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Complex Authority Network Interactions in the Common Information Sharing Environment

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Keywords: Complexity, Multi-stakeholder Collaboration, Information Sharing, Situational Picture.

Abstract: European authorities collaborate as a community toward a coherent approach of situational understanding and open trust base information sharing. Innovation in multi-stakeholder collaboration networks involve complex collaboration between user community members, providing cross-sector, cross-border and cross-authority interaction and information sharing for collaborative situation awareness, and cooperation to increase safety and security. This study analyses data consisting of elements of use cases, collected from EU funded innovation projects. These were placed in a table based on similarity, difference and relevance to produce a classification. The results of this study indicate that use cases and scenarios engage end-users to co-create very practical descriptions providing input communication for innovation projects; also multi-actor projects are complex networks thus, this study contributes to the network approach of innovation. The implications of this study are that reaching faster innovation can be facilitated by leading and organising projects well, providing appropriate feedback to ensure project plans and results stay connected with project goals, fostering project continuums, and having e.g. higher education institutions bring problems as project ideas. The results, innovations, and feedback from research and innovation projects can benefit the European society.

1 INTRODUCTION

European maritime authorities, as a community, have collaborated aiming at a coherent approach of situational awareness based on open trust base information sharing. Project MARISA (Maritime Integrated Surveillance Awareness, 2017-2019), which develops clean data based solutions, data refining tools and expanded data fusion functionalities is one example of such collaboration (MARISA, 2019). MARISA is based on prior collective maritime development projects from 2009 to 2019 (e.g. BLUEMASSMED, Perseus, CoopP, and EUCISE 2020). The MARISA user community acts as a forum that steers the project. Similar examples of end user engagement have been used in earlier FP7 funded projects (e.g. AIRBEAM) to built user communities and provide information sharing, and involve them in cross sector, cross border and cross authority exchange and co-creation. In MARISA, these exchanges have proven to be valuable in defining user requirements and identifying possible legal and ethical barriers.

MARISA has selected five use cases that serve as the basis for the project work (MARISA, 2018) to define cooperation mechanisms, trust-based data sets, and trust building mechanisms between the users of the Common Information Sharing Environment (MARISA, 2019). Earlier studies point towards complexity of collaboration having an effect on innovation in multi-stakeholder collaboration networks (Ruoslahti, 2018; Ruoslahti and Hyttinen; Ruoslahti and Tikanmäki, 2017). To further understand this issue, the research questions for this paper are:

RQ 1: How are use case narratives used to engage end-users in complex innovation projects?

RQ 2: Is the time needed to achieve innovation affected by the level of complexity of collaboration networks in the case project?

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2 LITERATURE

2.1 European-wide Collaborative Situational Picture

Interaction and information sharing between authorities is important in building collaborative situational awareness and promoting cooperation to increase maritime safety and security. European maritime cooperation aims at increasing situational awareness, sharing best practices, improving interoperability, removing overlapping activities, and promoting cross-border and cross-sector cooperation (Tikanmäki and Ruoslahti, 2017).

Project MARISA, divides its users under seven user community sectors. The EU also, in some other instances, uses a classification of ten EU Coast Guard Functions (ECGFF, 2014; Ruoslahti and Hyttinen, 2017). These mostly correspond to each other, and Table 1 below makes a comparison of the two classifications. One main difference is that the Coast Guard Functions do not include defence, and they make a finer division of Maritime safety into Maritime safety and vessel traffic management, Accident and disaster response, and Search and rescue at sea. The Coast Guard Function Maritime surveillance has not been included under any MARISA sector, as it is elementary to each sector and how Maritime surveillance relates to the MARISA use cases and end-user sectors is discussed below in the Methods and Results sections.

Table 1: MARISA user community sectors in relation to the Coast Guard Functions of the European Union.

Seven user community sectors of Project MARISA	Ten EU Coast Guard Functions (EUGCF)
	Maritime surveillance
Border control	Maritime border control Prevention of trafficking and smuggling
Customs	Maritime customs activities Prevention of trafficking and smuggling
Defence	
General Law Enforcement	Maritime security
Marine Environment	Maritime environmental response
Fisheries Control	Fisheries control
Maritime Safety	Maritime safety and vessel traffic management Accident and disaster response Search and rescue at sea

Project MARISA has an expansive approach, as data from various authority sensors and sources, and open access big data are used to build a situational picture for maritime surveillance and response. (MARISA, 2018).

The innovation action process of MARISA is co-creative. Maritime integration and development activities are structured as a relatively novel cross-border socially constructed user community (MARISA, 2018). The different sectors (Coast Guard Functions) have different user needs and, therefore, require different operational approaches and respective technical solutions. The European authorities are beginning to understand that sharing information cross-border and cross-sector is important and a benefit to all stakeholders concerned (Tikanmäki and Ruoslahti, 2017).

2.2 End User Community

Maritime awareness and safety can be improved through collaboration between partners. Inter-agency collaboration can broaden the knowledge of the multiple stakeholders on each other's concepts, measures, resources and plans (Tikanmäki, 2017). Eicken et al. (2016) note that it is a challenge to ensure that information is shared with all relevant entities and agencies from the regional or local to international level. According to the Ministry of Foreign Affairs of Finland (2018) individuals, organizations, businesses, and communities will most likely take larger roles in negotiating future international norms.

The Common Information Sharing Environment (CISE) is based on trust between the authorities on the maritime domain. This includes sharing operational information and procedures, and developing a culture and technology that enables also sharing confidential information. MARISA's user community involvements, together with other MARISA meetings aim to co-create value, such as a revised methodology, key performance indicators, readiness level metrics, a maturity matrix to assess resilience, and privacy impact assessments, all validated by the user community (Pirinen, 2017; Ruoslahti and Tikanmäki, 2017).

EU-wide projects such as PERSEUS, CoopP, EUCISE2020, and MARISA have shown that there is a need share information cross-sector and cross-border. Collaboration is needed between different national authorities; nationally, between the different EU member states, as well as with cooperative (non-EU) third countries (Ruoslahti and Tikanmäki, 2017).

Engeström,Kerosuo and Kajamaa (2007) argue that inter-organizational learning highlights networks that have trust, exchange information and resources, and solve problems collaboratively and across organizational boundaries. Ruoslahti and Tikanmäki (2017) highlight that the objects and phenomena, relevant to CISE, need to be continuously evaluated and redefined together with end-users; against changing risk and treat scenarios, evolving end-user needs, national and EU-wide strategies, and "taking

into account the assets, which cooperative third country nations may bring." (Ruoslahti and Tikanmäki, 2017, p. 273). Collaborative information sharing, situational awareness and open innovation opportunities support the building of organizational resilience (Rajamäki and Ruoslahti, 2018).

Communication helps engage stakeholders and innovation projects benefit from collaboration with relevant end-users. Setting and validating user requirements can be considered input communication, ensuring smooth information exchange throughput communication, and efficient dissemination output communication (Vos and Schoemaker, 2004).

Ruoslahti and Tikanmäki (2017) propose that cooperation between different authorities may have the potential to evolve into deeper modes of co-creation, and that added complexity may reduce the time to value creation and innovation. In the context of their study, they see innovation as the ability to create common knowledge, learning, and innovation value (Ruoslahti and Tikanmäki, 2017). Knuuttila (2017) points out difficulties in collaboratively improving practical resilience, because it may be seen as a risk to one's autonomy or a possible loss of power and, thus, the starting point to reach targets is the division of power between the different actors.

2.3 Complexity of Systems

Sociotechnical systems (Amir and Kant, 2018) are hybrids of people and technologies involving complex interactions between people, organisations, and technologies. Cyber-physical systems (Murakami, 2012) include cyber, physical, and social inputs and outputs that are designed by society organisations, and humans for their benefit. Domains that create shared situational awareness and a basis for decentralised decision-making are 1) physical; 2) informational; 3) cognitive; and 4) social (Alberts, 2002).

Mitleton-Kelly (2003) sees that complex systems, such as innovation and information sharing networks (such as CISE), have connectivity and interdependence. They co-evolve together and form dissipative structures to explore the space-of-possibilities, and generate variety. These systems self-organise to create new order, as groups within and between systems come together spontaneously to perform tasks, to share knowledge, and to generate new learning and knowledge. As their environments and social ecosystems are changing fast, these systems also face turbulence, chaos and complexity. This makes ensuring the survival of systems challenging, which calls for the ability to collect and react to feedback (positive, reinforcing feedback drives change, while negative feedback balances and maintains system stability).

2.4 Complexity of Collaboration

Collaboration within the MARISA user community is complex in nature. The use cases in the project MARISA include multiple actors from several sectors and often from many countries, and complexity is further increased with some EU Member States having multiple authorities under the same sector (e.g. police and gendarmerie perform general law enforcement) (MARISA, 2018).

Knowledge becomes developed by collaboration (Pirinen, 2017; Ruoslahti, 2018), even interdependence and resource integration (Ruoslahti and Tikanmäki, 2017). These result in the need to access resources from others and drive value-in-exchange: "knowledge itself is an increasingly important source to competitive advantage and a key to the success of modern organizations and creative higher education, strengthening the collective expertise, industry-service clusters, employees and competitiveness in the global economy" (Pirinen, 2015, p. 315).

Multi-stakeholder communication in organisations (also publicly funded innovation project consortia or CISE network) needs to stress dynamic interaction among multiple actors with diverse interests (Vos, Schoemaker and Luoma-aho, 2014). Issues central to people are the ones that matter to them most (Luoma-aho and Vos, 2010). Authority communities function as issue arenas for exchange of practical, legal and ethical issues and where actors co-creatively define and refine relevant use cases. Thus, these arenas also are competitive spaces for problem solving and influencing based on actors aligning behind common agendas, but also having their own (Vos 2018).

When innovation projects are understood as complex systems, collaboration across boundaries, and creating desired futures are their core organizational learning capabilities (Senge, et al., 2008). "EU Funded R&I projects represent a unique form of a knowledge community" (Norvanto, 2017, p. 78). The ways in which authorities work together (Frey et al., 2006) and elements of complexity (Mitleton-Kelly,2003) can be looked at in relation to each other. Elements of complexity are least visible in the simplest form of working together, Networking, and increase through Cooperation and Collaboration, to be the highest in Co-creation (Frey

et al., 2006). This seems to be supported by the notion that collaboration between authorities can evolve into deeper modes of co-creation. Thus, authority collaboration and interoperability become increasingly important (Ruoslahti and Tikanmäki, 2017).

2.5 Co-creation

Co-creation requires communication and interaction between multiple actors. Ruoslahti (2017) identifies that co-creation networks have cyclical connections in value. Networks require active facilitation and cooperation tools or platforms to actively and efficiently share co-creative innovation and knowledge. Active stakeholder participation can be motivated and guided through having common aims that promise benefits for all individual collaborators, and can result in an active drive to co-create of knowledge and change.

Sankowska (2013) notes that there are simultaneous relationships between trust, knowledge creation and transfer, and innovativeness. These strong links between them explains differences in competitiveness and innovativeness of organizations. Trust fosters knowledge creation. Climates of trust can create what the author calls virtuous circles of knowledge transfer, creation and innovativeness. Organizational trust must be built first, so it can foster innovativeness through knowledge practices.

Co-creation of knowledge can offer significant opportunities for innovation (Ruoslahti, 2017). Multiple-stakeholder co-creation projects benefiting innovation network stakeholders are highest in complexity, as roles between stakeholders are constantly changing. Common aims and issues to solve motivates stakeholders to collaborate, and open innovation environments may facilitate communication and interaction, and co-creation of knowledge requires intensive collaboration. Active stakeholder participation stems from common aims, and they should promise benefits for each stakeholder. All resulting in an active drive for co-creation of knowledge, innovation, and change. (Ruoslahti, 2018)

Learning, knowing, and becoming are the basis of evolution and change, a dynamic and iterative process of "continuous experiencing, learning and sense making" (Jakubik, 2011, p. 392). "The logic of complexity suggests that learning and the generation and sharing of knowledge need to be facilitated by providing the appropriate socio-cultural and technical conditions to support connectivity and interdependence and to facilitate emergence and self-organisation" (Mitleton-Kelly, 2003, p. 59).

3 METHOD

The main case project of this study, MARISA, is based on five selected use cases on authority information sharing on the maritime domain. Data for this study was collected from detailed descriptions and narratives of its five use cases. Six scenario descriptions of authority collaboration in recovery from disaster from project AIRBEAM were used as comparative background information for this study. These eleven use case and scenario descriptions were produced to identify requirements for systems demonstrations, which were the concrete and usable deliverables of these two projects – the innovations that they produced.

Project MARISA focuses on five of use cases (Table 2 below) and the results of this paper are structured accordingly. The use case descriptions that the data of study was collected from, are based on a total 94 use cases that were produced in the Cooperation Project, CoopP and narrowed to five in EUropean test bed for the maritime Common Information Sharing Environment in the 2020 perspective, project EUCISE2020 (MARISA, 2018).

The European Commission (2012) has set criteria for business value in the context of innovation projects, and these have been used in the case of project MARISA developing a European-wide CISE to address: 1) the number of user communities that benefit by the use case; 2) the number of user communities needed to fulfil purpose; 3) evidence that CISE helps reduce time or cost to meet the purpose;4) criteria for technical complexity (sensitiveness of data used, standardization of data models); and 5) the complexity of information exchanges between information systems (MARISA, 2019). The use cases selected for project MARISA involve seven end-user communities (Table 2).

Table 2: MARISA Use Cases in Relation to the User Community Sectors.

Potential number of user communities interested in the use cases	**13b**	**37**	**44**	**70**	**93**
Border Control	X	X	X		
Customs	X	X	X	X	
Defense	X	X	X	X	
General Law Enforcement	X	X	X	X	
Marine Environment	X	X	X		X
Fisheries Control		X	X	X	X
Maritime Safety		X	X	X	

Use Case 13b is the inquiry on a specific suspicious cargo vessel. The use case may include authorities from the five different sectors border control, customs, defence, law enforcement, and marine environment.

Use Case 37 covers the monitoring of all events at sea in order to create conditions for decision making on interventions, including authorities from all seven sectors border control, customs, defence, law enforcement, marine environment, fisheries control, and maritime safety.

Use Case 44 is about requesting any information to confirm the identification, position and activity of a vessel of interest, and it may include authorities from all seven sectors border control, customs, defence, law enforcement, marine environment, fisheries control, and maritime safety.

Use Case 70 looks at a suspect fishing vessel or small boat, which is cooperating with other vessels (such as a container vessel). This may include authorities from five sectors, which are customs, defence, law enforcement, fisheries control, and maritime safety.

Use Case 93 on detection and behaviour monitoring of vessels listed as IUU (Illegal, Unreported and Unregulated fishing). This use case may involve authorities from two sectors marine environment and fisheries control.

As MARISA is part of a project continuum, projects such as BLUEMASSMED (Cross-Border and Cross-Sectoral Maritime Information Sharing for a better knowledge and control of activities at sea), PERSEUS (Protection of European seas and borders through the intelligent use of surveillance), CoopP, and EUCISE2020 during a time span of 10 years have combined European efforts to build a Common Information Sharing Environment for integrated maritime surveillance. Thus, co-created end user narratives, both written, spoken, and collaborated, were collected to first produce 94 use cases, and then select the five, which serve as the basis to identify data fusion requirements for the collaborative information exchange in the Common Information Sharing Environment by project MARISA, and as the data for this study. The next project in this continuum is already in the funding pipeline and will commence 2019.

This study further analysed the five MARISA use cases, by comparing their respective elements, detailed in use case descriptions produced by project CoopP. The use case elements extracted from the use case descriptions and data was placed in a data extraction table (DET) based on their similarity, difference and relevance. The DET-table was then subjected to a series of three rounds of iteration among the researchers to restructure the data. Use case element were reordered according to similarity, difference and relevance in regard to the two research questions. As a result the final classification, which is presented in the Results section and the use case hierarchy that is visualized in Figure 1 below, were produced to answer RQ1 and RQ2.

4 RESULTS

The results of this study serve to motivate the use of use case narratives and scenarios as a practical way to engage end users in co-creation. These very concrete descriptions are shown to be a way to gain and share information on situations, circumstances, and efforts, which end users encounter or perform in fulfilling their tasks. The method of first co-creating end user narratives was used in the case projects to develop use cases or scenarios. These in turn served to define system requirements, which are needed to design and implement systems, both technical and social. Most modern systems are cyber-physical in nature and include technical, information, and human elements. The case system, the European-wide CISE system is an excellent example of a cyber-physical system involving physical technologies, shared information and human issue arena operations. Based on the results, the use of CISE use case narratives can also be regarded as one form issue arena, where relevant authorities exchange information, innovations and best practices regarding their respective operations and can identify more and better ways to collaborate with one another. This study finds that multi-actor networks are complex in nature and is thus within the multi-actor approach of research arenas, and also contributing to the network approach of innovation.

One further result of this study is the way in which MARISA use cases became hierarchically structured to show their occurrence in respect to each other (see Figure 1). Use case 37, Monitoring all events at sea, is common to all sectors, and it precedes all these other use cases. It is equivalent to the Coast Guard Function Maritime surveillance, which is a base function, where the seas are monitored, without anything out of the ordinary or dangerous having detected to have happened yet. All maritime authority sectors structure their daily operations to ensure adequate monitoring and detection of events at sea. The ways in which this is done differs from sector to sector. However, this function is addressed in one way or other by all maritime authorities. Thus, use case 37 can be classified as being a base function that

all other use cases and authority interaction are based upon, including adequate resources and information.

Once some possible anomaly is detected use case 44 Request information to confirm identification, position and activity of a vessel of interest becomes activated. The information that is relevant to each sector differs depending on their mission and tasks. This information may also be, as can other possible information may be gained relevant to other sectors that is relevant to some other sector. The case project use case narratives show what information can and should be shared, even though it might not have been directly relevant to the responding authority in question.

Use case 44 may then revert back to use case 37, or alternatively, it may escalate to one of the three remaining use cases: use case 13b Inquiry on a specific suspicious cargo vessel, use case 70 Suspect fishing vessel or small boat cooperating with other vessel, or use case 93 Detection and behaviour monitoring of vessels listed as IUU (Illegal, Unreported and Unregulated fishing).

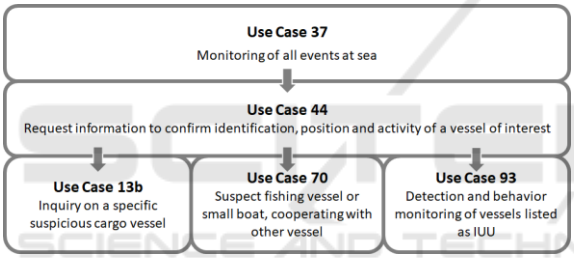

Figure 1: The five MARISA use cases in relation one another.

The results indicate that the MARISA user community provides a shared forum to enhance cross sector, cross border and cross authority exchange, while also taking into account legal and ethical issues. It has co-creatively defined these above five use cases, on which the user requirements for the MARISA data fusion services have been based on. Maritime authorities and stakeholders work together on different levels, ranging from networking to co-creation. On an authority level, some ethical issues to consider are authorized usage of data, distribution of interoperability resources, and basis of register listings. Some privacy issues may include usage and fusion of open source data, identity of vessel crew or passengers, authorized usage of registers, and basis of register listings.

All these use cases may include authorities from various nations, and contain privacy and related ethical issues, such as identity information of crew or passengers. Thus, the more authority sectors, member states, and other stakeholders involved, the greater is the complexity of their interactions, but also the opportunity to share information, and experiences to induce learning and faster reach innovation.

In summary, using use case narratives provides a process and arena to engage end-users in discussing complex issues in a practical ways, and serves as concrete input communication for innovation projects. The hierarchy between use cases further facilitates this, and serves to shorten the time needed to achieve innovation, as levels of complexity become added within the collaboration network.

5 DISCUSSION AND CONCLUSIONS

One implication of this study is that practical use case narratives are a useful way to engage end-users in complex project innovation. Use cases provide them with concrete situations, where end users can see commonalities and identify new needs. Results show that knowledge becomes developed collaboratively and as seen in literature this requires close, even co-creative interaction between actors (Pirinen, 2015; Ruoslahti, 2018). Collaboration may even deepen and provide resource integration and usage of common capacities to reach common goals (Ruoslahti and Tikanmäki, 2017). However, accessing the resources of other actors presents an ethical consideration of the ownership of data and information, and the distribution of resources, which most likely are scarce, and this is also one issue that is recommended to be co-creatively addressed by all project stakeholders.

A second implication is that care should be placed on how projects are led and organized. They form complex social networks, where each partner has its own interests and agenda. These many, sometimes even conflicting, interests need to be aligned in a way, which produces benefit for all stakeholders involved. The collaborative efforts of these networks require active coordination and facilitation that motivates the consortium members and other stakeholders to actively participate, both, in co-creating the consortium goals and the activities through which these goals become realized. One recommendation is, thus, that the use of use cases is led and organized in ways that stimulate the creation of new knowledge.

A third implication is that there is a tie between projects and education. Higher education institutions have a responsibility to bring problems and ideas that evolve from their classrooms as well as practical

contacts with their environments forth as project ideas and proposals. In addition, they have a responsibility to include the innovations and knowledge gained in projects in their study curricula. This is a way to further develop innovations, and to bring them to wider use in society. Moreover, industry and end user organizations will also benefit when they build ties between innovation projects and their in-house training programs. This speeds up the implementation of innovations, and builds a readiness in the organization to reach further innovations, faster and in more depth. Thus, results from the case project indicate, that the time needed to achieve innovation can indeed be affected by the level of complexity in respective collaboration networks. Stakeholders can share use cases and learn from one another, and it was pointed out in literature (e.g. Engeström and Kerosuo, 2007; Sankowska, 2013) that this is a useful way to create knowledge and innovation.

A fourth implication is that society may gain from promoting project continuums, where later projects build on the success and innovation of earlier projects to develop a path toward faster and deeper further innovation. The PERSEUS – CoopP – EUCISE 2020 – MARISA –continuum serves as a good practical example of this. This type of continuum thinking permits use cases to evolve, trust to build and collaboration to deepen, as these both take time to evolve. In addition, the connected projects may permit eco-systems to evolve and spread, as project efforts over time engage more and more stakeholders from all wakes of society.

Fifth, the results of this study also imply that creating and selecting appropriate measures provide the feedback needed to ensure that project plans and preliminary results stay connected with the goals of the project, and possibly changing or evolving end user needs. It is recommended that use case narratives become evaluated and re-written every so often to keep them up-to-date, and to identify changes and new opportunities, with the emergence of further innovation.

One further implication is that a European-wide policy can greatly benefit from the results, innovations, and feedback from research and innovation projects. Research takes time from idea to capability and this speaks in favour of linking projects in continuums, to deepen innovation and to take advantage of possible spin-off effects and innovations provided by these projects. This type of policy will enable EU-funded projects to create new knowledge and, by doing so, change society.

There seems to be positive a relationship between complexity within the innovation network and the time in which it could create new knowledge and innovation. When containing more elements of complexity, networks can work together in deeper forms of co-creation and provide faster innovation. Networks aiming at innovation must dare to become more complex in nature. Adding complexity can result in reaching networks innovation goals faster than in less complex networks. The results of this study indicate that more complexity of collaboration within a cyber-physical system, such as a Common Information Sharing System, can shorten the time to innovation leading to faster recognition, assessment, planning, and capability reaction. All these help realize a safer, more integrated European maritime surveillance.

All of the above results inductively point toward a relationship between complexity and the time needed to co-create knowledge and innovation. More study is recommended on this issue, as understanding collaboration for innovation and its challenges can help future co-creation collaboration networks to function better and gain added resilience to face the unexpected. This added knowledge may benefit future innovation networks.

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