fisheries control authorities need are knowledge of fishery resources and fish populations, applicable quotas, allowed fishing areas and detection of illegal fishing activity. Information on equipment allowed or disallowed, and licenses and permits needed by vessel or captain can also guide fisheries control authorities in their work – to control fishing, be it commercial or leisure fishing.

5 DISCUSSION AND CONCLUSIONS

The work that EU-wide projects such as PERSEUS, CoopP, EUCISE2020, and MARISA, or FINCISE on a national level, have begun, should be continued and elaborated. These projects have shown that it is important to share information cross-sector (a) nationally between different authorities; and cross-border (b) between responsible authorities from different EU member states; (c) and with cooperative third countries.

The objects and phenomena, relevant to CISE, need to be continuously evaluated and redefined. This should be done together with end-users and against changing risk and treat scenarios and evolving end-user needs, and national and EU-wide strategies, and also taking into account the assets, which cooperative third country nations may bring. Shared maritime information systems should inherently include both tools and processes for continuous re-evaluation of both the objects and phenomena, which it should be able to provide its users.

The cooperation between these different authorities has the potential to evolve into a deeper and more encompassing mode of co-creation, where the added complexity may greatly reduce the time to value creation and innovation. In this context the ability to create greater common knowledge, learning, and value can be seen as innovation. The value in this innovation to EU and national authorities are the in faster recognition, assessment, planning, and reaction capabilities, which lead to a safer, more secure European maritime domain.

Seemingly adding complexity to the common information sharing systems and processes is the way to substantially faster innovation: detection, assessment, planning, and response. In becoming more complex, mere cooperation has the potential of reaching deeper forms of co-creation. This enables the network to yield more value and innovation. In this case the innovation potential is in the faster and widely shared information. It demonstrates as confirmed objects and phenomena resulting in an accurate Recognized Maritime Picture.This in turn supports threat assessment, asset and operations planning, and sharing of resources. This is innovation and value.

The work in project MARISA, as also this paper, is just the beginning. Identifying these practical user needs can serve as a basis for further technical development of CISE, and these results directly serve further work in projects MARISA and FINCISE.

The framework of objects and phenomena identified in the DET analysis of this study is seemingly complex, but only by this adding of complexity can we shorten the time to innovation and value. Further research should amend and validate the results of this study, and continue to identify new objects and phenomena, while evaluating and redefining the existing ones. This research facilitates the study aiming to create the technical elements of CISE and bridge between the technical and human aspects of information sharing, and co-creative collaboration.

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