

# Turning Common Operational Picture Data into Double-loop Learning from Crises – can Vision Meet Reality?

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## ABSTRACT

This study proposes a framework for double-loop learning from crises, using common operational pictures (COP). In most crises, a COP is of outmost importance to gain a common understanding among inter-organizational response. A COP is sometimes expressed through a map visualization. While the technologies to support COP progress rapidly, the corresponding practice of evaluating the COP and situational awareness is not yet established. Tools that enable responders to learn after the crisis, look back in time on the COP development and detect the barriers that prevent the COP establishment, still seem absent. Double-loop learning is an organizational practice to learn from previous actions widely adopted in the safety domain, and lately used in crisis management. This paper addresses the perceived gap by presenting the technical, organizational and structural requirements derived from document analysis, observation, and a workshop with multiple crisis management stakeholders, and integrating them to an initial framework.

## Keywords

Common operational picture, situation awareness, double-loop learning, crisis management, map-based evaluation.

## INTRODUCTION

The need to retrospectively appraise and learn from a crisis operation – or an exercise – is an acknowledged part of crisis management, usually referred to as “the evaluation phase”. Nevertheless, scholarly articles on learning from incidents in crisis management are limited. Those that exist usually use terms and concepts such as “learning after a disaster” (O’Donovan, 2017), “lessons-learned approach” (Rostis, 2007) and “after-action review” (Savoia et al., 2012; Tami et al., 2013). In the past decade, the possibilities provided by information and communication technology (ICT) has expanded rapidly, e.g. by systems for decision-support, and common operational pictures (COPs). A COP is a display or a series of displays of relevant operational information from a situation, showing e.g. position of units, infrastructure, weather information, events, and decisions. It is often manifested as a geographical representation combined with a checklist that describes the characteristics of the response operation (Wolbers and Boersma, 2013). It can be used collaboratively by organizations participating in an operation. Although it lacks a univocal definition, it is contemplated as a promising support in actors’ development of situation awareness (SA) and to collaboration and information sharing difficulties in the field (Comfort, 2007).

There is currently limited technology support for visualizing and sharing a COP as a basis for systematic learning from incidents and exercises (Munkvold et al., 2019a; Munkvold et al., 2019b). This also means that studies that focus on evaluating SA, and common situational understanding using a COP are mostly absent. It is thus difficult to identify findings on how to evaluate COPs and common situational understanding at all. In relation, having access to technology-based COPs allowing for dynamic visualization and reconstruction of crisis operations or exercises do not necessarily in itself imply better evaluations. Our premise is rather that the emerging technology possibilities and COP data must be connected to organizational processes of turning “lessons identified” into “lessons learned”, organizational implementations, and “double-loop learning”. Double-loop learning is a concept stemming from organizational learning where Argyris and Schön (1978) distinguished between single-loop and double-loop learning. The latter is the learning process in which e.g. an organization is able to reflect upon, question, and modify the goals, values, assumptions and policies that led to certain actions. Single-loop learning is more of a repeated attempt at the same problem with no variation of method. The concept has since been used widely in different application areas, including emergency management and crisis management (e.g., Bakacsi, 2010; Pilemalm et al., 2014). From an inter-organizational perspective, a related challenge is that having joint, access to a COP does not in itself imply having a common situation understanding among organizations, and thus no joint organizational double-loop learning. To achieve such long-term improvements, some regional or national co-ordination is probably needed.

Our work is embedded in the INSITU research project aimed at developing a systematic approach for establishing a COP and shared situational understanding among multiple organizations in emergency response, in a Norwegian crisis management context. The project covers several other topics including building a common map-based interface, integrating harmonization of terminology, and collaboration support for information sharing and synthesis (Munkvold et al., 2019b). The topic relating specifically to our study is to explore and describe a high-level framework for improving inter-organizational “double loop” learning for crisis management, highlighting SA and common situation understanding. The suggested framework should enable the combined use of real-time data from a COP interface with organizational processes.

### **Aim of Study**

The aim of this study is to present an initial version of the framework outlined above. It is thus a first attempt to let vision meet reality: to create pre-requisites – identified technical, organizational and structural requirements – to turn COP data into evaluation results that can be actually used and organizationally implemented. We will thus also discuss the study outcomes in terms of recommendations for long-term improvement of crisis management evaluation and learning. The presented framework/evaluation concept focuses on emergency response inter-organizational collaboration, information sharing and SA. The intended audience are researchers and practitioners in the crisis management domain; not the least latter since the proposed framework need to be further developed together with them. The focus of the study is crisis management exercises since these are easier to evaluate short-term than real operations, but (parts of) the framework should be applicable to real operations as well.

The remainder of this paper is structured as follows. In the next section, we explain the background of our work and sketch the context of our study. We then describe our research method including the analytical framework used, followed by presenting our results. Eventually, we discuss our findings and conclude.

## **BACKGROUND AND STUDY CONTEXT**

Here, we first give a general overview of research state-of-the-art concerning evaluation and learning from crisis incidents, including learning challenges with specific focus on COPs and SA. We then present the study context.

### **Learning from Incidents in Crisis Management: the Continuous Challenges**

Different aspects of evaluation and learning from crisis management have been discussed in various studies e.g., learning from humanitarian operations (Charles et al., 2009); learning from major forest fires (Marklund and Wiklund, 2016); learning from Y2K and 9/11 response (Toelken et al., 2005), and knowledge sharing from exercises (Nordstrom and Johansson, 2019). A commonly used approach is After Action Review (AAR). While the original AAR focuses mostly on human performance in military training, its application in crisis management also embraces teamwork and collaboration. It seeks answers to questions like “What was supposed to happen? What actually happened? Why were there differences? What gaps materialized between planning and execution? What went well? What can be improved? What can we learn?” (e.g., Tami et al., 2013). AARs can be applied using various methods, e.g. surveys, interviews, group sessions. AARs can also be technology supported, e.g., by various computer and multimedia tools aimed at replaying and visualizing the crisis/exercise (Pilemalm et al., 2008).

Learning from crisis operations and exercises is essential since one needs to ensure that lessons *really* are learned so that the worst effects of the next crisis can be avoided. However, this comes with numerous challenges that have persisted over time. In real events, the paradox is that the timeline between the incident and report creation is insufficient to allow any organizations or personnel to actually learn from incidents, thus the report is referred to as “fantasy documents” (Birkland, 2009). An alternative is to carry out exercises, but these are simplifications of reality. Also, in real operations, it is well known that one crisis is different from another. In other words, learning must have a focus on common improvements that are transferable to future crises. In relation, Savoia et al. (2012) point at difficulties in aggregating and utilizing situation reports. Donovan et al. (2017) claim that various types of policy failures hinder policy learning, e.g., failure in policy program, failure of policy process agenda setting, policy formulation, decision making, policy implementation, and evaluation. In other words, there are often insufficient prospects for turning *lessons identified* into *lessons learned*. This can also be described as lack of *double-loop learning* processes, i.e., processes in which an organization can reflect upon, question, and modify the goals, values, assumptions, and policies that led to certain actions (Argyris and Schön, 1997). Pilemalm et al. (2014) point out that double-loop learning in emergency management is difficult to achieve since proposed changes are not accompanied by adequate organizational processes. With regards to AAR, a critique is its focus on *what happened* instead of *why it happened*. If you do not know why something happened, it is difficult to avoid it happen in the future or reduce the consequences. The challenge becomes even more substantial in large-scale crisis operations or exercises where numerous actors, organizations, and tactical levels are involved (Pilemalm et al., 2008).

### Technology Support for Situation Awareness and Understanding: Common Operational Pictures

Situation awareness (SA) can be described as the perception of environmental elements and events with respect to time or space, the comprehension of their meaning, and the projection of their future status. It plays an important role in situations where the environment is complex, and the actors need to ascertain critical cues to determine which decisions to make, e.g., in crisis management (Endsley, 1995). A related term is situational understanding that refers to the more long-term analysis and judgment of the unit's situation awareness, e.g., to determine the relationships of the factors present and form logical conclusions concerning the course of events and information gaps to make room for future improvements (Dostal, 2007). In inter-organizational operations, common SA and situational understanding – in the following referred to as *SA/U* for *situational awareness and understanding* – become crucial. COPs may be used to support them. Even if COPs lack a univocal definition, some recurring factors are significant: structure, representation, processes, and management (McNeese et al., 2006). A COP is a structure for available information to be collectively transformed by the actors into knowledge and a representation of the knowledge that provides a process, decision, and actions based on the structure and representation.

During the past decades, there has been a belief in the possibility of map-based COPs to increase common SA/U since it can capture and visualize the dynamics of crises. For instance, Pilemalm et al. (2008) suggested a multimedia tool for the reconstruction of large-scale crises or exercises, using a timeline, that enabled a focus on the *why* rather than try to reconstruct *what* actually happened. Nevertheless, as to date, few studies embrace the concrete use of COPs for evaluation of SA/U, collaboration, and information. There is an even more apparent lack of studies that connect them to evaluation processes and long-term inter-organizational learning. The learning process often stops at the reporting stage and usually focuses on the behavior of the hardware and the operators/workforce involved directly with the activities. This likely has to do with the general organizational challenges of turning lessons identified into double-loop learning and the challenges of distinguishing between a COP and to achieve common situational understanding. These points are an untapped potential for increasing the use of COPs and map services to support the evaluation and learning from crises and complement them with relevant processes that enable organizational use and improvements, based on the COP data.

### Study Context

The study is a part of the nationally funded INSITU research project running from 2019 to 2022. The overall project goal is to contribute to effective sharing, integrating, and using available information from different sources to establish a COP as a basis for shared situational understanding. The project will develop services for information sharing, suggest standards for intuitive and explicit map symbols, develop and design a user-friendly and easy-to-use common map-based interface, methods, and tool support for collaborative information synthesis. The prototype will provide a common map-based interface, integrating harmonization of crisis terminology and collaboration support for information sharing. The project is carried out in close co-operation with stakeholders from Norwegian authorities and crisis management organizations. As part of the overall project, the enhanced COP will also support evaluation and learning from exercises and incidents. Figure 1 presents a high-level design of the solution concept that is developed in the project, connecting the different project areas. The double-loop

learning and evaluation contributions to the overall project are marked with red dashed-line boxes. These boxes indicate the research area reported in this paper. The research area reported in this paper will contribute in two areas of the overall INSITU projects. First, it will contribute toward better use of terminology and map symbols for crisis management (upper dashed-line box). Second, this work will contribute toward the establishment of better evaluation and learning from exercise and real emergency response in EM organizations (bottom dashed-line box).

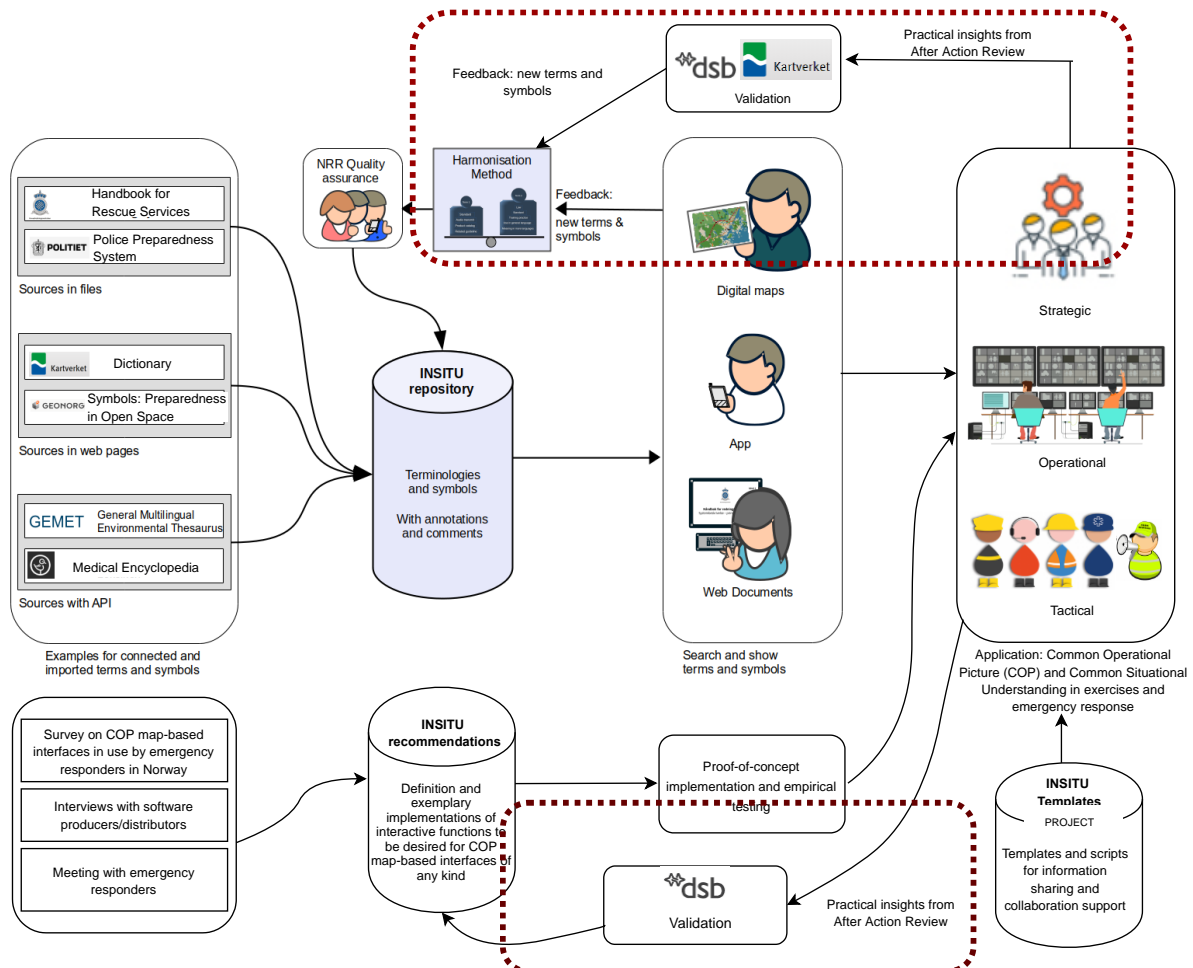


Figure 1. Illustration of the INSITU project solution concept

## METHODS

Our study is based on participatory design principles, which presume close co-operation with the stakeholders throughout the development process (Steen-Tveit, 2020). Data collection for this study included document analysis, participant observation, discussions, and a two-day stakeholder workshop involving three sessions: round-table discussion, brainstorming and the World Café method. Most documents used in this study are based on Norwegian emergency management, although in the overall project, we have also included examples from Sweden.

### Document Analysis

Document analyses are usually applied in an initial phase of a study to explore existing knowledge on the phenomenon under study (Bowen, 2009). In this study, different types of documents have been collected and analyzed, both as the background overview and including preparation for the empirical data collection. This includes scientific publications, national regulations and guidelines, government white papers, reports from exercises and evaluations, and documents from related projects. For the results section, the guidelines on evaluation provided by the Norwegian Directorate for Civil Protection (DSB) are in focus.

### Empirical Data Collection

Given the nature of the broad project, it was deemed important to combine various data collection sources for the evaluation and learning part to be used as input for suggested COP functionality and evaluation framework. Some of the data used in this study was collected through observation, performed during an inter-organizational drill in the field, and involved command and control centers. This data was mainly used for other purposes of collecting requirements for information sharing and SA and are presented in detail in (Steen-Tveit, 2020; Steen-Tveit and Radianti, 2019; Steen-Tveit et al., 2020). However, some of the insights are also relevant to this study since the results suggested alternative methods to evaluate, if existing communication and information sharing can serve as a basis for capturing the development of SA and a COP.

The main bulk of the data used in this study was collected from a two-day workshop with the project reference group. Altogether 24 participants from 20 organizations took part, including national directorates, authorities, and first responders, thus enabling the broad representation of stakeholders from the crisis management domain. For example, stakeholders from the police, the fire services, and health services, the county and municipal emergency management, the Norwegian Directorate for Civil Protection the Norwegian Defense Research Establishment, the Emergency Support Unit at the Norwegian Ministry of Justice and Public Security participated. The overall focus of the workshop was, based on current practices and needs for improvement, to provide input to the establishment of a COP, including identifying functionalities that can be used in evaluations and surrounding organizational needs. The workshop was organized in three sessions. The first day comprised two sessions: first, group roundtable discussions and experience exchange on current practice for establishing COPs and common situational understanding and, second, brainstorming on the stakeholders' needs for improvement. The participants were divided into four smaller groups where the aim was to have representation from various stakeholders, emergency organizations, and different levels (operative, management) in each group. The groups worked with different themes; one of them was on the support for evaluation of operations and exercises. The groups rotated to attend the presentation of each theme so that each group had a chance to provide feedback to the brainstorming results of the other groups.



**Figure 2. Brainstorming process (left), unsorted results (middle), clustered, prioritized results (right)**

On the second day, we employed “World Café” - a design method drawing on seven design principles requiring active participation of stakeholders and group dynamics; create a hospitable space, encourage everybody’s contribution, connect diverse perspectives, listen together for patterns and share collective insights (Camacho et al., 2020). A café-like atmosphere is manifested through the establishment of small groups working in round tables about a topic and then share experiences in the larger group. The same four groups rotated into different tables to discuss the various themes. The data collected in the brainstorming phase served as input. Different Café tables adopted different elicitation methods, depending upon the facilitators. For the intended COP support for evaluation of operations and exercises theme, a presentation based on the Norwegian government vision on future evaluations of crisis management operations was used as input to stimulate discussion. The results were shared in the larger group at the end of the workshop.

Throughout the workshop, the discussion was noted by the participating researchers acting as observers in each group. In the brainstorming phase, the stakeholders wrote needs and suggestions on post-it notes and sorted them into various categories. In the World Café, the stakeholders expressed their opinions based on questions posed by the facilitators that would contribute to each specific theme. The entire workshop was audio-recorded and transcribed.

## ANALYSIS AND ANALYTICAL FRAMEWORK

We applied a thematic analysis (Bowen, 2009) for the study. The authors participated in the workshop, used transcript data, post-it notes, and some identified requirements from the previous participation observation and

interviews described by Steen-Tveit (2020) as input<sup>1</sup>. We chose to structure identified requirements according to overall themes of *technical requirements*, *organizational processes and methods*, and *structural processes*, learning on the socio-technical system view and organizational learning theory, described below.

### Socio-Technical System View

The socio-technical system view assumes that technology consists of organizations, personnel, methods, equipment, and technological artifacts involved in implementing the assignments, e.g., in crisis response (Orlikowski and Iacono, 2001). According to this view, it is not sufficient to only study the technological part of an information system, such as a COP, to capture its complexity and the dynamic dimensions (Alter, 2003). In the study context, this means that we do not believe that providing new technical tools for improved evaluation of crisis management SA/U, collaboration, and information sharing is sufficient to achieve lessons learned and inter-organizational learning. Rather, stakeholders, organizational processes, and recommendations for implementation should be explored, identified, and developed in parallel.

### Organizational Learning

As explained in the introduction, early works on organizational learning distinguish between single-loop and double-loop learning. The latter is the learning process in which an individual or organization is able to reflect upon, question, and modify the goals, values, assumptions, and policies that led to certain actions (Argyris and Schön, 1997). Later, e.g., (Nonaka and Takeuchi, 1995) developed the idea of double-loop learning further, including aspects of tacit knowledge vs. explicit knowledge, and described a process of alternating between the two of them. The tacit knowledge of key personnel within organizations and collaboration can be made explicit by processes of socialization, i.e., acquiring the tacit knowledge of others through interaction. Next, the acquired knowledge is articulated and created in a corresponding process by externalization. Finally, the knowledge can be incorporated into processes for later internalization, i.e., embodying externalized knowledge in employees and/or applying it in practice.

As pointed out in the background section, double-loop learning is often related to lessons learned (e.g., Pilemalm et al., 2014). In the context of crisis management, single-loop learning, usually refer to repeated attempts at the same problem using the same method with no questioning of underlying goals (Argyris and Schön, 1978). A typical example would be an incident report that identify needs for improvement from a crisis operation but where no one takes the report further. The need to aim for double-loop learning in crisis management has been pointed out in several studies, e.g. by Deverell (2009), who presents a conceptual framework and explore it in relation to two large-scale blackouts in Stockholm, Sweden, and by Bakacsi (2010), who focuses on traditional leadership as a hindrance to double-loop learning. However, studies on double-loop learning in direct relation to SA/U and COPs still seem scarce. In this study, we therefore aim at developing a concept that will enable double-loop learning *in* and *between* organizations with specific focus on COP supported SA/U. For the latter, we refer to the Nonaka and Takeuchi (1995) use of *combination* which refers to the ability of organizations to cross-reference multiple bodies of explicit knowledge and to connect them to a coherent whole

## RESULTS

In the results section, we first focus on the COP data that can support evaluation and learning (technical requirements), then on organizational processes/methods, and finally on structural processes.

### Technical Requirements: Potential of COP Data

From the document analysis, we found that the Norwegian Directorate for Civil Protection (DSB) guidelines' recommendations on technology for evaluation and learning is on a general level and do not provide suggestions specifically related to COP use in evaluations, or for SA/U (DSB, 2016, 2018). Similarly, the recurring theme during all workshop sessions is about the general need to retrieve "*fact-based*" and "*objective*" information from the COP. In most cases, it was not clear what is perceived as a "fact" or "objective", as exemplified in the World Café:

*Historical and fact-based information will strengthen the evaluation work (Group 2, World Café).*

<sup>1</sup> This reference is not necessary for understanding our paper but is additional background work. The paper from 2020 describes interview results with a focus on requirements of map-based interfaces. For example, to gain a common operational picture, standardized symbol usage with a common cartographic design is recommended.



The exception was *map information*. Several of the workshop participants pointed out how current screenshots that are used to register and share SA are insufficient and point at a need for map-based alternatives. They want the COP to provide time scales, stamps, maps, logs, and symbols, to enable more exact evaluations of command and control of crisis operations and exercises against pre-defined goals:

*Today we need to use screen dumps for registering situational pictures – if we get a good map solution with time axis with map and symbols this will improve the evaluation.* (Group 4, World Café)

In the projects' previous research – taking extreme weather as an example –Steen-Tveit et al. (2020) identified more concrete needs for information sharing and SA/U that cover locations and critical buildings (e.g., coordination and meeting points, schools, hospitals), infrastructure (e.g., transportation, electricity, water supply, telecommunication), information on possible victims, evacuation possibilities, resources (e.g., units, vehicles, first responders), and weather information. All these are deemed relevant also for the evaluation phase.

The COP information should be *dynamic*, allowing better evaluations of large-scale exercises or crisis operations. In the workshop, the stakeholders suggested time scales, time logs and stamps, and continuously up-dated COPs that monitor the crisis development for improved SA/U and systematic follow-ups. The data can be extracted from the COP to support the *reconstruction of events* regarding, e.g., collaboration, information sharing, and situational development. They also suggested that map-based solutions could provide *decision-material* on decisions taken during different times and places. A *decision repository* was perceived to support the reconstruction of decision-making processes. In general, the stakeholders expressed the needs for repositories and report systems for storing cases, experiences, lessons identified, best practices, logs, analyses, and previous evaluations.

As to existing information systems, the stakeholders referred to the current Search-and-Rescue (SAR) systems at several occasions. The system currently includes automatized report systems used by the rescue services. The systems collect experiences provided by the responders that have been involved in a rescue operation and store them in the database to be used to improve future operations. The respondents suggested added functionalities i.e., the capability to *aggregate reports, generate action plans from reports and extract statistic data* to be used in future knowledge development. In general, there was a perceived need for a tool that can generate simplistic evaluations, sum-up learning points, and share experiences.

### Organizational Processes and Methods

As to organizational processes, the DSB states that the primary purpose of evaluation of crisis management operations and exercises is to enable reflection that can *contribute to learning and identify needs for changes* (DSB, 2016, 2018). Evaluations document *what* has happened, analyze *why*, *what* needs changes, and *how* to find learning points and suggestions for action. At organizational level, an evaluation team with several roles, such as the evaluation leader and local evaluators, is proposed. The guidelines suggest methods for data collection as a basis for evaluation, e.g. observations, questionnaires, interviews, and logs from other documents. Questions are proposed e.g. How will the data be processed? Will a written report be required? How will the evaluation result be conveyed to the relevant stakeholders?

Overall, the suggested evaluation method after the exercise (not an operation) follows the earlier described, commonly used AAR model. It should preferably be completed right after the exercise and involve all participating stakeholders. The AAR participants are supposed to fill out immediate learning points in relation to various aspects of the exercise. The guidelines thus indeed include many useful recommendations. However, as they are only high-level and general, they provide a limited basis for evaluating whether a COP and SA/U were established during the event. The learning points cannot be used to evaluate when and how common understanding was shaped, and if there were misunderstandings, how these were solved, among which actors, what were barriers causing the delay of establishing a COP and common understanding, and what were the consequences of this delay. In summary, the guidelines thus have no explicit connection to improved COPs, and SA/U. However, in the workshop, several respondents mentioned that future organizational processes for evaluation could indeed make use of the DSB templates and guidelines if they are further developed. Directives connected to the guidelines could also support practical implementation in the own organization.

Again, the re-current theme, both in the brainstorming and World Café session was, an objective and fact-based knowledge basis. There is thus a perceived need for a:

*“knowledge-based evaluation process”* (Brainstorming session)

The process should be based on a correct understanding of reality and the ability to reconstruct an incident or exercise. It is generally believed that this will also enhance inter-organizational cross-sector evaluations, “true” knowledge, and lessons-learned. The stakeholders also came up with rather detailed suggestions on how to *develop systematic, intention-based methodologies* connected to *pre-defined goals*. This included, in the preparation phase, to define goals and related data collection where a focus should be on dynamic results and the incident over time. If possible, the exercise is then carried-out with other organizations and sectors. In the debriefing phase, applying AAR (focusing on what went well and bad and taking this further to organizational and governmental level for lessons learned) immediately following the operation or exercise, was suggested. The value to sometimes perform joint, inter-organizational AARs were mentioned. In a longer time-perspective, the evaluations results should be transferred to action plans in the own organization and integrated in daily routines. Experiences, e.g., whether the goals have been met should also be documented to improve the next exercise/operation. They should also be stored in case databases to be used as learning material.

The stakeholders did not often refer explicitly to the SA/U topic when discussing how organizational processes for evaluations can be improved. However, some of them mentioned that making use of information sharing, COPs and SA data for evaluation must be considered in the planning phase of the exercise, and exercises that focus specifically on continuously updated SA were suggested. Some stakeholders also expressed the need for a feedback mechanism for the usability of collected COP information so that no unnecessary data is collected the next time. Also, besides the need for vertical and horizontal evaluations at the management and/or operational level, evaluations across organizations and sectors is emphasized in the data material. It is believed that this will produce overall pictures of COPs and improved SA/U – something that is currently perceived as a gap.

### **Structural Processes: the Need for Co-ordination**

As for the document analysis, the DSB, guidelines, and methods on how to evaluate exercises emphasize that the evaluation is a *systematic assessment* according to defined goals and the goal achievement criteria (DSB, 2016). The evaluation must, therefore, be part of the planning process. It is again notable that the current guidelines are on a general level with no methodology or support as to coordinate evaluations on a national level. However, the government has recently published a set of requirements that should be considered in future evaluations of crises. These demand to follow-up exercises and operations in all state authorities in the civil sector security domain and to take lessons-identified further, through action plans anchored at the respective authority management level. *The evaluation phase should not be considered as complete until all the points in the action plan are handled.* (Meld.St.10, 2016-2017).

In the workshop, the structural level was discussed in both the brainstorming and in the World Café session. In general, stakeholders agreed that time and resources must be set aside in advance, not after a crisis has occurred – to establish common long-term practices around evaluations. They argued that the DSB guidelines should be simplified to be useful. DSB could also support in developing concepts and training courses for evaluation; evaluations need to be turned into action plans, handled, and implemented. There should be a clear order as what actions to prioritize with a focus on those lessons-identified where improvement is clearly needed. Persons responsible for actions should be appointed and evaluations and learning points should be reported to and anchored at the management level both in own organizations, regionally and nationally, to the authority responsible for a specific area. The stakeholders also pointed at the necessity to develop *common and regular routines* for evaluations and to achieve *quality improvement* of current evaluations and common practices. Needs included focus on best practices and what can be improved; and establish a common practice for evaluation and feedback mechanisms as an integrated part of any operation. It is also deemed important to develop *standards* for evaluation based on directions from the national authorities. How information should be *stored, owned, and distributed* to enable transferring identified challenges from one exercise/operation to the next, was addressed in the World Café:

*Where should this info be stored, owned and shared – important to clarify.* (Group 3, World Café)

SA/U were again explicitly referred to only occasionally. However, a few respondents in the World Café session claimed that if you know that you will be evaluated on relevant SA/U, you can modify the exercise to include these aspects. Some respondents claimed that evaluation methodologies should be the same across organizations for synergy effects. In the brainstorming session, a recurring need was to address the perceived current gap of *coordinated, interdisciplinary or inter-organizational evaluations*, to coordinate evaluations from each sector to an overall COP/SA/U. The respondents thought looking deeper into mutual cross-sectoral dependences and challenges could provide added value to evaluations.



*Sector-wise evaluation will be strengthened by holistic evaluation based on facts and retrospective analysis.*  
(Group 1, World Café)

A few stakeholders even suggested generic operation rooms and physical arenas e.g., at regional level, to facilitate training, instructions, developing action plans and analysis of evaluations.

### **Analysis and Initial Framework**

Comparing the existing DSB guidelines with our findings, it is not surprising that there are several overlaps as to how organizational and structural needs (e.g., action plans, prioritization, appointed responsible persons, anchoring) are expressed. First, a few of the workshop stakeholders were from DSB. Second, these are recurring challenges relating to turning lessons identified into lessons learned and how to create organizational double-loop learning. That the stakeholders describe many evaluation needs on a general crisis management level and those COP technology and SA/U related on a rather high-level is also not surprising. This is a common challenge when a technology is new, emerging, or not yet existent (Bjögvinsson et al., 2012). Previous data in the project, on the other hand, have exemplified several needs for information sharing and SA/U, that can be displayed in the COP and used also for evaluation purposes

The rhetorical question then persists: *If both vision and knowledge on how to learn from crises has existed for so long; why is it so difficult to realize?* An additional challenge to those described in the background section are of course lack of time and resources. The workshop respondents argued several times that more resources need to be invested and set aside in advance for evaluations, both at the organizational and at the structural (regional, national) level. On the other hand, a COP support for improving SA/U may provide a basis for rendering the evaluations more effective and cost-beneficial in a long-term perspective. This, since you can spend less time on exploring the AAR theme “what happened” when the COP reconstructs the event according to a timeline and thus visualize this “what”. Thus, is it then possible for *vision to meet reality in the specific case of COPs* for improved evaluations that are turned into organizational double-loop learning and lessons learned and implemented? We believe that a start to address them is systemize the requirements to an initial framework, as presented in the following.

#### *Planning phase: to formalize the evaluation*

Pilemalm et al. (2008) argued that the benefits of technology support for reconstruction and visualizations of inter-organizational crises will not be realized if methodological challenges are not handled. This implies that for each exercise/operation the involved organizations must define a set of goals, actors and units beforehand, i.e. those most relevant to the SA/U themes that will be in focus during the reconstruction and analysis phase. This should be connected to intended evaluation goals, output, and its format, complemented by action/implementation plans. Relevant contacts to relevant organizations and sometimes to regional and national authorities should be taken. As to COP-based evaluations, SA/U are often difficult to evaluate in themselves, and scarce research and experience exist. One solution is to conduct exercises that focus on evaluating the involved actors’ SA, joint understanding, and decisions taken during different crisis phases. In relation, involved organizations should jointly define what data they need to extract from the COP for what evaluation purpose. This concerns many methodological issues as organizations must decide what data, information, and decisions to prioritize and connect them to defined goals and themes, how to capture (record) and store them during the exercise or operation, how to visualize them during debriefing and evaluation, and how to transform them to the desired output format. Thus, the COP data available should be connected to existing incident command systems (ICS) (Buck et al., 2006) and standard procedures for handling crises in various settings. In the framework (Figure 3), the planning phase addresses *what must be done* and *what data from the COP repository shall be integrated in the planning process*.

#### *Evaluation Phase: Taking Advantage of The COP*

It is possible to argue that the COP evaluation data is the result of preparation and a structured working methodology in the planning phase. It is important to emphasize that a single COP is not sufficient to provide a holistic operational picture for all involved organizations; rather, it is a selection of the relevant dynamic and static information that will contribute toward building a joint COP (Steen-Tveit and Radianti, 2019). During the exercise or operation, the pre-selected data, information and decisions, e.g. selected by the ICS, are recorded and stored in a COP repository. The COP should also include functionality for recording and playing back entire event handling in the map interface according to a timeline. Also, the COP should add functionality to produce a quick material that can be used to visualize the (ICS) pre-selected SA/U themes and what happened in relation to them for an immediate debriefing following the AAR approach. This applies to exercises and to operations when possible. In

terms of double-loop learning, it refers to interaction, socialization of experience and tacit knowledge among incident stakeholders (Nonaka and Takeuchi, 1995). The COP could also provide tools that ease aggregated evaluations that may be re-used in systematic evaluations and follow-ups, in the organizational implementation phase, to address the gap pointed out by Savoia et al. (2012). In the framework (Figure 3), the evaluation phase addresses *what did actually happen*, taking advantage of the COP repository.

#### Organizational Implementation Phase: Structural Support

In the organizational implementation phase, the output from the SA/U evaluations are action plans, appointing personnel responsible for implementation and anchoring at organizational management levels. This phase is the most complex requiring much further work with organizational stakeholders to develop suitable processes. Many countries, including Norway, have a decentralized command and control structure, thus creating additional complexity when it comes to ensure that stakeholders have access to the tools and data needed to build COPs and carry out ensuing evaluations. This requires coordination mechanism at the regional or national level (e.g., DSB). National co-ordinations mechanisms are also needed for validation of AAR evaluations and according updates, simplifications, further development and dissemination of guidelines and standards. In terms of double-loop learning, this refers to the externalization of knowledge and experience, for updates, and later internalization and combination across organizations (Nonaka and Takeuchi, 1995) that may result in improved joint situational understanding in a long-term perspective (Dostal, 2007).

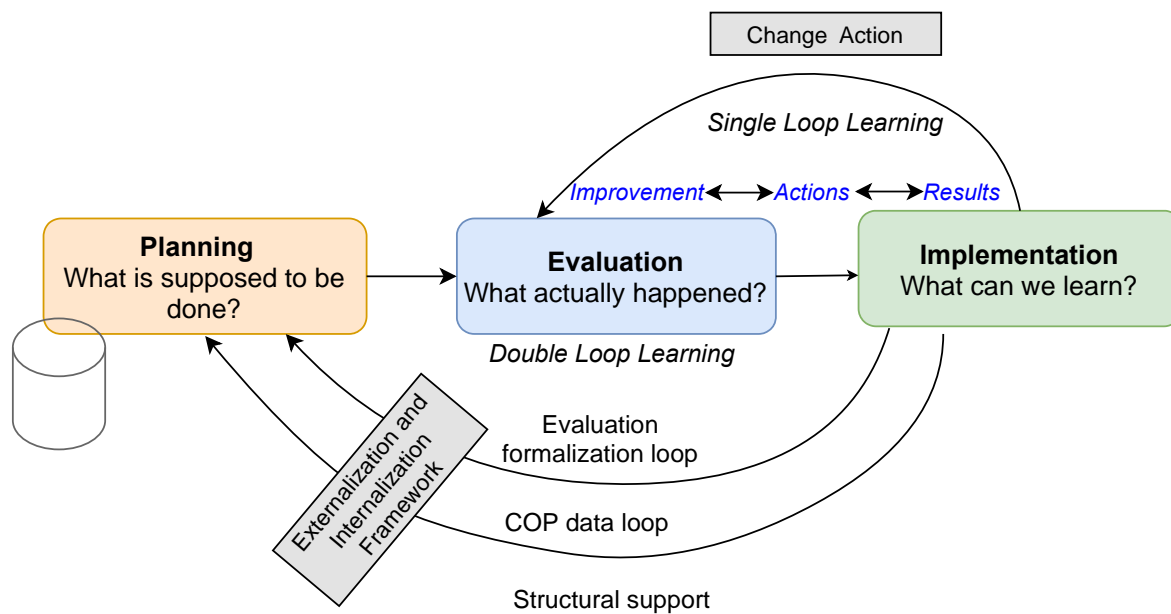


Figure 3. Integrated framework for double-loop learning using COP data

The COP could be used in the implementation phase by letting the repository collect those actors and organizations that are relevant to crisis management and systemize them horizontally and vertically with relevant contact information. It ensures accessibility for both evaluations and in the implementation phase. The repository could have different levels, e.g., actors at the local, regional and national level. Structural coordination is needed, again probably by a national mechanism such as potential ICDs where they exist, and here procedures for how this coordination shall be performed must be developed. In the framework (Figure 3), the implementation phase addresses *what can we learn and how can we support lessons learned through the various loops contributing to double-loop learning*. Single-loop learning occurs when an organization may experience mistakes during the implementation (crisis response), then learning through evaluation to correct the weaknesses and repeat the process without changing the underlying governing values as a basis for planning. Double-loop learning occurs when an organization corrects the identified mistakes in the evaluation through the internalization and externalization processes by changing the governing values for planning and then the implementation. We suggest achieving, above all the latter, through formalization, the internalization of the lessons-learned from COP data into planning. Overall, the value-changing process will require structural support. We consider such practice can lead to efficient organizational double-loop learning.

## DISCUSSION

Our results invite for a discussion. We will first review implications before weighting exercises against operations regarding learning effectiveness.

### Implications

Over the past decades, emerging ICT has been perceived as improving evaluation and learning from crisis exercises and operations. The current project, and SA/U are no exception. Even though a COP by no means are the only data source for improving related evaluations (in the workshop also general information systems, lessons-learned cases and simulation tool were mentioned), we believe that a COP with an integrated map interface could represent a major improvement in the evaluation phase. At the same time, practical examples of that technology indeed contribute to lessons-learned, and organizational double-loop learning are mostly absent. While technology for reconstruction of crisis management exercises have long existed, few studies address the related methodological issues and how to implement the learning in organizations (Pilemalm et al., 2008). For instance, Marklund and Wiklund (2016) describe several lessons-learned from a complex military operation but provides no detailed, systematic method to take the results further. Nordstrom and Johansson (2019) employ nine thematic clusters proposed by previous research to examine the inter-organizational learning derived from post-crisis management exercise and evaluation reports, including reviewing the suitability of the exercise report for inter-organizational learning. They argue that the majority of the reports focused on describing what happened and what actions were carried out during the exercise, but did not embrace later analyzing the problems, how they were solved, and what measures were needed to prevent them to reoccur. Meanwhile, Birkland (2009) argues that learning can only exist if we include the processes of how to structure organizations and policy systems that bring serious learning from disasters.

The above challenges are also clearly identifiable in this study that focus COPs specifically. According to the socio-technical system view, technology, people, competencies, organizations, and structures should be developed in parallel when developing information systems (Alter, 2003). In the study, the workshop stakeholders expressed technical needs at a rather “unproblematic” level where they seemed certain that “fact-based”, “objective” information could pave the way for better evaluations and fulfillment of organizational and structural needs. In other words, they focused more on the social components or surroundings of the COP. This confirms previous research and indicates that how to achieve lessons-learned and double-loop organizational learning is as relevant for COPs, and SA/U, as for any learning from a crisis. In Norway, it has also been noted how various software systems and lack of inter-organizational data access in the emergency management system are among the factors limiting efficient sharing of information during emergencies (Grottenberg and Njå, 2017). These difficulties give a compelling argument for establishing common dedicated capabilities across organizations, which can be used also for evaluation and learning purposes. By contrasting the document guidelines with identified requirements from the workshop, the stakeholders obviously experience a general lack of shared resources for supporting systematic organizational double-loop learning from crises and exercises. This means that we need to devote time to organizational processes and structural mechanisms – and reach out to decision-makers – if COP-based evaluations shall make real change and improvements. In this context, it is important to distinguish between the COP (technology) itself and the supportive processes surrounding it, for instance provided by an ICS (Buck et al., 2006).

In the study, the structural challenges seem those vaguest and thereby difficult to handle. O'Donovan (2017) suggests that the lessons-learned are successful only if corresponding learning processes are promoted, including Instrumental policy learning, Social policy learning, and Political learning. The latter refers to when the disaster turns knowledge about the effectiveness of strategies that the current policy advocates to advance policy ideas or draw attention to problems. In the case of Norway, and in many countries worldwide, the emergency management system is not centralized, instead emphasizing local decision-making and delegated authority, often adding to complexity (Grottenberg and Njå, 2017). Still, structural challenges might be those most important if learning experiences shall reach all the way to the political and decision-making level, i.e., having an actual impact. This calls for a socio-technical view on future development on COPs, and for integration in processes provided by general incident command systems/ICS, structures, standards and procedures in various regional and countries. In relation, we argue for a design approach based on user participation working with stakeholders on local, regional and national organizations responsible for the crisis management in various countries.

### Learning from Exercises Versus Learning from Operations

In the study, the research gap identified from literature includes both learning from exercises and real operations. Meanwhile, the planning documents from DSB focus mostly on exercises. There exist similar planning documents provided by authorities in many other countries, e.g., those provided by the Swedish Civil Contingencies Agency

(MSB) (MSB, 2017a, 2017b). However, MSB has also published guidelines that relate to real crisis investigations, e.g. MSB (2018). Even if learning from real operations is preferable, it is often difficult to accomplish due to the urgent nature of the crises themselves. Also, large-scale real crises often occur infrequently, implying that the ensuing evaluations tend to remain in reports until the next crisis takes place - not implemented as organizational “lessons learned”. Typical examples are the Indian Ocean tsunami of 2004, the forest fires in Sweden 2014 and 2018, and that the world was not prepared for Covid-19 hitting globally. As argued by Birkham (2009), disasters provide an opportunity to learn from the incidents, but often, given the haste of the decisions made in responding to them, the risk of superficial, single-loop learning –without attempts to analyze the underlying problem – likely occurs. Birkland suggests an “Event-related Policy Learning” model to maximize the learning process and avoid creating hasty learning from incident reports. In our study on the COP, we agree with this reasoning, even if, of course, also less optimal decisions and mistakes, later can be used for analyses and double-loop learning purposes. Our study also has similar findings as MSB (2018) which proposed a methodology based on document analyses and interviews with investigators on a number of crises in various European countries (e.g. forest fire, flooding, school shooting). The study concludes that there currently exist no coherent methodology to learn from crises and suggest planning of resources and inter-organizational coordination and responsibilities beforehand, clearing of juridical matters and practical training as some ways forward. From this study we see that apply these conclusions are also highly relevant to SA/U specifically. In relation, even if AAR or similar debriefing methods are seldom possible to carry out during the acute response phase of a crisis, using stored COP data provides the ability to reconstruct it once the acute phase ends. This makes it possible to recapture the crisis, not in an optimal but in a better way than before. Thus, the initial concept suggested in the study can be used for both exercise and operations developed, although it needs modification for various contexts (see future work).

## CONCLUSION AND FUTURE WORK

In this study, we addressed the persistent challenges of turning the possibility provided by new technologies into crisis evaluation and organizational learning processes. We applied this specifically to the ability of COP evaluations to improve SA and situation understanding, a domain with scarce studies. We did this by identifying high-level requirements on what COP data can support for evaluations complemented by organizational and structural requirements. Based on this, we presented an initial high-level framework for COP based evaluations.

COPs indeed have the capability to support the learning from incidents, but they will be of no use in this respect if knowledge is not turned into organizational double-loop learning and lessons learned and implemented. Therefore, we argue for a socio-technical approach and that devoting much effort to complex organizational and structural aspects is necessary if emerging COPs shall make a change, not only promises. This study reports from the document analysis, some observation data, and a stakeholder workshop. In the next step, we will integrate terminology and map support and additional functionality for recording and playing back event handling in the COP common map interface. It is also of importance to explore the high-level requirements in more detail and connect them to functionality, i.e., what are the “facts and objective data” (e.g., response times, positions, decisions, symbols) and what data is relevant to what situation. This is even more important for the organizational and structural processes and integration with existing ICSs and standards. Further work will take place in a group of stakeholders representing authorities and response organizations in the domain of inter-organizational crisis management, not the least DSB responsible persons. A combination of user participation and design innovation techniques (Osborne and Brown, 2011) will be used to create joint models and processes that stakeholders can take to their own organization for further implementation and training.

As for transferability, our study results are built on the Norwegian emergency management system with a decentralized crisis management structure. Thus, they are likely most relevant for countries with similar structures. However, the results can be used as inspiration for future research in the crisis management, command and control and SA/U domains and for practitioners wanting to carry out similar work. The proposal is initial; it needs to be further, developed, modified and concretized to each specific context. This especially goes for the framework use in exercises versus real crisis operations, since it has been initially developed based on exercise data.

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