IMPROVED RISK EVALUATION AND IMPLEMENTATION OF RESILIENCE CONCEPTS TO CRITICAL INFRASTRUCTURE

D4.6 Operationalising organisational resilience to critical infrastructure

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Deliverable Number: D4.6

Date of delivery: June 22, 2017

Month of delivery: M37

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement no. 653390

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1 Executive Summary

This work is an extension of the study presented in IMPROVER D4.3 (Bram, Degerman, Melkunaite, Urth, & Carreira, 2016), including an organisational resilience indicator framework. The overarching theme of D4.3 was that striving for resilience is not only about knowing what organisational abilities to boost, but more about the way in which such abilities are sought. It was also concluded that it may be difficult to integrate resilience into typical indicator follow-up activities. The study of organisational resilience requires a situated approach where work is studied from many perspectives.

In the present report, the indicator framework from D4.3 has been developed further in order to become more accessible and usable for its envisioned end users. This report also describes a work process which could be used to assess organisational resilience, based on framework indicators and other guiding concepts from organisational resilience research. The method includes core resilience concepts, requirements for the analyst, guidance on typical qualitative methods for inquiry and an analytical process with a workflow going from local analytical activities to a joint assessment workshop.

In addition, D4.6 includes an analysis of existing standards with some relation to organisational resilience and how those standards could be used to inform the introduction of organisational resilience analyses in the industry. These results have influenced the iterative development of the indicator framework.

It in concluded that the indicator framework should and needs to be treated as a living document. It is preferable if each organisation makes it their own and updates it regularly.

Furthermore, the pilot study in the Living Lab Barreiro, Portugal show that using a narrative and thus story-telling when having an assessment workshop on organisational resilience is preferable. This further indicates that it is the qualitative discussions and not the quantitative measurements that are most important for building resilient capabilities.

The result of the work behind this report shows that there is a need for the organisational resilience analyst and facilitator to have knowledge and a deep understanding of organizational resilience and also experience in facilitating organisational change in workshop format.

2 Introduction

One of the main findings of the study in IMPROVER D4.3 (Bram et al., 2016) was that organisational resilience does not primarily reside in simple organisational features, functions or resources, i.e. simple boxes to tick in an organisation's management system. Rather, some of the most important resilient behaviours in the observed cases had to do with adaptations, trade-offs and judgments made by professionals under the challenging conditions of real-world operations. In the same way, there are no easy organisational fixes to obtain the organisational features that can support such advanced decision-making. Rather, for an organisation to support resilient behaviours it has to make serious investments, not least mentally, in human-centred practices for management, design, decision-making and collaboration. The ambition was to manifest this complexity in the indicator framework.

A first version of a framework for organisational resilience (OR) indicators was presented in IMPROVER report D4.3 (Bram et al., 2016). In the light of criticism towards indicators as a representative tool in the analysis in complex systems, D4.3 mainly approached indicators as "something to look for in story-telling and to promote within an organisation". It was concluded that it may be difficult to integrate resilience into typical indicator follow-up activities. The study of organisational resilience requires a situated approach where work is studied from different perspectives, in context. It was also concluded that it is not enough to focus on what to look for, it is equally important how to look for it, and perhaps even more – the organisation's conception of how to affect those things that are studied. In D4.3 it was finally concluded that the list of indicators should be evaluated further in contact with potential end users, moderated and observed by researchers with systemic and usability competence. Organisational resilience is a new dimension of safety and operations, and it is fully expected that organisations maybe struggle to adapt its ideas. In a long-term perspective, work towards systemic resilient potential must be carried out in a way congruent with the concept of resilience throughout the entire legislation-user system.

2.1 Purpose and objectives

The purpose of the work described in this report was to help infrastructure practitioners assess and promote resilient abilities within their organisations. This purpose has been pursued by realising the following objectives:

- An evolution of the organisational resilience indicator framework first developed within D4.3, adding more lower-level observable organisational aspects that contribute to resilient performance
- A method for the analysis of organisational resilience, providing an assessment process and a set of guidelines for the organisational resilience analyst.

2.2 Outline of report

Chapter 3 describes the iterative development work of the indicator framework for organisational resilience.

Chapter 4 presents the work process for organisational resilience analysis and assessment.

Chapter 5 presents discussion and conclusions.

In addition, three appendixes have been added to the report.

In Appendix 1 a list of demands on the indicator in the framework is presented.

In Appendix 2 the final framework for organisational resilience is presented.

In Appendix 3 an analysis of standards connected to organisational resilience that is used in the iterations of the indicator framework is presented.

3 Development of framework for organisational resilience

The initial development of the framework for organisational resilience is described in IMPROVER report D4.3 (Bram et al., 2016). In this section a short summary of this work will be presented.

The work to develop organisational resilience indicators began with a collection of characteristics for resilient organisations described in research literature, which was combined with data from a study on organisational actions and interactions during a major event in the Öresund region 2015 and three events connected to fresh water supply in Barreiro, Portugal. These characteristics were developed further through a thematic analysis into a set of qualitative descriptions.

Rasmussen's (1985) work on purpose/function/physical form was used for sorting the different aspects of resilience hierarchically depending on their abstraction level. General organisational features, in this case the themes from the thematic analysis, were used as the highest level of abstraction, under which organisational processes and low-level organisational traits that should support resilience were sorted. The abstraction hierarchy works as a framework for describing the functions, forms and detailed organisational processes needed for maintaining the organisational purpose – "promoting resilient performance". Functions build the overall purpose and the function depends on changes in organisational forms and processes, the function's physical form. Hence, the overall system purpose 'resilience' could be described bottom-up (what builds resilience) or top-down (causes for meeting the purpose or not meeting it).

3.1 Iteration of framework

The further development of the indicator framework was carried out in several iterations. Below the focuses of the different iterations will be presented and then a description of the result of the iterations.

A first iteration was made through validating the organisational resilience indicator framework against the requirements form in Appendix 1 - Demands on indicator list. This requirement are a result of the work presented in IMPROVER D4.3 (Bram et al., 2016, p. 34) and are essential aspects and demands that the framework needs to meet.

A second iteration was done by the project partners who worked together to create more fine-grained and exact descriptions of indicators for organisational resilience, all the while maintaining the ability to analyse any socio-technical critical infrastructure system. This was done in order to improve the practical applicability of the framework, making it more usable. In addition, this was also done in order to make it possible to incorporate the framework in to the IMPROVER project web based tool**1**.

Furthermore, analyses were also carried out of standards with potential relations to organisational resilience. The analysis of ISO 31000:2009 on Risk management and ISO 22316:2017 on organisational resilience was made by identifying common themes within the indicator framework from D4.3 and the standard. This was done in order to support the indicator framework developed within IMPROVER as well as to look for differences, since the IMPROVER indicators are partly based on case studies of critical infrastructure operators. This work is described further in **Error!**

[1] http://improver-inov.herokuapp.com/users/sign_in

Reference source not found.. It could be concluded that there are challenges with combining the logic behind standardisation and organizational resilience. The purpose with standardisation in general is making things similar and easy to compare, the purpose with the IMPROVER OR assessment method is to promote adaptability in a variable context. If an organisation focuses too much on standards, it could make the organisation more rigid, which could endanger resilient adaptability. The content in the organisational resilience standard could of course be a tool of thinking and discussing, but the logic behind it risks directing the organisation towards fixed activities, fixed ways of thinking and fixed measurements. Is could be concluded that in any assessment situation, the most important aspect is how to perform the assessment work, not as much the specific indicators.

The iterations resulted in a restructuring of the framework with the primary aim to clarify and make it more user-friendly. At the Function level in the abstraction hierarchy, only smaller changes were made. This change was done to clarify the understanding of the different titles by re-wording some of the titles, but did not change the underlying ideas that is based on the thematic analysis in IMPROVER D4.3 (Bram et al., 2016). At the lower levels in the abstraction hierarchy, the Forms and Process levels, the iterations resulted in several changes and revisions. Some new or changed Forms were introduced in the framework. At the Process level indicators was re-worded and new ones were added. During the work the numbers of indicators (the Process level) have changed from eight up to fifty. Since the framework aims for a broad set of different types of infrastructures the iteration process resulted in a decision that it was better with fewer indicators that are more general and not adapted to specific infrastructures or organisations. This makes it possible to adapt the framework to suite different organisations. Stiil the framework supports the users in applying it. Descriptions and characteristics and also “aspects to examine further and promote” were added. This work is to be found in the IMPROVER tool.

The framework resulting from this work can be found in Appendix 2 – Updated framework after iterations. All descriptions, characteristics and aspects of each indicator is found in the IMPROVER web based tool.

3.2 Pilot study

The framework of indicators as well as the work process and guidelines for using the framework (see Chapter 4) was tested during a pilot implementation workshop in one of the IMPROVER living labs, the fresh water supply in Barreiro, Portugal.

The workshop focused on story-telling. Representatives from Barreiro fresh water facility chose a case themselves. During the workshop the scenario was used as a narrative to discuss resilient abilities and adaptations, but also aspects that could decrease possibility for resilience in the future. The workshop leaders connected characteristics in the scenario to resilient abilities, i.e. indicators in the indicator framework. Related to the development of the indicator framework and work process for assessing organisational resilience, the workshop showed that it is not the numerical measurement that is most important, rather the qualitative discussions both during and after the workshop. This further confirmed that it is preferable with fewer indicators. Otherwise there is a risk that the quantification takes over. Since an important aspect of resilience is keeping the discussions around risk alive, even if everything feels safe, it was decided to decrease the quantitative activities, giving extra room for qualitative dialogue. This work process was also liked by the Barreiro representatives. The workshop also showed that this work needs to be coordinated by a person that understands organizational resilience, therefore the work process also summarizes demands on the analyst.

4 Work process and guidelines

Striving for resilience is not only about knowing what organisational abilities to boost, but more about the way in which such abilities are sought. Even though indicators can readily be listed and integrated

into existing indicator systems, the main question for any organisation is *how* these indicators are interpreted and approached in practice, i.e. what the organisation should do to strengthen resilience and how to go about it.

The method and work process for using the indicator framework were developed based on a literature study of the basic requirements for qualitative evaluations and work studies that is presented in IMPROVER D4.3 (Bram et al., 2016) and in this chapter. Results from the literature study were then combined with team experience resulting in a description of different core concepts, process elements and methodologies.

4.1 Required attributes of the analyst

The Organisational Resilience (OR) analysis should be spearheaded by at least one person who acts as lead analyst and facilitator of any participatory activities. This person could be either an internal or external asset, the most important factor being that this person can develop a relation of trust with all contributors to the analysis. There may be advantages to using an external analyst in the way that this person provides an outside perspective and may have fewer normative conceptions about how work should be carried out. By contrast, an internal analyst may benefit from organisational knowledge and existing personal relations. In either case, the analyst needs to possess a certain set of skills including:

- Good knowledge in the subject of Organisational Resilience, its purpose and core concepts
- The ability to listen and good technique for interviews and observations
- The ability to study work - to develop a multi-faceted and sound understanding of operations and its challenges
- The ability to write uncoloured accounts of experiences and observations shared by other people
- Experience in facilitating workshop activities, promoting people to engage actively in discussions

In the next chapter, a number of core concepts from Organisational Resilience research are presented. These concepts have been developed into basic approaches that the analyst needs to adopt when trying to assess OR.

4.2 Concepts and approaches for qualitative enquiries and for OR

The analysis of organisational resilience is intimately connected with qualitative studies of work, because it is in the fine-grained information about everyday operations that the building blocks of resilience emerge. This kind of qualitative work needs to have certain properties in order to produce useable data.

When the analyst walks the organisation, conducting interviews and observing work, this person needs to have a *non-normative approach*, listening without judging. It is important to project a sincere interest in the people giving up their time for discussions. In these discussions, the analyst must be open for contributions and interpretations made by informants, using small cues to encourage contributions and refraining from imposing his or her own views.

A concept central to this practice is *local rationality* (EUROCONTROL, 2014). Local rationality is an analytical concept which stresses that decisions and actions within a certain work context most often are underpinned by reasons that may not be immediately obvious for an outside observer. These reasons are most probably logical in the local context, although they may be suboptimal in relation to higher-level organisational goals. The analyst is challenged with understanding this local rationality instead of passing judgment over operative decisions and actions. When local rationality is better

understood, many interesting cues to how decision-making and work can be better supported will often emerge.

The concept of local rationality can be tied to another common theme in safety research, namely the difference between *Work As Imagined* (WAI) and *Work As Done* (WAD) (Hollnagel, Woods, & Leveson, 2006). This dichotomy is simply used to stress that the farther a person distances herself from operational work, the more rudimentary her understanding of the real challenges of work will become. This can introduce a simplistic tendency in management, such as enforcing strict policies on procedural adherence without acknowledging the creativity and adaptation that goes into solving operative issues. Differences in WAI-WAD will manifest through a lack of shared situation awareness between actors at different hierarchical layers in the organisation, something that the OR analyst needs to pay close attention to.

The idea of *Work As Done* as a joint, complex activity, and that a *systems perspective* (Branlat & Woods, 2010) must be applied in work studies, is at the heart of the organisational resilience concept. Work, as any human activity, is *context dependent*. In order to understand what makes it successful, we need to study a breadth of factors represented by a number of academic fields, such as ergonomics, design, organisational science, social science and culture studies. Similarly, when we try to analyse OR we must also understand as much of the work context as possible.

Professionals are constantly adapting to varying conditions, herein lays the strength of human operators. What is a successful strategy in one situation may be unsuccessful in the next, meaning that there is often no way of judging operative behaviours according to a strict rule. An OR analyst must be respectful and expect to find valuable, professional knowledge on all organisational levels. It will be particularly important to pay close attention to operative adaptations, because in them lies a large portion of the organisation's potential for resilient action. This is why, in organisational resilience research, *humans are regarded as a main success factor* for positive outcomes.

4.3 Organisational Resilience assessment process

Organisational Resilience Analysis can provide a snapshot picture of the organisational factors that come together to enable resilient action. Its main purpose is to open up the organisation for a dialogue around the basic underpinnings of successful work. Since OR focuses on positive outcomes and improving general working conditions, discussions about resilience are often conceived as more positive and constructive than risk analyses or after-event analyses. The dialogue itself, the process of arriving to a shared conclusion, may often be the main benefit of conducting OR analysis. In this method participants could be asked to rate the organisation's potential for resilient action in relation to a number of different aspects, described in the Organisational Resilience Indicator Framework (Appendix 2 – Updated framework after iterations). The facilitator could also do this activity, and discuss the result on a joint workshop.

Ratings will allow the organisation to follow the development of indicators over time, but it must be stressed that since these numbers correspond to qualitative judgments of organisational dynamics that are hard to describe objectively, the most important aspect should be ascribed to the professional assessments and experiences that lay below. Thus, management should not become too focused on quantitative measures for OR, but instead make sure that they are actively engaged in the dialogue that produce them.

This report suggests a simple bottom-up process for Organisational Resilience Analysis, where the analyst engages with local practitioners, gathering experiences and other data to support a later, joint workshop, focusing on story-telling, where the organisation is assessed for the different aspects of OR. Organisational analyses are always labour-intensive. Therefore it may be advisable to limit the scope of an analytical period in some way, either by only analysing one or few organisational functions or by

limiting the analysis to one or few themes/functions or aspects of OR. The time spent on OR analysis will differ based on factors such as the organisation's size and the level of experience of the analyst.

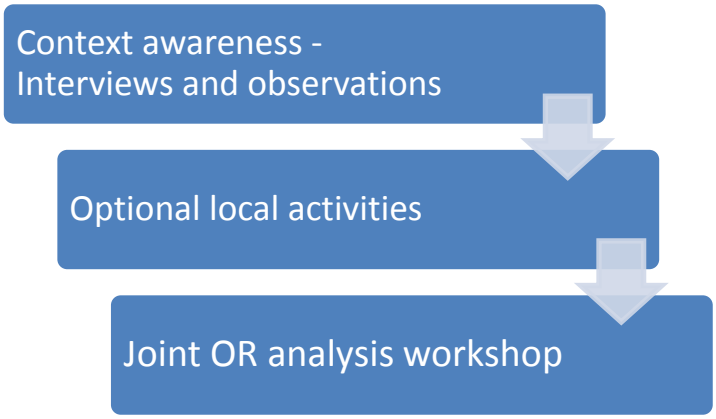

Figure 1 - Organisational Resilience Analysis Process Overview

4.3.1 Context awareness - Methods and procedures for data collection

The choice of method is dependent on what is adequate in the specific case. It is argued preferable to use several different techniques in a study. This is commonly seen as a way to validate the result, but as critics argue a method is used to investigate the phenomenon in a specific way; "we should combine theories and methods carefully and purposefully with the intention of adding breadth or depth to our analysis but not for the purpose of pursuing 'objective' truth" (as Fielding and Fielding (1986, p.33) in Flick, von Kardoff, & Steinke, 2004).

4.3.1.1 Interviews and observations

Two techniques that are suitable for discussing organisational resilience in most organisations are interviews and observations.

Interviews are one of the most commonly used methods to gather data about people's experiences and thoughts. In an interview situation it is the interaction between the interviewer and the respondent that produces knowledge (Brinkmann, 2008). Through the interview, the interviewer aims to see and understand the world from the interviewee's point of view. Based on this understanding the interviewer then interprets the information received and describes the meaning of it (Kvale, 1996).

To be able to capture the respondent's view but still structure and control the discussion around the areas that are of interest for organisational resilience, semi-structured interviews (see e.g. Ayres, 2008; Brinkmann, 2008) seem preferable. To this end the analyst could base questions on a combination of organisational resilience indicators and a Human Factors analysis framework such as Common Performance Conditions:

1) availability of personnel and equipment
2) training, preparation, competence
3) communication quality
4) human-machine interaction, operational support
5) availability of procedures
6) work conditions
7) goals, number and conflicts
8) available time
9) circadian rhythm, stress
10) team collaboration

11) organizational quality

This will help informants to reason about different factors that may undermine resilient performance. Further, there is a choice between single interviews or group interviews that both can be suitable for the aim to interpret organisational resilience.

Observations are here seen as a data collection method where information is gathered by observing and participating in other people's interactions and work. Observation is not just exposure, it is an outcome of an active choice connected to the two questions: *what* to see and *how* to see it (Kearns, 2005).

Observations are commonly combined with interviews. But unlike formal interviews, taking place in constructed environments, something that is characteristic of observations is that people are studied in their natural environment. In observation it is often required that the observer is staying for a relatively long period of time in the context and among the people to be studied. The observer can take different roles in the observation situation, from a complete observation to complete participation (Kearns, 2005).

4.3.1.2 Conducting interviews and observations

Below a couple of aspects that need to be taken care of when working with interviews and observations is presented.

Underlying assumptions: As data resulting from interviews is seen as a product of the interaction between the interviewer and an interviewee or a group of interviewees (see e.g. Brinkmann, 2008) it is essential to uncover the underlying assumptions of the interviewer. The same applies for the observers underlying assumptions. In this context, relevant underlying assumptions are those connected to the interviewers or observers understanding of what constitute and create organisational resilience. Thus it is essential that the interviewer or observer has a good understanding of the theories behind the framework. Some of the core concepts of organisational resilience are described briefly in Chapter 4.2.

*Choice of environment***:** The choice of environment, the physical environment as well as the general situational context, for the interview can also affect outcomes. One should choose an environment that is calm and undisturbed and where the interviewee feels safe and relaxed. This is also a way of affecting any potential asymmetric power relations between interviewer and respondent. This aspect is not as essential for observations since observations are as mentioned commonly taking place in the natural environment of the people studied.

Selection of respondents: Both when it comes to interviews and observations results are dependent on whom is interviewed or observed. When studying organisational resilience purposeful selection can be preferable. In purposeful selection the logic is that the strategy for sampling should serve the purpose of the study (Patton, 2007). The selection and sampling method involves choosing information-rich cases to deepen the knowledge about this by choosing persons that provide knowledge that is central for the investigation. It is generally advised to choose a wide variety of respondents, representing relevant but different organisational functions and operative levels, with differences in background, age, sex etc.

Number of interviews: When it comes to purposeful sampling there are no absolute rules governing the perfect sample size. Instead there is always a trade-off between breadth and depth (Patton, 2002). A simple rule is to stop interviewing or observing when new interviews do not add any new information or new interpretations. This is often termed theoretical saturation.

Confidentiality and anonymity: Confidentiality as well as anonymity is essential in the interview and observation situation. This is especially important in this context when interpreting organisational

resilience since it then is important that the respondent dare to express her opinions without being afraid of negative consequences.

4.3.2 Complementary local activities and mini workshops

Local activities carried out in separate organisational functions should be guided by the general concepts and approaches described in Chapter 4.2. These could be done throw for example interviews, observations and workshops. The main purposes of these activities are to prime the organisation for a discussion on the preconditions of work and not least, to give the analyst a good enough understanding of operational practice and organisational dynamics. In most cases, the analyst should not try to cover large portions of the OR indicator framework in the same session. One or two connected indicators may often be enough to spark a discussion and provide valuable insights, perhaps ruled by a thematic analysis as suggested in above. It is often rewarding to lead informants into thinking of real-world cases where it has been possible to observe how the organisation functions with regard to aspects of organisational resilience.

Local activities as mini-workshops are likely to generate large amounts of data and when people share their views and experiences, that information will not follow the neat form of the indicator framework. A large portion of the analyst's work will therefore be to analytically categorise the data and look for patterns of resilient capabilities in the organisation, guided by the indicator framework. This kind of material, when presented in an accessible way, will provide a good foundation for the joint OR analysis workshop.

4.3.3 Joint workshop

When the analyst has worked up a sufficient material, a joint workshop with representatives from different parts of the organisation should be carried out. Personnel from all hierarchical levels should be present, it is not preferable only engaging management since they have a work-as-imagined view on work. This view needs to be balanced with real work experience (worsk-as-done) from operational workers. The purpose of this workshop is to assess the organisation's performance in relation to indicators from the OR indicator framework (Appendix 2 – Updated framework after iterations). As always the primary goal for the workshop is to promote a healthy discussion about what enables positive outcomes in operations. The workshop should be carried out in an open climate where free sharing of ideas and experiences are encouraged, and where participants from different functions or hierarchical layers in the organisation are equally heard. Figure 2 displays an example structure for this workshop.

Figure 2 - Joint Workshop Overview

Here follows a more in depth discussion of the steps in Figure 2:

01. At the start of the workshop, the analyst should briefly present the basic concepts of organisational resilience (OR) relevant for the theme of the particular activity, the reasons for talking about OR and the purpose of trying to develop it. At the same time, some general guidelines for the workshop, expected outcomes and future feedback to the participants should be presented.

02. It is advised that the workshop follows the analytical focus of prior interviews and observations, paying attention to one singular aspect of organisational resilience. This OR aspect is presented and explained, after which prior findings that have some bearing on the topic are laid out. At this point participants should also be allowed to share their own experiences of the preparatory work, or any other information that they seem relevant.

03. Partcipants chose a case, often a passed event to describe and discuss. The facilitator asks questions for being able to match organizational abilities to the framework. The analyst leads the group in a discussion, inviting participants to share their assessments and comments

04. During a break the facilitator makes a quick preliminary analysis of the case according to framework indicators. The analyst starts with aspects that manifest resilient performance. The facilitator could then talk about risks in the organization, aspects that could undermine resilience.

05. The analyst summarises the key issues and conditions reported at the prior stage. The facilitator presents the preliminary results, which should lead to a new group discussion. Here it is possible for the entire group to be a part of grading of each indicator according to the maturity scale. In the IMPROVER tool there are characteristics of each indicator. Also aspects to further examine and discuss. It is also possible that the facilitator makes the grading and presents this to the group.

06. The facilitator leads a discussion about possible response actions. In this discussion it is important that the analyst maintains a systemic approach, i.e. that response measures reflect all the different factors that have been found to contribute to successful operations (corresponding to the Function abstraction level of the indicator framework).

07. The analyst sums up the discussions and outcomes, repeats how participants will receive feedback about the continued process, and then closes the meeting.

4.4 Compilation and action

The joint workshop produces a number of areas of improvement that need to be addressed in order to strengthen the organisation's capacity for resilience. These areas of improvement should now be compiled in a report describing what aspect of resilience has been analysed, the organisation's evaluation of this aspect and examples from operations that support the claim. At this point, data should also be introduced into the IMPROVER web based tool[2].

[2] http://improver-inov.herokuapp.com/

Actions suggested at the Joint workshop should be presented to management for final decision, in the case these decisions cannot be made on a lower level. A suggested format for actions can be found in Table 1 below.

Table 1. Suggested format for actions

Action	Goal	Responsible	Finished by	Fulfilment metric
Make contacts with neighbouring industry to investigate the potential of cooperation in the event of crisis.	To build common ground and create sustainable communication channels. To identify scenarios for cooperation. To identify some possible forms of cooperation, e.g. through the sharing of resources. Look for ways of building relations on a more daily basis [To build aspect X of organisational resilience?]	Jane Doe	2018-06-01	Relations established. Suggested forms of cooperation presented to management.

5 Discussion and Conclusions

The purposes of the work described in this report have been to help infrastructure practitioners assess and promote resilient abilities within their organisations. This has been done through a further development of the organisational resilience indicator framework that was presented in IMPROVER D4.3 (Bram et al., 2016) as well as the development and description of a work process for performing analysis of organisational resilience. The updated indicator framework for organisational resilience can be found in Appendix 2 – Updated framework after iterations and the IMPROVER web based tool. The work process can be found in Chapter 4 - Work process and guidelines.

Below a couple of essential results is presented:

As mentioned in IMPROVER D4.3 (Bram et al., 2016), to divide a complex system in a hierarchy could be problematic. An indicator is here seen as "what to look for and promote in an organisation for building resilient abilities". The indicator framework should thus not be fixed. This means that the indicator framework presented in this report needs to be treated as a living document.

Furthermore, the pilot study in the Living Lab Barreiro, Portugal show that using a narrative and thus story-telling when having a workshop on organizational resilience is preferable. This further indicates that it is the qualitative discussions and not the quantitative measurements that are most important for building resilient capabilities.

The result of the work behind this report shows that there is a need for the organisational resilience analyst and facilitator to have knowledge and a deep understanding of organizational resilience and also experience in facilitating organisational change in workshop format.

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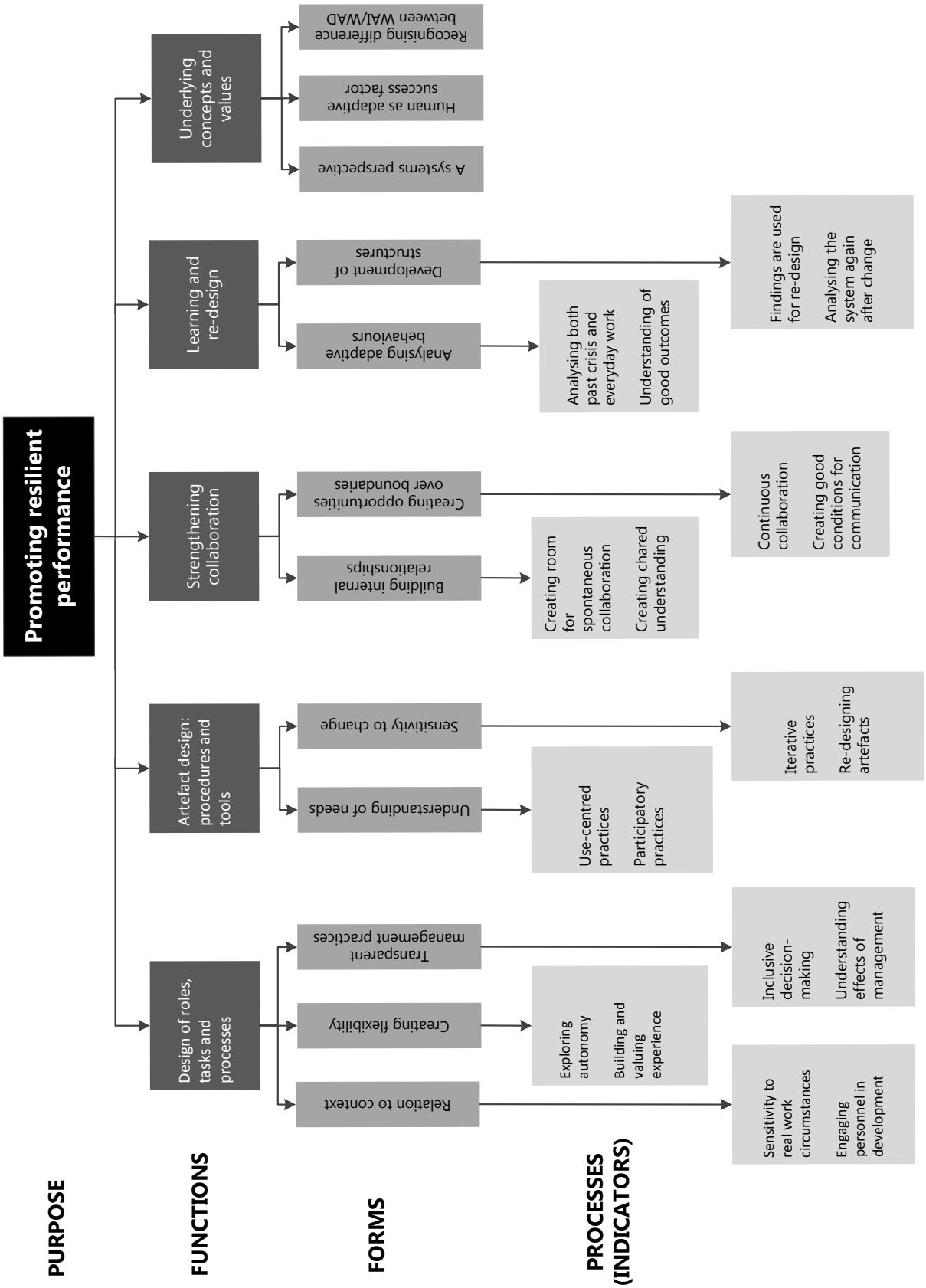
Appendix 1 - Demands on indicator list

The analysis of the scientific theory and body of empirics resulted in demands on the indicators.

The indicators should…

- include an "instruction" in how to be interpreted (and not interpreted) for promoting resilient performance
- invite to ongoing reflection and analysis.
- encourage a systemic interpretation. Indicators should not easily lend themselves to linear and mechanistic interpretations
- promote a shared view on real work challenges and identification of work-as-done
- help the user in moving between abstract and detailed functions in the organisation
- encourage work towards complex goals. Indicators should not easily lend itself to existing counterproductive driving forces to optimise towards measurability, monitoring, high standardisation, control and formal compliance (Power, 1999)
- be a starting point that must be further developed
- be continuously revised in alignment with organisational and contextual development
- be able to manage the whole overall organisational structure, including how decisions about technology and artefacts are made.
- manifest and recognise human capacity and significance in real work practice
- promote use-driven artefact design within the organisation
- encourage the reflection around goal-conflicts and trade-offs
- promote work with identifying good outcomes and successful adaptive performance, not only minimising risks and threats.
- promote a learning through re-designing the structures, artefacts and conditions
- create dialogue and cross-border forums and promote collaboration

Appendix 2 – Updated framework after iterations



Design of roles, tasks and processes

Relation to context

Sensitivity to real work circumstances

A task becomes work in a context, work close to the practitioners

Rethink analyzing isolated fragments, they always relate to each other

Strive for decision-makers having practical experience

Blunt-end managers with former experience in real work situations, loose this perspective over time

Root decisions in understanding of actual work conditions

Engaging personnel in development

Manifest the desire of engaging workers. Meet their needs.

Creating flexibility

Exploring autonomy

In retrospect, view decisions as locally rational

Challenge hindsight bias when analysing decisions in retrospect

Building and valuing experience

Do not confuse role descriptions with actual skill, there are tacit aspects that couldn't be described in documents.

Recruit with diversity in mind, different perspectives enriches overall knowledge and perspective

Transparent management practices

Inclusive decision-making

Have structures so that sharp-end worker needs are heard by decision-makers

Different perspectives enriches the image of real world challenges

Understanding effects of management

Challenge organisational fears of failing, these could restrain adaptive abilities

Be humble regarding the power relationship between hierarchical levels

Examine double mixed messages from management

Artefact design: procedures and tools

Understanding of needs

Use-centered practices

Challenge a strictly technical or procedural focus. A human being is often the most important factor in a crisis.

The human being must be able to understand the process behind the technology or procedure

Knowing purposes and functions guides negotiations of procedures

Acknowledge cognitive needs in humans and the system

Challenge a strict focus on easily observable and measurable aspects

Participatory practices

Perform artefact development in dialogue with sharp-end workers

Base development of artefacts on dialogue

Sensitivity to change

Iterative practices

Expect that constant questioning is needed

Re-designing artefacts

Learning from crisis should not just lead to adding a new tool or procedure

View errors as a need for further development of the artefact, the artefact didn't meet real work needs and guide decision-making

Strengthening collaboration

Building internal relationships

Create room for spontaneous collaboration

Listen to workers' fears about acting autonomously; reflect on how organisational aspects could be changes for manifesting the mandate better

Value personal relationships and friendships, collaboration grow over time in well-established interactions

Let sharp-end workers make decisions in stressed situations and later report upwards about their actions.

Creating shared understanding

Between those who detect early signals and those who decide about actions

Don't blame workers close to operations for making wrong decisions, instead strive for understanding why the decision was rational in their context

Creating opportunities over boundaries

Continuous collaboration

Reconsider clear responsible boundaries between departments or actors

Be aware that formal business agreements is not an assurance for real work collaboration

Focus on interactions, not pre-defined organisational departments and responsibilities

Be creative in identifying other actors to work together with, let everyone contribute.

Creating good conditions for communication

Strive for understanding other perspectives and local realities

Analyse interfaces of interactions and flows in everyday work

Be curious of the needs, fears and desires of the recipient

Learning and re-design

Analysing adaptive behaviours

Analysing both past events/crisis and everyday work

View success factors as embedded in real work practice

Every day adaptive work reproduces itself in crisis

In event analyses, reflect around WYLFIWYF

Understanding of good outcomes

Success factors lays in human adaptive behaviours, not pre-defined routines

Strive for understanding why actual work was locally rational, don't focus on counterfactual aspects, like "why didn't someone follow a routine"

Understand sharp-end workers. Lessons learned collected from higher hierarchical levels are not representative for sharp-end adaptive success factors

Development of structures

Findings are used for re-design

View errors as a symptom of poorly design pre-conditions and artefacts, don't view errors as humans violating procedures

Reflect upon strictly administrative measures and what sharp-end workers face when routines co-exist collectively

Analysing the system again after change

New artefacts always change work

Changes in one part of the system could unintendedly change something in another part of the system, both for good and bad

Evaluate changes so that changes didn't cause other success factors to disappeared

Underlying values and interpretations

A systems perspective

Change perspective to systemic foundations

Challenge the idea that risks could be foreseen

Be less scenario-dependent when foreseeing the future

Acknowledge that surprises will occur

Challenge the thought that interactions and flows are sequential and predictable. They constantly change and this requires flexibility

Human as adaptive success factor

Value the social system as critical

The organisation has aspects that could not be aggregated from detailed procedures. The not easy observable aspects, like the social system, are important for overall performance

Shifts the focus from blaming the individual for errors, to looking at the broader context of work

Success factors in an organisation is tacit and experience based knowledge built over time and this is manifested in interactions amongst humans

Recognise difference between work-as-done and work-as-imagined

Don’t just focus on how negative outcomes can be minimized, also understand good outcomes

Challenge clinging too hard to established regulations, procedures and processes, discuss trade-offs between standardization and flexibility

Be transparent with trade-offs being made, engage in reflection around it

Challenge assumptions about real work

Meet workers and observe real work challenges with the focus of understanding, not changing and controlling it

Appendix 3 – Analysis of standards connected to organisational resilience

There are several ISO standards that are used in areas connected to organisational resilience. In the below text we will focus on ISO 31000:2009 and ISO 22316:2017.

ISO 31000:2009, *Risk management – Principles and guidelines*

ISO 31000:2009 is an international standard that defines so called best practices on risk management[3]. Several of the other ISO standards (e.g. ISO 22320 (Emergency Management) and ISO 22301 (Business Continuity)) refer to this standard, which also is the reason that we in this analysis focus on ISO 31000. The standard establishes principles that need to be satisfied to make risk management effective. This standard recommends that organisations develop, implement and continuously improve a framework whose purpose is to integrate risk management into its overall management system[4,5].

ISO 31000 provides a structured framework which intends to align with the organisational goals and needs. This link strengthens both the relevance and the importance of risk management[5,6]. To be applied to different risks and activities, the proposed approach in the standard is fundamentally intended to be generic and rational [6,7].

Some central concepts of ISO 31000 are Principles, Framework and Risk Management Process as well as their relationship. Risk Management Framework can refer to the entity of an organisation's risk management system. According to ISO 31000, Risk Management framework is a "set of components that provide the foundations and organisational arrangements for designing, implementing, monitoring, reviewing and continually improving risk management throughout the organisation"[7]. Risk Management Process is a process dedicated to managing risk, namely "communicating, consulting, establishing the context, and identifying, analyzing, evaluating, treating, monitoring and reviewing risk"[7].

The existence of these three concepts and their relationships was one of the leading factors that differentiate ISO 31000 from earlier standards that have been mainly focused on depicting the process of managing risk. Another factor was the decision to include the background organisational arrangements supporting the Risk Management process as an equally important component.

ISO 31000 is a standard with qualitative requirements, being a very generic standard. Therefore, ISO 31000 is not certifiable. The key idea of the standard is that by using the presented qualitative elements, each user should tailor the risk management architecture to suit his organisation's needs. Being generic ISO 31000 aims to apply to "any risk, whatever its nature, whether having positive or

[3] Dorothy Gjerdrum and Mary Peter," The New International Standard on the Practice of Risk Management – A Comparison of ISO 31000:2009 and the COSO ERM Framework", 2011

[4] International Organisation of Standardization, "ISO 31000 Risk Management-Principles and Guidelines", 2009

[5] Carole Lalonde and Olivier Boiral, Managing risks through ISO 31000: A critical analysis", 2012

[6] Grant Purdy, ISO 31000:2009- Setting a New Standard for Risk Management", 2010

[7] US Government Accountability Office, "Report to the Chairman, Committee on Government Reform, House of Representatives," Aug 2006.

negative consequences" and for "any public, private or community enterprise, association, group or individual"[7].

The creation of ISO 31000 has been strongly motivated by the fact that the Risk Management industry has traditionally suffered from the diversity of risk management -related terminology, which predictably causes challenges with communicating risk information. One of the goals of ISO 31000, in addition to providing a sound, contemporary Risk Management architecture applicable to any organisation, is to harmonize the language used in the Risk Management industry and academia[6].

ISO 22316:2017, Security and resilience - Organisational resilience - Principles and attributes

In 2017 a new standard connected to organisational resilience was relieved, ISO 22316:2017 - Security and resilience - Organisational resilience - Principles and attributes. ISO 22316:2017 is formulated to fit with other relevant management disciplines such as business continuity management and risk management.

ISO 22316:2017 standard defines organisational resilience as the "ability of an organisation to absorb and adapt in a changing environment". The standard aims to provide guidance to improve the resilience in an organisation by offering 1) principles to build a resilience strategy upon, 2) attributes that a resilient organisation show based on these principles and 3) activities for measuring and evaluating these attributes within the organisation. The standard is not delimited to certain sectors or industries and is framed to match an individual organisation's specific requirements which make it possible for organisations to incorporate already existing data, methods and processes for evaluation of resilience attributes.

The principles that serve as the foundation for organisational resilience in ISO 22316:2017 focus on behaviour, diversity and coordination among other things. In a resilient organisation the behaviour of all parts of the organisation contributes to enhancing its resilience i.e. people as well as larger system components in the organisation act resilient in themselves. The organisation's resilience is supported by a diverse set of skills, knowledge and experience and there is coordination and collaboration across management disciplines.

An organisation that has adopted these principles should exhibit a range of attributes proposed in the standard. Attributes such as showing ability to anticipate and manage change, sharing information and knowledge as well as understanding the context of the organisation are included. The standard also focuses on support of continual improvement which signifies that enhancing organisational resilience is a continuous process throughout the life of an organisation.

Activities are proposed that will guide the organisation to reach these attributes. Among these activities are:

- Think beyond current activities and/or strategies and promote innovative ideas
- Apply knowledge and information in organisational learning
- Foster cooperation on all levels of the organisation as well as interested parties
- Empower all levels of the organisation to make decisions for enhancing OR
- Implement performance monitoring and evaluation mechanisms

Applicability to IMPROVER

There are some common topics found in ISO 22316 and the IMPROVER OR analysis framework developed, for example giving personnel mandate to act, value of knowledge and experience and focus on learning. The IMPROVER OR assessment process is, compared to any standard, a living document, which the organisation could adapt to their own pre-conditions. The OR assessment method is built upon the insight that standardisation could make the organisation more rigid, which negatively affects resilient abilities. The IMPROVER OR assessment method could function as an evaluation activity both initially, in terms of determining aspects in the organisation which needs to be addressed

directly, and continuously in terms of monitoring and evaluating the organisational resilience. The standard states that top management should develop measurement criteria specific to the organisation in order to assess the status of the organisation's resilience attributes. The IMPROVER framework however, provides a slightly different approach which 1) focuses on including all levels in the organisation when performing an assessment and 2) suggests that the indicators should not be seen as fixed, but rather used as guidance to produce discussion about OR.

The list of demands on the indicators in IMPROVER D4.3 (Bram et al., 2016, Chapter 6.2 and 6.3) share several similarities with the attributes listed in the ISO 22316. The indicators from D4.3 are partly based on the case study of two of IMPROVER's living labs and therefore they could be seen as more applicable and specific to critical infrastructure actors. Some of the joint topics are listed below:

- Design of tasks and roles
  - Engaging personnel in development
  - Giving personnel mandate to make decisions
  - Building experience and practice
- Goals, rules, processes and procedures
  - Knowledge of the organisation's purpose and functions on all levels
- Strengthening collaboration
  - Giving mandate to act adaptively
  - Create joint understanding
  - Creating opportunities over boundaries
- Learning and re-design
  - Analysis of both past crisis and everyday work
  - Understanding of good outcome
  - Analysing the system again after change (continual improvement)
- Underlying values and interpretations
  - A systems perspective
  - Human as adaptive success factor