Evaluation of a workshop to capture knowledge from subject matter experts in maritime surveillance

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Abstract – This paper reports on a brainstorming workshop with subject matter experts that aimed at identifying potential anomalies for world wide maritime surveillance. An extensive description of the workshop process and output is presented. The evaluation consists of two parts. First, the output of the workshop is compared with the output of a similar workshop as presented in Roy [1]. Secondly, the methodological differences between capturing know-how of subject matter experts in a workshop versus observing daily work of operators, as applied in Nilsson et al [2], is discussed. The conclusions are that brainstorming workshops and field studies should be combined to compensate for their weaknesses. Also, the outcomes of both methods heavily depend on the selection of operators to be observed, respectively the selection of subject matter experts invited. A final recommendation is that multiple studies and workshops are needed until no ‘new’ anomalies are identified.

Keywords: Maritime Surveillance, Anomalies, User Study, HCI, Situation Awareness.

1 Introduction

Maritime domain awareness is getting increasing attention as advances in the technology enable more data to be gathered and analyzed. However, creating appropriate maritime domain awareness is not without problems [4, 7] and therefore more research is needed. The Swedish Emergency Management Agency (SEMA) and the U.S. Department of Homeland Security (DHS) have acknowledged this and identified a number of capability gaps related to Maritime Domain Awareness. University of Skövde, Saab and the Swedish Defense Research Agency (FOI) have in collaboration conducted a pre-study addressing one of the gaps concerning “world wide maritime surveillance” (funded by SEMA). The project involved an investigation of the need for “world wide maritime surveillance” in Sweden and resulted in a proposal of a technical solution (presented in [3]). This paper focuses on one part of this project, namely, a workshop performed to identify needs for world wide maritime surveillance in Sweden (i.e., identification of user requirements for the proposed technical solution). The workshop gathered subject matter experts and Swedish stakeholders for one day. The workshop started with a presentation of the current state of anomaly detection, followed by a computer supported brainstorming session aimed at identifying potential anomalies in word wide maritime surveillance. Identifying user requirements at an early stage is very important for successful systems development, as the end users are the ones which actually may or may not use the proposed system in future, depending on whether they are satisfied.

In addition to the description of this workshop, two other studies are elaborated upon in detail for evaluation purposes. First, a similar study performed in Canada and reported in Roy [1], and second, a study performed by the authors of this paper [2]. The first study is chosen to compare the output of the two workshops, the second study is chosen for a comparison of the methodology used. The result of the evaluation of the studies provides insights to information fusion researchers in terms of what type of method to use for capturing subject matter experts’ expertise, in different situations, under different constraints.

The outline of the paper is as follows: first, some background on the application area of maritime surveillance is provided in section 2. Our brainstorming workshop is presented in section 3, the other two studies in section 4. In section 5 the strengths and weaknesses of the three studies are presented in a comparative evaluation and in section 6 implications for information fusion research and practice are discussed. Finally the main conclusions are summarized in section 7.

2 Background

Today we have possibility of advanced tracking through initiatives such as Maritime Safety and Security Information Systems (MSSIS) on the US side and SafeSeaNet on the European side [4]. This has created new possibilities for anomaly detection. Data driven anomaly detection is one approach which can exploit data from this technology by learning what is normal and from that, detect deviations from normalcy [8]. Hence, one of the benefits of data driven anomaly detection is the possibility to detect previously undetected or unthought-of activities [9]. That is, the system does not require a predefined signature representing known activities. However, a drawback is that the system needs a training period to create baseline profiles for determining normalcy [10]. The development of these applications is not easy and many systems are still in a concept stage.

An alternative approach, which can be complementary, is starting with what the experts already
know. Many times an operator has knowledge of what is “abnormal” behavior; hence, it may be a good idea to exploit this knowledge in so-called rule-based systems. A knowledge driven approach for anomaly detection takes advantage of knowledge acquired from occurred events [10]. One of the major advantages, compared to data driven anomaly detection systems, is the possibility of detecting activities/behaviors in a reliable manner [10]. One major problem with these systems is that they need constant updating, that is, the classification of events which has become known as illegal activity may change to be normal as time evolves, or vice versa. Despite this, these kinds of approaches have proven to be successful.

One challenge is how to capture knowledge of subject matter experts to feed such systems. There are many methods which can be used. Amongst others, case analysis, critical incident analysis, commentaries, conceptual graphs and models, brainstorming, prototyping, performance reviews, which are all examples of methods used for the purpose of capturing knowledge from experts [12]. For information fusion researchers it may be difficult to know what methods to use.

This paper will shed some light on this issue by first presenting a performed workshop which aimed to capture knowledge of subject matter experts and then comparing the workshop with two other studies.

3 Anomaly detection Workshop

This section reports in detail on a workshop performed by the authors of this paper during autumn 2008 as part of a larger project supported by SEMA.

Purpose. The goal of the workshop was to collect user requirements regarding what anomalies are of most interest for Swedish organizations involved in maritime surveillance. More specifically, the participants were asked to list the events for which they would want to get an early warning.

Method. To identify anomalies a workshop was performed in the format of a computer supported brainstorming session. Workshops [5] are typically intensive and only last for a day or few days. The workshop can be structured in a way that consensus regarding a topic can be achieved at the end of the workshop. Brainstorming sessions [5] most often involve idea generation with the goal to identify as many ideas as possible. This type of method allows the opinions of the users to be collected without being interpreted by the researcher.

Location. The workshop was performed in Gothenburg, Sweden, at Lindholmen Science Park. In other words, a conference center independent from the organizers of the workshop was chosen as a location for the workshop.

Material. During the workshop a special group support system was used involving 20 lap-tops, two projectors, a facilitator, and software that support brainstorming, categorizing, and voting (Groupsystems).

Participants. Participants from different stakeholders such as the Swedish Armed Forces, Swedish Coast Guard, Department of Fisheries Control, Port of Gothenburg, Swedish Customs, Lloyds and Swedish Emergency Management Agency were invited and present at the workshop, as well as several researchers involved in the project. Each organization was represented by one or two participants. From the Swedish Armed Forces 10 participants were present, however, they had different roles within the organization. The background of these participants ranged between being an operator to being a strategic advisor representing the need of an organization. In total, the workshop had about 25 participants. After the workshop, 6 representatives from U.S. potential partners (e.g., government and universities) participated in a technical review process which aimed at evaluating the output of the workshop. In addition, the Swedish Coast Guard also participated in the review process due to the fact that they could not participate in the workshop that particular day. The review process was conducted due to the nature of the overall project (i.e., the initiative for collaboration between Sweden and the US).

Procedure. Before the workshop, an intentional choice to focus on “early warnings” was made. The project group believed that anomaly detection is not a concept used by operators, and thus, “early warning” would be easier to understand as a concept. The participants for the workshop were invited via individually tailored e-mails. The ones which did not reply within the time frame were contacted by telephone.

The workshop was held during one day. The workshop started with a presentation of the purpose of the workshop, followed by a presentation of the current state of maritime domain awareness by a senior expert in maritime domain awareness applications. After the presentation a computer supported brainstorming session started on the question “What early warnings do we need in the future?”. The participants did first participate in a 10 minutes training session to get accustomed with the tool. After the training session the participants had about 20 minutes to brainstorm regarding what early warnings were needed. In this short period 75 early warnings were identified. A voting activity aimed at selecting the most interesting early warnings resulted in identification of 31 prioritized early warnings. These 31 early warnings (cf. Figure 1) were discussed in more detail with respect to the following questions:

- What information is needed to detect this early warning?
- Where can that information be found (sources, systems, organizations)?
- How can one tamper with this information, and how can that be prevented?
- How can this information be fused (methods/algorithms)?
- What is the added value of fusing compared to the existing situation?

In this elaboration discussion over 200 comments regarding these questions were gathered for these 31 early warnings. Most external participants were given individual computers. Project members shared a computer, as well as some representatives from the Swedish Armed Forces, as they
were such a large group. The computers allowed the participants to simultaneously add comments and ideas. Submitted ideas of all participants were visible both on the own work station as on the projector screen.

![Figure 1. Participants using the computer supported brainstorming tool during the workshop.](image)

After the workshop, the Groupsystems software was used to produce a summary report of the comments made during the workshop. This report was, after some minor editing, used as the base for the technical review process. That is, chosen representatives reviewed the output of the workshop on quality and completeness. In the following section the main results from the workshop are presented.

### 3.1 Main Results

The result of the workshop consists of the ideas generated during the brainstorming session. In total 75 early warnings were identified. A vote aimed at selecting the most interesting ones resulted in identification of 31 early warnings (cf. Figure 2). The most desired early warnings, reflecting preferences of Swedish stakeholders, concern issues in the following categories:

- Tampering
- Owner/crew
- History
- Rendezvous (object, location)
- Movement
- Cargo

The tampering category exemplifies issues which describes an intentional act to hide current activity. The category owner/crew relates to interesting characteristics regarding the people connected to the ship. The largest category is history, that is, early warnings based on data captured in different registers. Rendezvous exemplifies situations when for example a vessel encounters another object or location. Movement is a specific category aiming at the behavior of objects at sea. Cargo is a category including interesting characteristics regarding goods the ships are transporting.

The 31 most important early warnings selected in the voting activity have been discussed in more detail. Table 1 gives an example of what kind of comments have been gathered, in this case for the early warning ‘ownership and flag history: recent change of flag, change of ownership’.

### 3.2 Conclusions

Many of the early warnings identified in the workshop combine information regarding radar and AIS information. In follow-up discussions after the workshop, this was identified as a possible “defense-biased” conclusion of the workshop, caused by the large number of participants from the Swedish Armed Forces. According to non-defense participants, such as the Swedish Customs, the Port of Gothenburg and the Swedish Coast Guard, there is also much interesting information gathered in various databases kept by them and by other public organizations such as the Swedish Maritime Administration, the Swedish Board of Fisheries etc. Fusion of these kinds of data is a challenge, since most information gathered in these databases does not regard movements and position. Also, it was emphasized that these warnings should cover vessels that enter as well as leave Swedish water.
Table 1. Detailed comments on one of the elaborated top 31 early warnings

<table>
<thead>
<tr>
<th>Early Warning</th>
<th>Movement</th>
<th>Early Warning (i.e., anomalies)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Ownership and flag history:</strong> recent change of flag, change of ownership</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>What information is needed to detect this early warning?</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• owner, flag state, other ship data</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• It is important to determine not just who the owner is but the whole ownership structure. There are 7 levels of ownership from Beneficial Owner (the one who financially benefits from the commercial activity of the ship) to the Operator. Flag changes are not a problem per se, however frequent flag changes denote highly unusual behavior and should be a leading indicator of anomalous behavior.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• data in order to have the most recent information in the VMS-fishing vessel register.</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Where can that information be found (sources, systems, organizations)?</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• ship registers, National ship register, Lloyds, Jane's registers?? (if they cover civilian vessels)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• All 7 levels are available from Lloyd's Register Fairplay. LRF have data on 154000 merchant vessels and issue the IMO number (unique global vessel ID) on behalf of the IMO. LRF and Janes are owned by the same company</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>How can one tamper with this information, and how can that be prevented?</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• flag in corrupt state</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• As long as the data is from a trusted third party, this is not an issue as it is fusing self reported data (AIS) with validated data (LRF). The added value is the output based on the expertise and the knowledge of the people validating the basic data</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>How can this information be fused (methods/algorithms)?</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• compare with data from arrival/customs declarations</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• compare with intelligence data on allegiances of owners, connections to known terrorist/crime organisations/rogue nations</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• create models for vessel behaviour depening not only on specific ship and ship type but also on current owner (and crew)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• by using search engines like google among the ship data bases its technicall possible to fuse the information. Change of ownership in fisheries usually goes together with change of ICRS and external marking. Imported VMS-data from other states are therefore compared concerning vessel ID</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>What is the added value of fusing compared to the existing situation?</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• identify vessels that behave as cooperative targets (deception)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• The output is then more useful as a decision support tool as it gives the end users not just a mass of information but the RIGHT information at the right time.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Figure 2. Overview of identified anomalies during the brainstorming workshop in Sweden
4 Related Research

In this section, two papers exemplifying related research are presented. The studies are presented in a similar way (by using the same headings) as the performed workshop for evaluation purposes.

4.1 Anomaly detection workshop Canada

This section presents a summary of the article Roy [1] (denoted as Study 2). This article is used for comparison with the output of the workshop reported in Section 3.

Method. This paper [1] reports on a maritime domain workshop performed in Canada. It is noted that a workshop can be considered “a small-scale activity”, however, it was judged that the knowledge captured was appropriate and representative enough and sufficient for the development, implementation and testing of the developed “proof-of-concept prototype”.

Purpose. It was reported that the goal of the workshop was to collect enough information to develop and implement a proof-of-concept prototype of a rule-based expert system to support anomaly detection in the maritime domain as a part of a larger project.

Location. The location of the workshop is not indicated in the paper [1]. The report refers to another report, with limited distribution, which is currently not available to the authors of this paper.

Material. The material required for the workshop is not mentioned in the paper. This information is also included in the internal report with limited distribution (hence not available to the authors of this paper).

Participants. The participants of the reported workshop were Canadian Forces subject-matter experts working in an operation center in the maritime domain (i.e., operators). The exact number of the participants is not mentioned in the paper [1]. Details may be available in the earlier mentioned internal report with limited distribution (hence not available to the authors of this paper).

Procedure. The following is an interpretation of the procedure used in Roy [1] as far as it is explicitly stated in the paper. Prior to the workshop, a number of objectives were identified in order to focus the workshop and to ensure the success of it. Also, prior to the workshop, an activity to determine a dictionary of normal and abnormal was performed (to be used as a starting point for the forthcoming discussion). At the day of the workshop, several activities were conducted, as follows: (1) A so called “dictionary perspective” exercise was performed where the participants discussed the result of the prior-workshop activity. During the discussion the participants were free to restrict or widen the “dictionary” definition so that it matched the participants’ interest in anomaly detection. The discussion at the workshop resulted in a definition of anomaly and the relationship between anomaly, threat and vessel of interest. The end of the activity was reached with a consensus of the term anomaly. (2) One of the most important activities during the workshop was to identify a classification scheme of anomalies (thus, this activity was allowed to take much time during the workshop). A brainstorming technique was used to generate ideas. (3) Another activity aimed at expressing and capturing the knowledge of the subject matter experts in some rule format. In other words, the activity intended to list the criteria used to determine whether or not an anomaly has occurred. (4) A document review process was performed involving the participants of the workshop.

4.1.1 Main results

The reported results in paper [1] with regard to the workshop can be divided into three parts (presented in the order they are presented in the paper).

First, the notion of normal and abnormal, and the relationship between the terms anomaly, threat and vessel of interest was identified. Then a dictionary term of anomaly was determined as “Something peculiar (odd, curious, strange, weird, bizarre, atypical) because it is inconsistent with or deviating from what is usual, normal, or expected, or because it is not conforming to rules, laws, or customs” [1, p. 4]. The working definition was reported as “a deviation from the expected.” As they continue to explain: “an anomalous behavior is a behavior that is inconsistent with or deviating from what is usual, normal, or expected, or that is not conforming to rules, laws, or customs”.

Secondly, the main activity of the workshop, according to Roy [1] was to develop a classification scheme (taxonomy) based on the results of the discussion during the workshop. At the highest level, the classification scheme divides maritime anomalies into static (i.e., attributes related to the name, IMO number, international radio call sign, ship control number, license, etc., of a vessel) and dynamic (cf. Table 2). The dynamic anomalies were presented in greater detail in the paper [1].

Table 2. Classification categories of anomalies

<table>
<thead>
<tr>
<th>Dynamic kinematic anomaly</th>
<th>Dynamic non-kinematic anomaly</th>
</tr>
</thead>
<tbody>
<tr>
<td>Course</td>
<td>Next port of call</td>
</tr>
<tr>
<td>Speed</td>
<td>Last port of call</td>
</tr>
<tr>
<td>Manoeuvr</td>
<td>Cargo list</td>
</tr>
<tr>
<td>Reporting</td>
<td>Ship signature</td>
</tr>
<tr>
<td>Location</td>
<td>Crew list</td>
</tr>
<tr>
<td></td>
<td>Passengers</td>
</tr>
</tbody>
</table>

Only the first sub category level is mentioned due to limitation of space. For a more detailed overview we refer to the figures in [1]. Each anomaly was further elaborated upon in detail. More specifically, a table format template was produced to summarize the key descriptive attributes of each anomaly. It is implied that
this documentation has been reviewed by participants of the workshop.

Third, a number of production rules were identified which exemplifies the knowledge of the subject matter experts. The exact number of identified rules is not mentioned in the paper [1].

In addition to these results [1] reports on the development of the prototype such as the created ontology, the requirements and the design constrains for the proof of concept prototype design. As limitations of the study, it was noted that these should be considered as initial result and the produced classification scheme needs to be further investigated and validated by subject matter experts.

4.2 Field study anomaly detection Sweden

This section is a summary of the study reported in [2] performed by the authors of this paper, herein denoted as Study 3. This article is reviewed for comparison with the methodology of the workshop reported in Section 3.

Method. A participatory observation [6] is a type of observation where the researcher is allowed to include himself/herself in the study environment. In this way, the researcher is allowed to ask questions and to be instructed by the ones observed when they perform various tasks. In this way, the users can explain the task while they are being performed (i.e., focus is not only on what they know, but how they actually use that knowledge which they might not necessary be able to verbalize themselves).

Purpose. The field study was performed to collect information which could be turned into rules into a rule-based anomaly detection application.

Location. The observations were performed on site at a maritime control room in Sweden operated by the Swedish Navy.

Material. Field notes were collected during the observations. Thus, the requested material for performing the study is pen and paper.

Participants. In the reported study seven Swedish Navy subject matter experts (i.e. operators), with an average of three years experience, participated in the study.

Procedure. The observations were conducted during four occasions (including a pilot test) distributed evenly round the clock to allow for different conditions, for a total of 16 hours. About 70 vessels were identified and tracked during the observations by the team of operators. During the observations, when needed, operators were asked to explain the reason for making a specific action. Field notes (pen and paper) were used to capture work procedures and events which could later be formalized into rules. After the observations, a summary of the rules has been verified by two of the operators for validity. The focus during the observations was guided by the following research question:

- How do operators in a maritime surveillance control room classify/interpret suspicious behavior when interacting with the overview display, i.e., when and what triggers users to make a decision and/or to take action?

4.2.1 Main results

The participatory observations resulted in a collection of field notes on how the team of operators interacted in the control room in order to be aware of what was going on at sea. The observations revealed a number of different interesting factors concerning situation awareness and anomaly detection. For instance, operators either used their experience, the context of the event, incoming reports or the list of permits to determine whether or not an anomaly had occurred. In addition, the observations resulted in the identification of the following 8 anomalies [2]:

- if a vessel has a speed above X then the operator wants to be notified
- if a vessel enters area X and has a name Y then the operator wants to be notified
- if a vessel is laying still during a longer period of time then the operator wants to be notified
- if a vessel abandons previous speed (i.e., high speed, low speed, high speed, etc.) then the operator wants to be notified
- if two vessels are going towards each other, and upon encounter make a turn, then the operator wants to be notified
- if one vessel encounters a smaller boat then the operator wants to be notified
- if vessels abandon a planned route or go beyond the specific area commonly referred to as E4/E6 then the operator wants to be notified

Looking at the identified rules, one can see that they consist of: relations (binary, unary), combination of future state and attributes, combination of physical (border) and abstract, (land) attributes, and describing situations evolving over time.

5 Comparative evaluation

5.1 Comparison of output

In this subsection the outcomes of study 1 and study 2 are compared. The focus is on the comparison of the overlapping parts, e.g. the identification of early warnings respectively anomalies in maritime surveillance in a brainstorming session.

A first striking difference is that the categories in which the identified anomalies are sorted are different between the Swedish and the Canadian workshop. In Canada, creating these categories as part of a taxonomy has been part of the workshop, in Sweden this has been a post-workshop activity. The differences do not seem to be very important; one could easily re-categorize both workshop outcomes according to the categories of the
others. In both cases, it seems that categories have been created to create some structure and overview in the long list of anomalies.

Secondly, some examples can be given on anomalies identified in both workshops, e.g.:  
- Owner/crew: criminal history  
- Owner/crew: large crew turn over  
- Movement/unnusal routing: presence in protected or closed area  
- Movement/unnusal routing: not to port of call  
- Movement: speed does not match vessel type  
- Tampering, report quality: conflicting data  
- Cargo: does not match port of call  
- Cargo: does not match vessel type

Similarly, some examples can be given of early warnings only identified in the Swedish workshop:  
- Rendezvous with airplane  
- Tampering: intelligence report on smuggling of drugs/weapons  
- History: change of ownership/flag  
- History: visited ports of interest/port with known criminal activities  
- Cargo: cargo does not match crew

And some examples of anomalies only identified in the Canadian workshop:  
- Maneuver: loitering  
- Reporting: missing reports, 96/24 hrs call  
- Last port of call: Failed CBRN (CBSA checks ships when they leave ports)  
- Passenger: too many people on deck  
- Passenger: More than to be discussed % sick in similar disease

In conclusion it can be said that about half of the indentified anomalies are overlapping, and half were unique. Possible reasons for these differences and their implications will be discussed in section 6.

5.2 Comparison of methods

In this subsection the working methods of study 1 and 3, and the impact on the outcomes, are discussed. A full comparison between the workshops (study 1 and 2) seemed not reasonable, as we are lacking too much detail on the actual working method of the Canadian workshop. If they conducted a traditional pen and paper brainstorming workshop, it would be interesting to compare that with our computer supported workshop, but then more detail on the actual time spent on brainstorming and the exact number of participants is needed.

Our computer supported brainstorming workshop (study 1) generated many early warnings and detailed comments in a very short time frame. Less than 3 hours were spent in the computer supported brainstorming session, and 75 ideas and 200 comments on the top 31 early warnings were gathered. This is a clear difference with the field study (study 3), where only 8 anomalies were identified in 16 hours, as one is dependent on the type of anomalies that actually occur during the observations. Furthermore, during the field study there are only observations at one organization, with one to one discussions between the researcher and the seven different operators, while the workshop included 25 participants, which actively interacted with each other. Some other benefits of the workshop compared to the field study are that participants phrase the anomalies in their own words, as well as the easy documentation. The workshop report was generated within one minute and only two hours of fine-tuning were needed to produce a nicely edited report. The field study notes required much more time to document and edit.

However, a drawback of the brainstorming workshop may be that the early warnings generated are described poorly, or that the researcher/project teams may not understand what they mean due to lack of context. The lack of context may also influence participants, it may not be so easy to come up with anomalies when you are not in your working situation and there is only 20-30 minutes scheduled for this brainstorm activity. The field study has the benefit to obtain a more in depth understanding of the anomaly, e.g. why it is important and how it functions.

6 Discussion

In this section reasons for the identified differences are discussed, as well as their implications for information fusion research and practice.

The differences in outcomes between the Swedish and the Canadian workshop may have different reasons. One can be that the interests of Canadian and Swedish stakeholders differ that much, but that is not very plausible. A more convincing reason may be that both are incomplete, e.g. that more iteration of workshops, alternatively a merging of the outcomes leads to a more complete taxonomy. Also, it has been shown that the invitation of the ‘right’ stakeholders may have a large impact on the outcomes, and possibly create some bias. In the Swedish case Armed Forces were overrepresented, which may have led to a bias in the results.

To go from a more abstract brainstorm (75 ideas) to a more in depth discussion (200 comments on 31 selected ideas) it was necessary to prioritize the early warnings in a vote. However, it can be questioned whether the different stakeholders actually prioritized on the same criteria. For example, when they are asked to rank on importance, one may interpret this as ‘highest impact’, another as ‘occurs most often’, and a third as ‘easiest to implement’. This may have influenced our outcomes in unwanted ways.

From a working method perspective there is no easy conclusion that study 1 was better than study 3 or vice versa. Both types of capturing knowledge from subject matter experts have their value, and in combination they can actually compensate for their
weaknesses. This requires a clever design of how field study results can feed brainstorming workshops, or how outcomes from brainstorming workshops can be explored in more detail in field studies. In each case, it is important to note that these techniques require quite some experience, and that the major challenge is to do ‘good’ brainstorming sessions and field studies, rather than ‘poor’ ones. More background on potential benefits and work methods for each approach can be found in [13] and [14] for computer supported brainstorming and [15] and [16] for participant observation studies.

7 Conclusions

The aim of this paper was to identify the benefits and drawbacks of different ways of capturing knowledge from subject matter experts. For this purpose, three studies involving the identification of anomalies in maritime surveillance were compared, partly on their outcomes, and partly on their different ways of working.

The main conclusions are that brainstorming workshops and field studies both have their benefits, and that both methods need to be combined, to compensate for their respective weaknesses.

Furthermore, the large differences in outcomes between the Swedish and Canadian brainstorming workshop imply that more iterations of the workshops, or possibly the merging of their outcomes, should be performed, to arrive at a more complete taxonomy of maritime surveillance anomalies. More workshops and field studies can be conducted until no ‘new’ anomalies are identified.

Finally, it has been observed that outcomes of both workshops and field studies are heavily dependent on which subject matter experts are invited, respectively which operators are observed at what sites. Therefore, a strong recommendation is to put a lot of effort in identifying all relevant participants as well as in the cumbersome process of making sure that they actually show up.

References


