



Unthinkable is not un-educable: New mindset for training preparedness

Ossi Heino^{a,*}, Annina Takala^b, Vesa Huotari^a

^a Police University College, Finland, P.O.Box 123, FI-33721, Tampere, Finland

^b Tampere University, Faculty of Engineering and Natural Sciences, Tampere University, P.O.Box 1001, FI-33014, Finland

ARTICLE INFO

Keywords:

Critical infrastructure
Learning
Exercises and training
Exceptional situations
Emergency response

ABSTRACT

The increasing complexity of critical infrastructure subjects it to problems that are even more wicked, unexpected, and unthinkable than the ones faced before. Hence, the lessons that are drawn from the previous experiences and absorbed into preparedness schemes and planning may well become part of the problem rather than core elements in their effective resolution. This article scrutinizes the potential for the emergence of such a mismatch in the case of a severe disruption to critical infrastructure. As a remedy, we suggest a more encompassing approach to learning, and essentially, a new mindset for training preparedness that would better equip emergency response actors when they come face-to-face with the unthinkable. Based on research, it is advisable to be cautious of relying too much on what is known with certainty. In addition, this study raises doubts as to whether training inevitably improves the ability to act in exceptional situations.

1. Introduction

Are we prepared for surprising threats that, in the light of the history of experience, are highly unlikely and would put our ability to imagine to the test? How could we prepare for something we do not even have a clue about yet? Between what we know from experience and what we do not have a similar knowledge base on, remains a fruitful area of learning. In this area, we can reach out to the latter with the concepts and lessons adopted from the first one. This article delves into that area of learning in the context of preparedness, and more specifically, the learning of emergency response (ER) actors in the terrain of unthinkable problems that a severe disruption of a critical infrastructure (CI) could open.

However, the relationship between learning from experience and preparing for the unknown is anything but straightforward. We do our best to prepare for the unknown based on experience from past events, perhaps because no better point of reference is available. We are thus inclined to (over)trust the past and our ability to learn from it effectively as well as the sufficiency of the lessons drawn from it. We tend to face the same difficulties when dealing with crises — these include poor communication, ambiguities in coordination and responsibilities, limited planning, and a lack of resources [1]. These flaws have been taken up and targeted explicitly in training and exercises. Without doubt, such learning from critical flaws and incidents in order to increase capacities in handling the respective events is both well justified and necessary. Exercising appears as an unsurmountable and efficient

way to enhance preparedness both in general terms as well as in terms of particular skills and competencies that have turned out wanting in one way or another by the previous exercises or incidents.

But what if this also has its downside? What if the learning process described above would entail following: strengthens the ability to deal with well-structured problems; provides means for structuring unstructured problems; prepares to manage the expected, well-known situations more effectively; builds a belief that these can be applied also to unforeseen problems with *unbelievable*, *unthinkable*, and *inconceivable* aspects [2]? Instead of an optimistic worldview, we can also start from the premise that what works in one context does not necessarily do so in another one. In this case, our way of learning from the past and translating what we learn into organized, well-rehearsed action can in itself be a source for systemic vulnerability (cf [3]).

Critical Infrastructure is both a blessing and a curse in this matter; it provides a fruitful context to analyze the threats that test the limits of our imagination and reinforce our ways of preparing for them, but in return, what we could not even imagine can become reality through CI. Modern societies are dependent on the availability and reliability of CI services. It is very difficult or even impossible to experiment with the disruption potential to CI to reveal differing problem configurations. As a complex structure with various interdependencies, CI is not only prone to nonlinearly and surprisingly behaving chains of disruption, but also a favorable platform to propagate and escalate other undesirable phenomena [4–8]. Moreover, given that CI extends widely and deeply into

* Corresponding author.

E-mail addresses: ossi.heino@poliisi.fi (O. Heino), vesa.huotari@poliisi.fi (V. Huotari).

<https://doi.org/10.1016/j.ijdrr.2021.102470>

Received 30 December 2020; Received in revised form 9 July 2021; Accepted 13 July 2021

Available online 14 July 2021

2212-4209/© 2021 The Authors. Published by Elsevier Ltd. This is an open access article under the CC BY license (<http://creativecommons.org/licenses/by/4.0/>).

the fabric of societies, it also appears to be an interesting target for terrorism and other intentional harm, providing mechanisms for destruction and paralysis [9]. There is no doubt that the boundaries of knowledge and mindset would be challenged in a case of severe disruption to CI [10].

Safe and secure CI is a cornerstone of the resilience of societies, and it cannot be reduced to the durability of technical structures, but it also includes the capacities of the human and institutional dimensions [11]. It is no wonder, then, that resilience has become a key concept in the research literature on both crisis management and CI, the attempt being to understand how to preserve key functions, structures, and identities despite various ordeals [12]. Conceptually distinguishable from the process of resilience is the preparation for unwanted events with anticipation and advance planning, systematic training, effective responses to actual ordeals, recovery from the bumps caused by ordeals, and learning from all this for the future. Thus, it is essentially linked to the system's ability to learn in relation to its own environment [13,14]. In addition to strengthening knowledge and skills, there is also an attitudinal dimension to learning; the way of seeing abilities as modifiable, considering mistakes as a natural part of competence development, and the willingness to address grievances can be termed resilience-related learning. They contribute to coping with difficulties and generating new insights in adverse conditions [15–17].

Because safety and security are not something to be taken lightly, in this article we review the possibility that investing in competencies development through training, exercises, and other methods of learning from experience will not automatically and inevitably reinforce our ability to solve unthinkable problems — it may even turn against its good intentions. Since the experiences, both our own and those of the others, are, after all, the only available source of information [3], we need to find a balance between learning effectively from the past and healthy distrust of the value of the very lessons drawn from it without undermining the professional identity and can-do attitude of the emergency response (ER) actors. This article aims for a new kind of mindset in this kind of learning field.

2. Methodology

In this article, we underline specifically the quality of learning in the ability to face unthinkable problems [18]. We ask: *What and how we should learn, for example through training, in order to strengthen our readiness to act in situations where established patterns of action and solutions are insufficient?* The idea of this article and the logic of answering the research question proceed as follows: Based on literature, we perceive CI as a vital structure for modern societies, which, by forming multi-level connections and dependencies, develops into an increasingly complex, capable, and enabling system. That is also why it is likely to cause serious, unexpected, and unthinkable clusters of problems. We call this enabling but unpredictable property of CI *Dynamics I*. Perceived in this way, CI forms a specific context for ER actors. Then, inspired by earlier research, we describe the operational logic of ER actors and the way it develops, also in relation to other key actors. We call this *Dynamics II*.

We are particularly interested in describing the tensions and dissonance formed when the logics of ER actors is encountered with that of other key actors. We identify this dissonance in the inability to formulate problems, to take appropriate action, and in the conditions for fruitful forms of collaboration. In order for this conceptual discussion to also have practical relevance, we discuss guidelines for the training and education of ER actors in the unthinkable terrain. To this end, we first present a theoretical-conceptual framework for learning in such a specific context, and then refine this framework with practical examples and experiences in a way that clarifies and concretizes the meaning of what is outlined. Relying on the chain of argumentation thus formed, we finally draw conclusions.

This article has gained momentum from Finnish research projects and training evaluations where CI disruption and ER actors have been at

the center: Vulnerability of the critical infrastructure and the capabilities of the authorities (2017–2019) and Critical infrastructure as a target of terrorism (2018–2021).¹ Both projects focused on examining the capacity of ER actors to act in a situation where, due to a serious disruption of CI, they would face clusters of problems that differ quantitatively and qualitatively from what is possible and sensible to prepare for in detail.

These projects included following exercises and trainings that were particularly platforms of observations for this study:

- two tabletop exercises for students of Master of Police Services degree at Police University College Tampere, Finland (the students have at least three years of working experience after their bachelor's degree)²
- developing a training concept that consisted of a simulation exercise for ER actors about severe disturbance to CI
- participation in the development of stress test for actors in CI.

In addition, we have attended three large-scale, regional preparedness exercises in the role of an external expert evaluator and made observations particularly from the point of view of learning. The participants in the exercises consisted of the ER actors, the authorities, the providers of municipal services, and businesses — in other words, the key players during a situation of a severe disruption to CI, as well as other large-scale emergency and crisis situation. The findings that have emerged from these efforts have set the tone for this article and carry with us the way we address the research problem. In this paper, we also utilize these findings as examples in a way that refines the theoretical-conceptual approach, concretizes it, and thus guides training in the problematics opened up by CI disruption.

The experiences and observations have made us think about the paradoxical nature of developing preparedness in relation to situations that are unexpected and transcend the capabilities of routine responses. In our view, this phenomenon has not been sufficiently studied, let alone understood, which is why it deserves attention, conceptual discussion and guidelines for better preparedness.

3. The emerging mismatch between current ways of learning and CI

We next describe two dynamics that seem to be in dissonance. We first shed light on the essence of the two in isolation, and then discuss the contrast between the two dynamics as a central but often ignored problem of the prevailing conception of preparedness.

3.1. Dynamics I: CI as a platform of novel problems

In research, CI is identified and described as a complex system, most often meaning that it consists of many subsystems, their different components, and different variables in the connections between them [19]. With complexity and system interdependencies, CI is described as a potential platform for cascading and nonlinearly propagating perturbations [6,7,20]. Thus, it is also understandable that even if each function and actor involved in CI is aware of and able to manage the identified risks targeting them, similar capabilities are not achieved in interconnected systems where the dynamic of disturbance is different [7, 8,19,21,22]. In the light of what is experienced, a highly unlikely outcome may be the result (and consequence) of the escalation of some

¹ For more information about the projects, please visit: <https://www.kivihanke.fi/in-english/> and <https://www.emaileri.fi/g/1/275432/0/0/6046/1984/5>.

² All new police officers graduate from the Police University College in Tampere. This Police University College is also responsible for further and continuing education for the police. For further information, see <https://polamk.fi/en/master-of-police-services/>.

much more possible and seemingly limited initial event.

Severe disruption to CI can reveal the dependencies and limitations, which in normal conditions have not been seen as worthy of concern [19,20,23]. However, the dependencies that are revealed as the context changes — that is, from a normal situation to an unexpected disturbance — have already existed before they were revealed, but not in a way that is visible or noteworthy in the prevailing perceptions. The unnoticed dependence is the result of the constraint and attachment of knowledge set by the context. The actors whose task it is to normalize the situation and minimize the damage in the event of a disturbance are also connected to the dependencies in one way or another. Disruptions thus succeed not only in revealing dependencies, but also concretize measures taken or not taken to create alternative courses of action and increase system redundancy (see e.g., Ref. [4]).

One aspect worth noting is that CI is a material element defining urban security and insecurity [24,25]. As such, it is not only prone to disruption caused by nature or human error, but an attractive target for both terrorism and otherwise motivated harm-seeking efforts [9,10,26,27]. It can be weaponized as an instrument of violence, reversing its function to serve interests contrary to the original purpose [28]; Meiches 2017; [29]. The ER responses are also part of the critical infrastructure restoration process [20], and thus possibly the target of intentional disturbance or part of a broader plan of harm. When a severe disruption is not caused by natural hazards or technical or human errors, but by a purposeful and intelligent actor in its operational strategy, the question of the appropriateness or danger of responses also arises in the new framework.

The above illustrates the tendency of CI to both brood and carry surprising, unwanted events. Severe disruption is likely to open a situation where the number and quality of problems drastically exceed what the responses are tailored to Ref. [20]. CI, in all its sophistication, has become a meta-structure. The elimination of the above-mentioned properties is not only impossible in theory, but also in practice. In this sense, CI is an excellent platform to create situations that can only be identified and named retrospectively when sufficient information is revealed. CI is thus not only a fertile context for destabilizing mindsets that swear by the name of pre-naming and taking control over events, but at the same time a cradle with the potential for unexpected materialization. Perceived this way, it is not at all irrelevant how we develop ways to tackle such problems.

3.2. Dynamics II: learning in emergency response

CI was described above as a favorable platform for generating unexpected problem clusters. When considering what capacities are needed to deal with disruptions in such a structure, the ability to conceptualize the highly uncertain nature of the situation, to consider the limitations of knowledge and certainty, and to mobilize resources to generate responses, comes to the fore. The way in which ER actors' ability to generate responses develops is ultimately the result of its way of learning from past experiences (cf [3]. and translating it into a capacity that is strengthened through training, exercises, plans, and other measures. However, this learning process is conditioned by the structures of ER actors. In a functionally differentiated society, preparedness lies with a number of different sectors, levels and actors, each with its own assigned responsibilities, competencies and tasks, and the operational logic, tools, rules and practices. It is in the interest of each actor to become an increasingly efficient actor within its own sector and thus also to maintain confidence in the ability to solve problems. ER actors are one part of this sectoral entity, which is why the logic of its development is framed by its sectoral worldview.

In this regard, the organization of ER actors follows the ideals of bureaucracy [20] in which the idea that the encountered problem situations are essentially known, so that operational capacity can be built on pre-established content, competencies and training, as well as action plans, rules and procedures. The necessary capacity can be ensured

based on the division of labor, the definition of responsibilities and authorities, the allocation of resources, and planning. In addition, criteria for performance accountability can be defined for each area of responsibility, and feedback mechanisms can be connected to pinpoint desirable or undesirable behavior. When facing a situation, the attention of the actors is thus focused on assessing whether the situation meets sufficient characteristics and conditions to fall within their own area of responsibility or activity. In a complex and versatile situation, it is necessary to discern the tasks that belong to one's responsibility and perform them effectively. In this way, actors are sensitized to identify and face situations as already known in terms of content, as ready-made orders or tasks waiting to be delegated and performed. Learning takes place as a strengthening ability to pay attention to those areas in a complex overall situation that are relevant in terms of standard responses [30,31]. This also forms a projection on what and how it is profitable to prepare for and develop capacity [32], and it furthermore enables determining the necessary focal points for education and training; that is, explicating the necessary competencies and skills.

The overall system of preparedness learns within given tasks in a way that makes procedures increasingly efficient and error-free. Development and strengthening of capacities can be observed, which is why it can be trusted and its certainty can continue to be relied on. It is becoming more and more flawless and sophisticated machinery capable of performing and focusing on known tasks. The operational capacity seems to be perfecting, which it actually does in its own way, but limited to the default settings and boundary conditions of the machine. Learning is attached to specific goals and incremental improvement measures within sectorized worldviews, in other words, based on the assumption that future situations and their background conditions are essentially similar to those that learning and development have been built on (cf [33–39]). With increasing capacity, actors do not have to reinvent themselves, their responsibilities or tasks, but perform what the mechanism facilitates.

The logic of development draws attention to shortcomings that can be formulated as explicit development targets, specific goals and learning contents that frame training and education [40]. As Zebrowski [41] states, “the form of security enacted within preparedness exercises is related to an altogether different affect: a sense of confidence in the ability of oneself and one's colleagues to effectively respond to a future emergency”, which is why it is seen that training must be able to clearly demonstrate the development of knowledge and skills. This is the rationality of the specifically formulated goals, which makes it clear to the people participating in training what kind of knowledge and skills they are expected to strive for and what areas of development the exercise is expected to reveal. Explicit expressions can be used to design learning situations that are as focused as possible and targeted at identified shortcomings. Against the goals, it is also possible to observe, evaluate and develop training systematically. In this way, what is learned from the situations experienced is anchored into the training, maintaining the premise that learning, exercises, and the capabilities of the whole system develop systematically in the desired direction [42]. This kind of capability development thus creates a sense of increasingly comprehensive understanding and control of situations. The system becomes more complete and resilient in terms of preserving key functions, structures, and identity in the face of various ordeals [12].

3.3. Dealing with the emerging mismatch

We have described what kind of problematics the characteristics of CI constitute (Dynamics I) and the operation and development logic of ERs (Dynamics II). Next, we analyze the collision of these two dynamics and outline how the tension between the two could be utilized to seek guidelines for a solution that goes beyond the problem.

A severe disruption of CI is likely to open problematics that exceed the expected in terms of quantity and quality, whose complexity is not properly controllable through sectorized problem identifications, and

where the overall situation can have non-linear, unpredictable chains of events. Even if the problematics do not correspond to the way in which the various key actors have developed their capacity, they are still expected to respond effectively to take control over the situation and minimize damage. Such problematics implies that effective responses require a holistic perspective on the significance of the situation and the identification of leverage points and intervention points [43–45]. Due to the surprisingness and non-linear chains, or an intelligent actor, the leverage points that have proven to be most decisive in previously experienced situations are not guaranteed to be relevant in the next situation. The dynamics of the situation violates the ideal of symmetry to which our machinery is built [34]. Indeed, action plans complemented by past experience, procedures embedded through training, and an increasingly comprehensive collection of action cards do not provide a way out of the problem, but rather represent learned helplessness with a tendency to take on secondary tasks and ignore sensitivity to systemic leverage points. The structures of the machinery, which have been honed more and more effectively to focus on the projected core problems, will effectively ignore or reject clues that are outside of this projection. In this case, what is strength and capability in the realm of known problems and within the sectorized task field is at the same time the inability to detect the lever points of the system, produce new formulations of the problem and, above all, direct action as a result of this formulation (cf [46]).

When each actor develops its capacity in the direction of its own sector, the results are that their expertise, operational logics, concepts, and worldviews diverge from each other. Separation is noticeably observed, for example, in collaborative training. As noted above, the problematics require combining different expertise to produce richer problem formulations and finding each other to achieve better capability to solve problems [20]. It has been found, however, that development of collaboration is directed to the ability of each actor to manage their routines so that they would disturb others as little as possible while others strive to do the same [47–50]. Collaboration develops in a direction where all actors are able to operate sensibly and as efficiently as possible in the light of their own logic and rationality. But as everyone sticks to their identity, structures and operating models and reinforces these in their own directions, the actors grow alienated from each other. Operational capacity and resilience are being strengthened, but in a way that is increasingly limited in scope to pre-known, sector-specific problems. The ability of actors to reinvent themselves, their roles, tasks and tools in terms of the emerging problem situations is weakened. It is exactly the knowledge base that brings security and clarity to respond to routine situations that may disappear completely, or in the worst case, be included in a plan of an intelligently operated threat. The problematics is dynamic in which decision-making in the face of high stakes, time pressures, and inappropriate information and other resources is cumbersome but necessary [51,52], and where reliance on procedures that normally provide certainty, efficiency, and legitimacy limit rather than enable the realization of the most effective responses [53]. In these kinds of situations, what is called for are other skills than those that prove to be effective in routine situations [54].

At the individual level, the situation would then require an ability to tune in to surprising, exceptional, and nonlinear dynamics rather than the expected, routine, and linear dynamics of events. It requires the ability, if necessary, to reject established models that have proven to be effective under normal circumstances with situation-tailored responses [55,56]. It requires deviating from what is most important for the effective management of one's own area of responsibility, what attention has been paid to and what solution one's own expert identity has developed. For this reason, the idea appears to the actor as irrational, insane, and socially incorrect risk-taking, as we can see from Weick's [57] case study of a wildland firefighting. The way in which actors learn is not inclined to question the basics, to develop alternative solutions, to overtake responsibilities from others and, more generally, to see past a sectoral system, to perceive its necessity on the one hand and its

inadequacy on the other. It can thus be assumed that the events experienced in the past do not in themselves structure, narrow or enrich the possibilities for action, but are determined by the perceptions of the actors, the internal models of what can be done with the experiences. It is evident that when the situation is taking place, actors do not have time to consider their internal models, because they have to act and do what the situation seems to require – the latter could be interpreted through the tools at hand and the identity adopted rather than the faced urgency. That is exactly why exercising and the way of learning from experience provides irreplaceable means to reflect professionalism in action when hands and mind are not tied to the real situation.

4. Preparing for the coming of unthinkable problems

We have described a kind of standard view through two different dynamics — dynamics that, as they continue to evolve, increasingly diverge from each other. From this perspective, what is interpreted as a strengthening ER capability may prevent rather than promote the production of responses that meet the requirements of the situation in the event of a severe disruption to CI. If functional ability relies on mechanistic learning from past experiences and their bureaucratic translation into the operating system, the dynamics of CI will be interpreted in a way that actors need luck in that the situations encountered are, in critical respects, adapted to the way in which problems have been identified. Since relying on luck is not a sustainable basis when it comes to safety and security, it is necessary to change the prevailing approach to learning. In the following, we outline a possible solution, both as a general level learning concept and as practical training application. The outlines we propose thus provide a transition in which the tension of the two dynamics described above does not disappear but acts as a potential tuner to the processes necessary in crisis.

4.1. General principles

When examining guidelines for the kind of learning that ER actors should embrace in order to respond to the problematics opened by a severe disturbance of CI, we must start by conceptualizing learning. In general, learning is not a question of a single and clearly definable event, but rather of a complex system consisting of learning processes occurring at different levels [58]; Lehtinen et al., (2014). It occurs both through experience and doing as well as deliberate cognitive effort [59]. Learning involves the idea of the emergence of something new, whether it is a change in action or behavior, the acquisition of new knowledge or skills, the reorganization of knowledge structures, or the transfer of something previously learned from one context to another [60].

In addition, one form of learning is unlearning [61,62], which following Klein's [63] interpretation is not so much about forgetting what has been learned but more about the ability to form responses that differ from the established and default ones. Understood in this way, on the one hand, learning is the ability to utilize characters, elements, structures and dynamics accumulated from different situations in the sense of combining them and transferring them from one context to another. On the other hand, learning is also attitudinal, which in our view appears to be a critical approach to problem identification and a search for contradictions to form better identifications. It is, in this sense, an orientation of interest in the interface between knowing and unknowing [64].

In such a learning context, what are the key issues that need to be taken into account? In the pursuit of a capacity that is not mechanistic but seeks to overcome the limitations of solutions that have proven to be most effective in familiar problem areas, it is not a question of knowledge and skills that can be isolated and transmitted through action. Rather, it is a question of operating at another level, opening the path to richer mental models and ways of thinking [65]. It is an attempt to combine such configurations of information that did not exist in the person's thinking before the combination [60,66,73], which means

influencing information processing, attitudes, mindsets and adopted ways of thinking. When this kind of learning occurs, it involves interfering with what is perceived to be profoundly one's own, and questioning those functions, structures, and identities whose permanence has been sought in the past. To succeed in this, learning situations should lead to contradictions [53,67–69]. This implies that the pedagogies of the design and implementation of the training/exercises should be focused on providing conflicting information frameworks and assessing them in a way that highlights the limitations and perspectives of knowing (cf [58,70–72]).

When understood in this way, the learning to be pursued remains beyond the reach of observation-based, clearly defined and measurable competences and skills [60]. From this perspective, the specifically formulated and consistent goals as a prerequisite for learning (e.g. Refs. [40,42], specifically capture actors in the learning framework from which they would need to be exempt. When the core of learning in exercises is related to participants structuring not only their own but also shared ways of thinking, the planner of the exercise cannot know for certain the actual outcome of this process. However, this structuring has consequences that appear in some cases immediately but more often only later. These consequences are usually difficult to verbalize, let alone trace back to a particular moment or activity of learning.

If training focuses on severe disruption to the CI, special attention should be paid to the characteristics of the CI, such as interdependencies. This means that the participants should face situations that succeed in concretizing the importance of interdependence as a chain of disorders and an escalation of situations. Thus, the situations to be practiced should be able to show the dependence of an activity on some external factor and, perhaps even more importantly, to concretize the dependence of that factor on yet another factor. In addition, the situations to be practiced should show how the performance of ER actors is, in many respects, conditioned by CI. However, it is not just a question of looking at physical dependencies, but also paying more attention to how the different functionalities and capabilities are built on the availability and security of CI.

Exercises should manifest the limited nature of the sectorized problem formulations and the related responsibilities in relation to the situation encountered. Herein lies also the key to collaboration. The situation to be addressed in the exercise should serve the idea that the optimization and securing of efficiency and resources within the actor's own frame of reference emerges from the perspective of the overall solution to the situation. In other words, it is not enough to identify the complexity of the problem, but the situation should also illustrate what kind of action is likely to produce inadequate solutions. In this case, the training would also provide the necessary focal points and inputs for the requirements of collaboration. In addition, training can show that the drive to preserve conventional roles and borders may itself be a source of vulnerability, even if its effectiveness has been demonstrated in other contexts throughout history. In this way, learning situations can be created in which actors have to reflect on the limitations and attachments of their own knowledge and ability. It is noteworthy that this kind of training does not promise joyful creativity, the fulfillment of designated goals, or growing self-confidence, but rather unease with what has earlier manifested itself as strength and perfection. The key challenges are in learning not to take the context for granted, avoid mixing up different contexts with each other and to discern the context-, tool- and collaboration-related dependencies that, when faced with unforeseen situations, can undermine competencies and capacities while leaving responsibilities intact.

4.2. Practical application

We next provide a few reference points for practical training that exemplify the previous conceptual-theoretical outline, provide ideas for real-life training and guidelines for further development. These are based on the observations and experiences described in Section 2 but we

discuss them in a more general manner to enable their use in preparedness and ER training. We refine our review with a few supportive questions - written inside the parentheses - that serve as auxiliary questions to facilitate learning and to stimulate reflection.

As mentioned, the exercise situation should lead the participants to perceive different problem formulations, to deal with conflicting perspectives and the most effective solutions for the overall situation. The learning situation should succeed in raising the standard responses to a critical spotlight, for example, in a way where optimization in each actor's own frame of reference is adjusted with the overall response. It should be illustrated how, for example, securing one's own resources or focusing on one object means neglect of other, perhaps more important, objects from the point of view of systemic problem-solving ("is what you ought do now the most important thing you could be doing in this situation?"). The aim is to get participants to reformulate the problem as well as to identify the structures that led them to solve a problem formulated in a certain way.

Let us look at a practical example. We organized and observed a tabletop exercise -type learning situation, where the participants, students of Master of Police Services degree, were divided into groups of 4–6 people that were given a task to develop "deadlock situations"; scenarios in which both standard responses and non-response could both lead to a catastrophic outcome. Another group had to perform this scenario and the group that had developed the scenario acted as opponents or devil's advocates ("Not in your area of responsibility? There is nothing you can do in this situation? So, non-response is the only thing you can do about the situation?"). The rest of the groups were tasked with evaluating the performance and making observations related to the key decision points, such as background assumptions and perspectives. These observations were then raised in a debriefing discussion after the scenario had been performed. It should be mentioned that this exercise was preceded by introductory lectures about severe disruption to CI. However, the scenarios developed by the groups were not limited to CI, which in itself suggests that the learning situation provided a good basis to transfer what is learned from one context to another.

Our findings also suggest that participants in an exercise are mainly very locked to their own job description and position. As a result, they perceive the situation from that perspective ("what should I do in my role in this situation?") and its limitations ("what am I allowed to do?"). When they are locked to their role, they do not perceive the situation from the perspective of wider and systemic problem-solving ("what is this situation about, what should be done and who could do it best?"). In exercises, this could be avoided by role play, switching roles or giving up roles all together. This could open new pathways for participants to perceive situations, their responses, logics and their limitations as well as to understand the limits of their own assessments. In the example mentioned above, it is noteworthy that the opponents were able to position themselves outside their own official and professional position and task identity, which provided an opportunity for them to forget at least to some extent the expectations that narrow the formulation of the problem. We assume that this contributed to perceiving the effect of task identity on both thinking and action.

More generally, if training addresses a severe disruption to CI — which it does not necessarily have to do to resonate with the discussed dynamics — the direct and indirect dependence of participants' ability to function on CI should be clearly illustrated (i.e. "what made you conclude that the current situation does not affect your ability to function?"). For example, in a situation of power grid failure, the effects of energy supply should be incorporated into training in a way that cannot be ignored. Since there is a lot of uncertainties in situations such as this, for example on how a power grid failure would affect the functionality of base stations, our findings suggest that participants tend to explain such lack of information in a way that is favorable to them. Sometimes information is subconsciously ignored, sometimes consciously. It is the reflection of such behavior ("why did you explain the uncertainty in your favor, when you might as well have explained it to your own

detriment as well?“) that promotes the desired learning.

Explaining and interpreting things in most favorable ways also extends to the root causes of the situation encountered. According to our observations, in an uncertain situation, participants tend to approach the underlying causes of the situation according to the most obvious explanatory model and the least harmful one. For example, in the exercise on grid failure, the cause of the failure was not known in the scenario. From this lack of information, the participants made the assumption that the fault was due to bad weather, because it has most often been the cause of power outage, and adjusted their responses accordingly. In other words, when there was no better information about the cause of the situation, it was assumed to be due to the most obvious or favorable factor. In terms of the pursuit of learning, participants should be made to reflect on the basis of such assumptions (“on what basis did you conclude that all of this is caused by a storm?”). In this way, the possibility of an active threat can also be included in the reflection (“in the light of the information you received, why did you think the situation was due less harmful cause?”).

The collaboration training between different actors is undoubtedly very challenging - from our point of view, it is, in fact, much more difficult and uncomfortable than generally assumed. According to our observations, in the face of an exceptional problem situation, actors tend to secure their own resources and their own capacity to act, turning inwards and outlining the need for collaboration on the terms of their own resources. This is a consequence of separating the actors functionally, linguistically, and in terms of worldview, as noted earlier. As a result, collaboration can be successful in itself, but in a form that paves the way for each actor in its own problem-solving and worldview. In this way, promising conclusions can be drawn about the capabilities and the desired nature of collaboration. There is a danger that, viewed in such a frame of reference, collaboration will develop in a direction that does not promote capacity in problematics such as a severe disruption of CI; combining different expertise to reformulate problems and thus finding others to achieve better problem solving capability. According to our findings, reflecting on this issue is extremely challenging for participants of exercises, as improving holistic problem-solving ability would require the abandonment of one’s own resources, detachment from one’s task identity, and decisions that deviate from dealing with routine situations. However, all the practical training measures outlined above may contribute to development in this regard.

In the examples described above, one crucial aspect is that exercises should be extended to cover the bureaucratized learning processes and building of bureaucratic action capacities that give character to the very design of ER exercises and training. It would open up questions related to *us* as well as *the others*. It would expose how the view forward has become conditioned by the history or, rather, the mechanistic way to make sense of it, turn it into worthwhile lessons, and carrying out the respective learning. What is most likely to hamper an effective response to novel situations are rigid thought patterns. Therefore, what will be most requested is the ability to better measure up such situations by forming new configurations and putting forward fresh perspectives on thought patterns. These are skills that can, and, we believe, should, be effectively exercised.

5. Conclusions

In this article, we have discussed the tension and dissonance between a historically highly functional operating model of known probable situations, and the situation of unexpected, nonlinear, unknown, and potentially malicious severe disruption to CI. It can be concluded that capacity building in the former can in itself become a source of vulnerability in the latter operating environment. We can, however, find ways for a different kind of learning. This learning is critically skeptical about the adequacy, moderation, and competence of the former and it seeks to find factors that expose the possibility of error rather than ignoring these factors as irrelevant. It questions the validity of the

mindsets behind the policies and directs critical attention to decisions made in the face of a lack of information and uncertainty.

The dynamics described in this article are constantly diverging. The ability to solve known problems is developing and becoming an increasingly sophisticated and effective machinery for solving the problems that are seen to be its responsibility. However, the dynamics, of which severe disruption to CI is an expressive example, incur problems that are increasingly unlikely to actually belong to the solution repertoire of that machinery. In worst case, the problems are driven by the machinery’s ability to use well-know solutions. When training and exercises are viewed critically from a learning perspective, it can be concluded that they do not necessarily always have positive learning outcomes but also potentially harmful ones.

The way of learning that we have outlined does not offer the right solutions and does not push uncertainty aside — on the contrary, it is skeptical of models presented as solutions and it surfaces uncertainty from what presents itself or is presented with certainty. The price of learning to think differently and also to build capacity based on this emerging alternative perspective can prove to be valuable in future.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgements

This work was supported by Academy of Finland [decision no. 315074]. The financial support from European Union [Internal Security Fund (ISF) of EU Home Affairs Funds (project no: SMDno-2016-1525)] is also gratefully acknowledged.

References

- [1] A.K. Donahue, R.V. Tuohy, Lessons we don’t learn: a study of the lessons of disasters, why we repeat them, and how we can learn them, *Homel. Secur. Aff.* 2 (2) (2006) 1–28.
- [2] P. Lagadec, Crisis management in the twenty-first century: “unthinkable” events in “inconceivable” contexts, in: H. Rodríguez, E.L. Quarantelli, R.R. Dynes (Eds.), *Handbook of Disaster Research*, Springer, New York, 2007, pp. 489–507.
- [3] S. Ohlsson, *Deep Learning: How the Mind Overrides Experience*, Cambridge University Press, Cambridge, 2011.
- [4] C. Clearfield, T. Tiltsik, *Meltdown: Why Our Systems Fail and what We Can Do about it*, Atlantic Books, London, 2018.
- [5] D. Alexander, A magnitude scale for cascading disaster, *Int. J. Disaster Risk Reduction* 30 (2018) 180–185, <https://doi.org/10.1016/j.ijdrr.2018.03.006>.
- [6] L. Hempel, B.D. Kraff, R. Pelzer, Dynamic interdependencies: problematising criticality assessment in the light of cascading effects, *Int. J. Disaster Risk Reduction* 30 (B) (2018) 257–268, <https://doi.org/10.1016/j.ijdrr.2018.04.011>.
- [7] G. Pescaroli, D. Alexander, Critical infrastructure, panarchies and the vulnerability paths of cascading disasters, *Nat. Hazards* 82 (1) (2016) 175–192, <https://doi.org/10.1007/s11069-016-2186-3>.
- [8] G. Pescaroli, D. Alexander, A definition of cascading disasters and cascading effects: going beyond the “toppling dominos” metaphor, *Planet@Risk* 3 (1) (2015) 58–67.
- [9] M. Coward, Network-centric violence, critical infrastructure and the urbanization of security, *Secur. Dialog.* 40 (4–5) (2009) 399–418, <https://doi.org/10.1177/0967010609342879>.
- [10] A. Boin, P. Lagadec, E. Michel-Kerjan, W. Overdijk, Critical infrastructures under threat: learning from the anthrax scare, *J. Contingencies Crisis Manag.* 11 (3) (2003) 99–104, <https://doi.org/10.1111/1468-5973.1103001>.
- [11] S.E. van der Merwe, R. Biggs, R. Preiser, A framework for conceptualizing and assessing the resilience of essential services produced by socio-technical systems, *Ecol. Soc.* 23 (2) (2018), <https://doi.org/10.5751/ES-09623-230212>.
- [12] K. Scholten, P.S. Scott, B. Fynes, Building routines for non-routine events: supply chain resilience learning mechanisms and their antecedents, *Supply Chain Manag.: Int. J.* 24 (3) (2019) 430–442, <https://doi.org/10.1108/SCM-05-2018-0186>.
- [13] C.D. Kayes, *Organizational Resilience: How Learning Sustains Organizations in Crisis, Disaster, and Breakdown*, Oxford University Press, Oxford, 2015.
- [14] B. Walker, L. Gunderson, A. Kinzig, C. Folke, S. Carpenter, L. Schultz, A handful of heuristics and some propositions for understanding resilience in social-ecological systems, *Ecol. Soc.* 11 (1) (2006), <https://doi.org/10.5751/ES-01530-110113>.

- [15] M.L. Doerfel, I. Prezelj, Resilience in a complex and unpredictable world, *J. Contingencies Crisis Manag.* 25 (3) (2017) 118–122, <https://doi.org/10.1111/1468-5973.12177>.
- [16] A. Carmeli, J. Schaubroeck, Organisational crisis-preparedness: the importance of learning from failures, *Long. Range Plan.* 41 (2) (2008) 177–196, <https://doi.org/10.1016/j.lrp.2008.01.001>.
- [17] K.M. Sutcliffe, T.J. Vogus, Organizing for resilience, in: K.S. Cameron, J.E. Dutton, R.E. Quinn (Eds.), *Positive Organizational Scholarship: Foundations of a New Discipline*, Berrett-Koehler, San Francisco, 2003, pp. 94–121.
- [18] C. Lalonde, C. Roux-Dufort, Challenges in teaching crisis management: connecting theories, skills, and reflexivity, *J. Manag. Educ.* 37 (1) (2013) 21–50, <https://doi.org/10.1177/1052562912456144>.
- [19] T. Macaulay, *Critical Infrastructure: Understanding its Component Parts, Vulnerabilities, Operating Risks, and Interdependencies*, CRC Press, Boca Raton, 2009.
- [20] O. Heino, A. Takala, P. Jukarainen, J. Kalalahti, T. Kekki, P. Verho, Critical infrastructures: the operational environment in cases of severe disruption, *Sustainability* 11 (3) (2019), <https://doi.org/10.3390/su11030838>.
- [21] A. Cedergren, J. Johansson, H. Hassel, Challenges to critical infrastructure resilience in an institutionally fragmented setting, *Saf. Sci.* 110 (2018) 51–58, <https://doi.org/10.1016/j.ssci.2017.12.025>.
- [22] M. de Bruijne, M. van Eeten, Systems that should have failed: critical infrastructure protection in an institutionally fragmented environment, *J. Contingencies Crisis Manag.* 15 (1) (2007) 18–29, <https://doi.org/10.1111/j.1468-5973.2007.00501.x>.
- [23] J.P. Peerenboom, R.E. Fisher, System and sector interdependencies: an overview, in: J.G. Voeller (Ed.), *Wiley Handbook of Science and Technology for Homeland Security*, John Wiley & Sons, Inc., NJ, 2010, pp. 1161–1171.
- [24] S. Sassen, When the city itself becomes a technology of war, *Theor. Cult. Soc.* 27 (6) (2010) 33–50, <https://doi.org/10.1177/0263276410380938>.
- [25] L. Howie, *Terrorism, the Worker and the City. Simulations and Security in a Time of Terror*, Routledge, Abingdon, Oxon, 2009.
- [26] J. Kahan, Critical infrastructure protection: can we defend against terrorism? *Hemel. Secur. Aff.* 13 (1) (2017).
- [27] R. Thurlby, K. Warren, Understanding and managing the threat of disruptive events to the critical national infrastructure, *J. Facil. Manag.* 12 (3) (2014) 231–246, <https://doi.org/10.1108/JFM-04-2013-0020>.
- [28] A. Bouquet, J. Grove, N. Shah, Becoming weapon: an opening call to arms, *Critical Studies Security* 5 (1) (2017) 1–8, <https://doi.org/10.1080/21624887.2017.1343010>.
- [29] M. DuBois King, The weaponization of water in Syria and Iraq, *Wash. Q.* 38 (4) (2016) 153–169, <https://doi.org/10.1080/0163660X.2015.1125835>.
- [30] R.J. Bye, P. Almklov, S. Antonsen, O.M. Nyheim, A.L. Aalberg, S.O. Johnsen, The institutional context of crisis. A study of the police response during the 22 July terror attacks in Norway, *Saf. Sci.* 111 (2019) 67–79, <https://doi.org/10.1016/j.ssci.2018.09.011>.
- [31] E.L. Rake, O. Njå, Perceptions and performances of experienced incident commanders, *J. Risk Res.* 12 (5) (2009) 665–685, <https://doi.org/10.1080/13669870802604281>.
- [32] A. McConnell, L. Drennan, Mission impossible? Planning and preparing for crisis, *J. Contingencies Crisis Manag.* 14 (2) (2006) 59–69, <https://doi.org/10.1111/j.1468-5973.2006.00482.x>.
- [33] J. Borell, K. Eriksson, Learning effectiveness of discussion-based crisis management exercises, *Int. J. Disaster Risk Reduction* 5 (2013) 28–37, <https://doi.org/10.1016/j.ijdr.2013.05.001>.
- [34] S. Corbacioglu, N. Kapucu, Organisational learning and self-adaptation in dynamic disaster environment, *Disasters* 30 (2) (2006) 212–233, <https://doi.org/10.1111/j.0361-3666.2006.00316.x>.
- [35] D.D.P. Thompson, Leveraging learning to improve disaster management outcomes, *Int. J. Disaster Risk Sci.* 3 (4) (2012) 195–206, <https://doi.org/10.1007/s13753-012-0020-4>.
- [36] A. Löf, Exploring adaptability through learning layers and learning loops, in: M. E. Krasny, C. Lundholm, R. Plummer (Eds.), *Resilience in Social-Ecological Systems: The Role of Learning and Education*, Routledge, Oxon, 2011, pp. 63–77.
- [37] G. Bakacsi, Managing crisis: single-loop or double-loop learning? *Strategic Manag.* 15 (3) (2009) 3–9.
- [38] P. Baumard, W.H. Starbuck, Learning from failures: why it may not happen, *Long. Range Plan.* 38 (3) (2005) 281–298, <https://doi.org/10.1016/j.lrp.2005.03.004>.
- [39] M.D. Cannon, A.C. Edmondson, Failing to learn and learning to fail (intelligently): how great organizations put failure to work to innovate and improve, *Long. Range Plan.* 38 (3) (2005) 299–319, <https://doi.org/10.1016/j.lrp.2005.04.005>.
- [40] T. Grunnan, H. Fridheim, Planning and conducting crisis management exercises for decision-making: the do's and don'ts, *Euro J. Decision Proc.* 5 (1–4) (2017) 79–96, <https://doi.org/10.1007/s40070-017-0065-0>.
- [41] C. Zebrowski, Emergent emergency response: speed, event suppression and the chronopolitics of resilience, *Secur. Dialog.* 50 (2) (2019) 148–164, <https://doi.org/10.1177/0967010618817422>.
- [42] I. Wenzel, The ten commandments for translating simulation results into real-life performance, *Simulat. Gaming* 40 (1) (2009) 98–109, <https://doi.org/10.1177/1046878107308077>.
- [43] J.P. Kalkman, Sensemaking questions and crisis response teams, *Disaster Prev. Manag.: Int. J.* 28 (5) (2019) 649–660, <https://doi.org/10.1108/DPM-08-2018-0282>.
- [44] G.A. Koehler, G.G. Kress, R.L. Miller, What disaster response management can learn from chaos theory, in: A. Farazmand (Ed.), *Crisis and Emergency Management. Theory and Practice*, second ed., CRC Press, Boca Raton, 2014, pp. 111–133.
- [45] J.B. Moats, T.J. Chermack, L.M. Dooley, Using scenarios to develop crisis managers: applications of scenario planning and scenario-based training, *Adv. Develop. Hum. Resour.* 10 (3) (2008) 397–424, <https://doi.org/10.1177/1523422308316456>.
- [46] S.O. Johannessen, *Strategies, Leadership and Complexity in Crisis and Emergency Operations*, Routledge, London, 2018.
- [47] J.L. Sørensen, E.D. Carlström, G.-E. Torgersen, A.M. Christiansen, T.-E. Kim, S. Wahlström, L.I. Magnussen, The organizer dilemma: outcomes from a collaboration exercise, *Int. J. Disaster Risk Sci.* 10 (2) (2019) 261–269, <https://doi.org/10.1007/s13753-019-0220-2>.
- [48] A. Andersson, Boundaries as mechanisms for learning in emergency exercises with students from emergency service organisations, *J. Vocat. Educ. Train.* 68 (2) (2016) 245–262, <https://doi.org/10.1080/13636820.2016.1166450>.
- [49] A. Andersson, E.D. Carlström, B. Ahgren, J.M. Berlin, Managing boundaries at the accident scene – a qualitative study of collaboration exercises, *Int. J. Emergency Service* 3 (1) (2014) 77–94, <https://doi.org/10.1108/IJES-02-2013-0003>.
- [50] J.M. Berlin, E.D. Carlström, Why is Collaboration Minimised at the Accident Scene? A critical study of a hidden phenomenon, *Disaster Prev. Manag.* 20 (2) (2011) 159–171, <https://doi.org/10.1108/09653561111126094>.
- [51] F. Tena-Chollet, J. Tixier, A. Dandrieux, P. Slangen, Training decision-makers: existing strategies for natural and technological crisis management and specifications of an improved simulation-based tool, *Saf. Sci.* 97 (2016) 144–153, <https://doi.org/10.1016/j.ssci.2016.03.025>.
- [52] L. Sayegh, W.P. Anthony, P.L. Perrewé, Managerial decision-making under crisis: the role of emotion in an intuitive decision process, *Hum. Resour. Manag. Rev.* 14 (2) (2004) 179–199, <https://doi.org/10.1016/j.hrmr.2004.05.002>.
- [53] E.P. Borodicz, *Risk, Crisis and Security Management*, John Wiley & Sons Ltd, Chichester, 2005.
- [54] A. Farazmand, Hurricane Katrina, the crisis of leadership, and chaos management: time for trying the "surprise management theory in action, *Publ. Organ. Rev.: A Global J.* 9 (4) (2009) 399–412, <https://doi.org/10.1007/s11115-009-0099-2>.
- [55] A. Farazmand, Learning from the katarina crisis. A global and international perspective with implications for future crisis management, in: A. Farazmand (Ed.), *Crisis and Emergency Management. Theory and Practice*, second ed., CRC Press, Boca Raton, 2014, pp. 461–476.
- [56] D. Mendonça, F. Fiedrich, Training for improvisation in emergency management: opportunities and limits for information technology, *Int. J. Emerg. Manag.* 3 (4) (2006) 348–363, <https://doi.org/10.1504/IJEM.2006.011301>.
- [57] K.E. Weick, Drop your tools: an allegory for organizational studies, *Adm. Sci. Q.* 41 (2) (1996) 301–314, <https://doi.org/10.2307/2393722>.
- [58] M. Murtonen, E. Lehtinen, Adult learners and theories of learning, in: E.K. Kallio (Ed.), *Development of Adult Thinking: Interdisciplinary Perspectives on Cognitive Development and Adult Learning*, Routledge, London, 2020, pp. 97–122.
- [59] M. Zollo, S.G. Winter, Deliberate learning and the evolution of dynamic capabilities, *Organ. Sci.* 13 (3) (2002) 339–351, <https://doi.org/10.1287/orsc.13.3.339.2780>.
- [60] E.K. Kallio, From multiperspective to contextual integrative thinking in adulthood: considerations on theorisation of adult thinking and its place as a component of wisdom, in: E.K. Kallio (Ed.), *Development of Adult Thinking: Interdisciplinary Perspectives on Cognitive Development and Adult Learning*, Routledge, London, 2020, pp. 9–32.
- [61] M. Visser, Learning and unlearning: a conceptual note, *Learn. Organ.* 24 (1) (2017) 49–57, <https://doi.org/10.1108/TLO-10-2016-0070>.
- [62] K. Becker, Individual and organisational unlearning: directions for future research, *Int. J. organisation. Behav.* 9 (7) (2005) 659–670.
- [63] J.I. Klein, Parenthetic learning in organizations: toward the unlearning of the unlearning model, *J. Manag. Stud.* 26 (3) (1989) 291–308, <https://doi.org/10.1111/j.1467-6486.1989.tb00729.x>.
- [64] E.P. Antonacopoulou, Impact and scholarship: unlearning and practicing to co-create actionable knowledge, *Manag. Learn.* 40 (4) (2009) 421–430, <https://doi.org/10.1177/1350507609336708>.
- [65] G. Klein, J. Borders, E. Newsome, L. Militello, H.A. Klein, *Cognitive Skills Training, 13th International Conference on Naturalistic Decision Making*, Bath, UK, 2017.
- [66] A.J. Baroody, The development of adaptive expertise and flexibility: the integration of conceptual and procedural knowledge, in: A.J. Baroody, A. Dowker (Eds.), *The Development of Arithmetic Concepts and Skills: Constructing Adaptive Expertise*, Lawrence Erlbaum Associates, Mahwah, NJ, 2003, pp. 1–33.
- [67] J.L. Mishra, D.K. Allen, A.D. Pearman, Understanding decision making during emergencies: a key contributor to resilience, *EURO J. Design Proc.* 3 (3) (2015) 397–424, <https://doi.org/10.1007/s40070-015-0039-z>.
- [68] D. Smith, D. Elliot, Exploring the barriers to learning from crisis: organizational learning and crisis, *Manag. Learn.* 38 (5) (2007) 519–538, <https://doi.org/10.1177/1350507607083205>.
- [69] B. Robert, C. Lajtha, A new approach to crisis management, *J. Contingencies Crisis Manag.* 10 (4) (2002) 181–191, <https://doi.org/10.1111/1468-5973.00195>.
- [70] H. Seppälä, S. Lindblom-Ylänne, E.K. Kallio, Integrating epistemic knowledge and logical reasoning skills in adult cognitive development, in: E.K. Kallio (Ed.), *Development of Adult Thinking: Interdisciplinary Perspectives on Cognitive Development and Adult Learning*, Routledge, London, 2020, pp. 33–46.

- [71] E. Kallio, Integrative thinking is the key: an evaluation of current research into the development of adult thinking, *Theor. Psychol.* 21 (6) (2011) 785–801, <https://doi.org/10.1177/0959354310388344>.
- [72] P. Tynjälä, E.K. Kallio, H.L.T. Heikkinen, Professional expertise, integrative thinking, wisdom, and phronēsis, in: E.K. Kallio (Ed.), *Development of Adult Thinking: Interdisciplinary Perspectives on Cognitive Development and Adult Learning*, Routledge, London, 2020, pp. 156–174.
- [73] Baroody, A.J., Tiilikainen, S.H. Two perspectives on addition development. In: Baroody, A.J., Dowker, A. (Eds.) *The Development of Arithmetic Concepts and Skills: Constructing Adaptive Expertise*. Mahwah, NJ: Lawrence Erlbaum Associates, pp. 75–125.