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D5.3 – Report on initial testing simulations

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Executive Summary

This deliverable D5.3 “Report on initial testing simulations” is part of the Task 5.2 of the CascEff project which deals with initial testing of the Incident Evolution Tool (IET) for providing early feedback when the tool was still under development and its implementation was still at the prototype stage.

The project elaborated an Incident Evolution Methodology (IEM) for predicting crisis evolution involving cascading effects, with the ultimate goal of ensuring a better understanding of cascading effects in crisis situations (see deliverable D4.2). To this end, the development of an Incident Evolution Tool (IET), as a supportive tool of the IEM, was also undertaken. The development process of this prototype followed an iterative and end-users centred approach. A series of two focus groups was conducted along the development process to better apprehend the end-users’ perceptions as well as their expectations about such a tool, and to refine the conceptual design of the tool into a functional prototype able to support decision-making in crisis management. The end-users’ involvement allowed the investigation of the relevance, usability, and acceptability of the IET at various stages of the development process. The feedback gathered from end-users was then used to inform the development team on requested modifications and thus, to contribute to the improvement of functionality and usability aspects of the IET.

Following the completed development of a prototype of the tool able to run simulations, the project partners conducted an internal validation test of this prototype. The purpose was to make sure that the available version of the tool was ready to be used by end-users. This was done by validating the accuracy of the predictions obtained when running a simulation based on a chosen historical scenario, and by checking if all the bugs identified during the Borås meeting as those having high priority for resolution were fixed or not. This involved designing and implementing a test, based on this historical scenario, up to simulation results allowing the prototype validation.

The present deliverable reports the outcomes from these initial tests, done in connection with the development of the IET prototype, including the focus groups sessions and the internal validation campaign. Following the compilation of the findings from the two focus groups sessions, it was shown that the participants expected to be pleased with the services the tool could offer once it will be fully operational. However, the results also indicated that the willingness of the participants to use the tool is quite low. Their potential intention to adopt the IET may be subject to certain conditions.

Below is the summary of what was learnt from the series of focus groups.

- The participants' perceptions on the potential services of the IET were influenced by their ordinary use of Incident Management Tools (IMTs). Many felt that, as such, the IET will be less practical than their own tools. They were expecting a tool able to quickly evaluate a given crisis situation with respect to, on one hand, the various types of consequences at the level of each impacted system; and on the other, temporal aspects. From their perspective, a successful uptake of the IET will depend on its capability to provide them with advice just at the time when they have to handle situations with fast kinetics, and on a reduced level of data entry workload. Eventually, they saw a great utility for the tool either for focusing on the prevention of incidents or for creating sample scenarios in a training perspective.
- The intuitiveness of the User Interface and the usability of the Map view were some of the features indicated as needing improvement by the development team.
- The features of the IET that were most often appreciated by the participants were the tree views (showing graphically the cascading effects spreading amongst systems) and the timeline views (depicting the time delay between the potential cascading effects starting from the initiating event).

Additionally, the pre-validation outcomes have shown that the predictions generated by the tool matched the tree view and the timeline of the events of the historical scenario used for the test. This proved that such a tool for reproducing or modelling cascading effects induced by a given initiating event amongst systems is satisfying. However, at this stage, the IET prototype could not yet be considered as ready for public launch. The findings drawn from the pre-validation test will allow developers to mature the IET and an improved prototype is to be expected by the end of the project.

1 Introduction

The Incident Evolution Tool (IET), the technical supporting-tool for the implementation of the Incident Evolution Methodology (IEM), was developed to provide prediction of potential cascading effects associated with an initiating event in a territory based on:

- the intrinsic characteristics of the systems inventoried on the territory of the study case (location, typology, effects to which they are sensitive to, effects produced, endurance time for each type of effect, etc.);
- the dependencies between those systems;
- the environmental/situational factors;
- the characteristics of the initiating event (location, type, intensity, produced effects, extent of the effects, propagation time);
- the effects inter-systems propagation time and
- the potential decisions made or actions taken (for what-if analysis of cascading effects trajectory: possibility to modify the tree view in relation with a given decision).

The IET development process relied on a user centred approach (Wallach and Scholz, 2012). By doing so, the main goal was to obtain a prototype ready to be used by the target audiences and which would effectively help to improve incident management including if these situations involved cascading effects. Figure 1 illustrates the steps involved in the IET development process. As planned in the DoW (Task 5.2), the prototype was submitted for initial testing (focus groups and internal validation test) and the results from these tests were fed into subsequent development cycles. This process followed the "*design – validate – redesign – validate & red*esign" approach (Wallach and Scholz, 2012). The benefit of this iterative model was to facilitate the creation of an innovative tool that better matches the potential users' needs and requirements. However, it should be kept in mind that one of the important disadvantages of collecting focus groups perceptions on a prototype is that the prototype can be viewed by the participants as the final product.

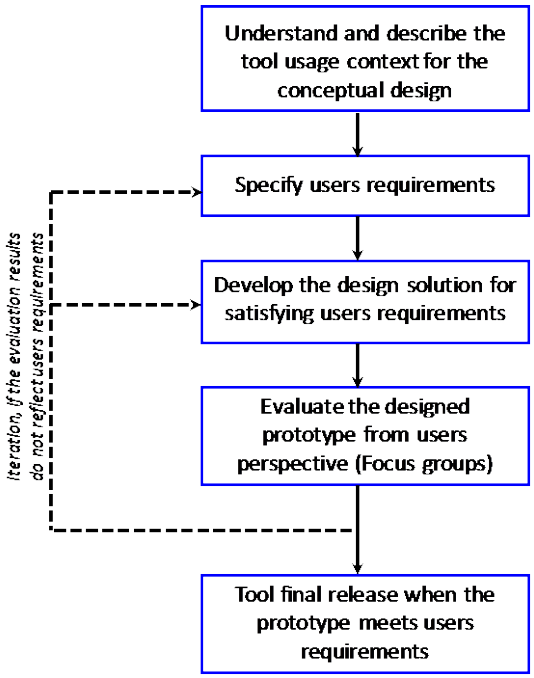


Figure 1 CascEff iterative method for the Incident Evolution Tool development

The scope of the potential end-users' involvement in the development process (through focus groups) was to ensure a tool with the most appropriate functionalities and usability from a users' perspective. Though to this end verification (process of tracking bugs and identifying the tool defects) and validation tests (process of controlling whether the outputs of the tool comply with the expected results) must be performed in combination with focus groups discussions to ensure the development of a good-quality tool. Unfortunately, because of the delay in the development of the tool and given that the focus of the validation task is the IEM not the IET itself (Task 5.3), there was not enough time to conduct a proper validation test with potential end-users. Thus, an internal validation test was performed to check that the IET reached a satisfactory level of confidence guaranteeing that it fulfilled the user requirements and needs. Furthermore, the internal validation test also checked that the IET met minimal criteria of quality standards for computer-based tools. By doing so, the project consortium could guarantee that the IET was technically robust enough to be used for modelling cascading effects until the completion of a real validation phase with real end-users under real-life crisis management conditions.

The present deliverable aims at reporting findings from these initial tests done in connection with the development of the IET prototype. Apart from an introduction and conclusion, the report consists of three main parts. The first part makes the core of this report and provides the findings of the two rounds of focus groups meetings. The internal technical verification test is depicted in the second. The last part includes an overview of the internal validation campaign and its preliminary findings about the IET.

2 Focus groups series

Scientific computer-based tools are generally used to model given phenomena (herein cascading effects) and provide information for decision-support. However, in order to really understand the framework of implementing a new supportive tool, one must gain at least a rudimentary knowledge of what it will take to get the target audiences to employ it.

As mentioned before, the IET development process was based on a user centred approach, involving potential end-users from the very beginning of the development of the tool through its following stages. The steps of the technical development of the tool were as follows:

1. Input validation
2. Output validation
3. Auto depend validation
4. User planning test
5. User Interface Visualisations
6. Timelines
7. User response test
8. Link-up of the IET with IMTs
9. Link-up of two IETs
10. Final user response test

Initially three focus groups series were scheduled (after steps 3, 6 and 9) in line with the Task T5.2 description but because of the delay in the development of the prototype, it was necessary to cancel the third one as the delay entailed time constrains in performing all the sub-tasks planned within the IET development process. Yet despite that drop, no quality concessions were allowed in the IET development process due to an internal process of verification of the required features and functionalities of the tool.

National focus groups were formed within each of the five countries (Belgium – BE, France – FR, The Netherlands – NL, Sweden – SE, United Kingdom – UK) involved in the CascEff project. These focus groups were composed of invited experts and selected people from the different partner countries. As the aim was to involve potential end-users. Therefore, emergency planners, incident commanders and competent authorities from different public agencies as well as private industry and critical infrastructure providers were invited to participate in the different focus groups. The idea was to keep the composition of these focus groups the same throughout all the sessions. However, due to availability concerns, some participants were unable to participate in both sessions. Some new participants were added in order to make the focus groups participants the more representative possible of the target audiences of the IET. During focus groups meetings, the participants were given the opportunity to see and to interact with the prototype (see Figure 2).

(a)

(b)

Figure 2 Second focus group meeting in The Netherlands (a) and France (b)

2.1 Purpose and objectives

The goal of the focus groups meetings was to gather information which could help to create a useful (with added-value) and usable (applicable) final tool, with the aim of facilitating the application of the IEM in a credible way. The specific goals of the focus groups can be described as follows:

- investigate the functionalities (functional completeness and appropriateness, outputs forms, technical performance when there are multiple simultaneous users logged, etc.) and the features (usefulness, user-friendliness, intuitiveness, learnability, etc.) of the tool from the users' perspective;
- estimate potential benefits of the IET to the users;
- provide feedback to help developers refine the functionalities/features as well as to gain additional insights into users' requirements and needs for purposes of ensuring an optimal quality of the final version of the tool;
- proactively identify potential problems which could be faced by the users when interacting with the tool, as stops and/or breakdowns could undermine the users' confidence in the tool and
- determine users' acceptance and intention to incorporate this new assistive tool into their ordinary functioning.

2.2 Process and methodology

The duration of the meetings was between three to five hours. The procedure in the two focus groups sessions was quite similar:

- introduction of the participants;
- brief introduction to the project and the tool;
- presentation of the aim of the IET development focus groups and of the meeting;
- demonstration of the tool;
- individual experimentation of the tool by the participants through the execution of a given task (creation of a case and data entering for the first session, creation and simulation of a test case for the second one) leading to task-based observation with a note taking of their comments and the arisen bugs when testing the tool;

- group discussion on the IET regarding its content, functionality, usability, how it can be used in a real situation, the motivations and expectations of the participants, etc. The participants were encouraged to question the CascEff moderator/partners about ideas and suggestions presented during the discussion for clarification and better understanding;
- participants feedback on the tool collected via surveys (at the end of the meetings for the first focus groups, and by January 25 for the second ones). The questionnaires for the two sessions are reported in the appendices.

A total of 29 and 28 persons participated, during May 2016 and January 2017, in the first and second focus groups sessions, respectively. Tables 2.1 and 2.2 summarise the meetings locations, time schedule, and number of participants involved in the different focus groups.

Table 2.1 First round Focus Groups meetings

Date	Place	Number of participants	Country
9 May 2016	Université de Lorraine, Nancy	6	FR
10 May 2016	XVR office, Delft	5	NL
12 May 2016	SP office, Stockholm	5	SE
20 May 2016	Campus Vesta, Ranst	13	BE
Total of participants		**29**	

Table 2.2 Second round Focus Groups meetings

Date	Place	Number of participants	Country
6 January 2017	XVR office, Delft	3	NL
9 January 2017	SP office, Stockholm	4	SE
10 January 2017	Université de Lorraine	6	FR
11 January 2017	Campus Vesta, Ranst	9	BE
12 January 2017	West Midlands Academy and Command Development Centre, Smethwick	6	UK
Total of participants		**28**	

2.3 Compilation of outcomes across the two series of focus groups

This section presents the main findings, comments, questions and recommendations from both sessions. The detailed outcomes from each country were communicated to the CascEff partners in an internal report.

2.3.1 Findings from the first focus groups series

The goal of these meetings was to test cases creation by focus groups participants. Only steps 1 and 2 of the technical development process (Input validation and Output validation) were ready for this first series of focus groups. The User Interface presented during the meetings was a temporary demo interface for entering data in the IET. When using this demo version of the IET, it was difficult for the participants to precisely understand what they were asked to do because the tool didn't work properly, and it was quite impossible for them to interact with it. The participants' interaction with this demo interface was hindered by repetitive bugs. Only the "General" information page of cases, comprising name, location, and some situational factors (such as type of day, weather conditions, etc.), was accessible, and participants could not have an idea on what would be the results of the use of the IET. However, despite this limitation, the focus groups provided useful information for the further steps of the IET development.

2.3.1.1 Main general comments on the tested version of the IET prototype

The participants were interested in the project and its objectives. Several advantages were seen in these, e.g. for risk management within municipalities. Based on the explanation of the philosophy underlying the tool, they thought that, when fully developed, the IET could be useful, especially for preparedness phase. In relation to the response phase, it was suggested to have two different versions: one on site where one could input information on the actual situation, and one in the management staff where managers could use the information to see what would happen in a possible evolution of the incident.

The participants pointed out specific expectations of the tool for decision-making while facing situations with cascading effect. They expected that the IET could provide:

- a sort of checklist for possible cascading effects to think of;
- a visualisation of targets that would likely be affected in combination with the potential consequences for better assessing the priority of responses such as the schematic sketch shown in Figure 3;
- a list of actions to be taken in their order of importance or priority according to the potential consequences.

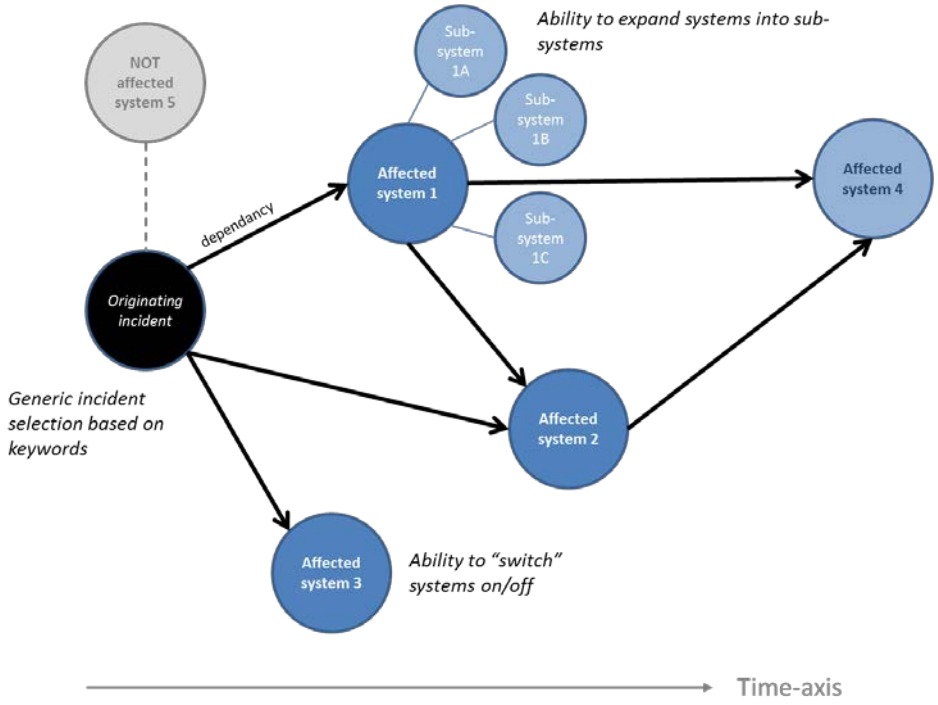


Figure 3: "Button-board" visualisation as suggested by the focus groups participants

At this stage of development, the most important concern expressed by the participants was related to technical problems. Some issues were pointed out as mentioned hereafter:

- some participants were not able to connect to the system, thus raising a question on the limitation of the number of connections;
- the scalability (possibility to adjust to local or site scale conditions) of the tool was arisen considering the aim of using the tool at different scales;
- all the common browsers were used (Internet Explorer, Safari, Google Chrome and Firefox). However, Safari worked well on Mac whilst Google Chrome or Firefox didn't on some Windows personal computers;
- some functionalities were not well understood as they could not yet be (fully or even partially) demonstrated or tried out by the attendees.

Referring to discussions and participants' comments during the meeting, a SWOT analysis of the tool (shown in table 2.3) was performed.

Table 2.3 SWOT analysis of the Incident Evolution Tool

Strengths	Weaknesses
• Innovative tool • Will provide prediction of cascading effects • Will contribute to common and relevant information for decision-making and could help justify management decisions • Usefulness during planning and preparation was especially stressed • High chances of appropriation as focus groups workshops are conducted early in the development process to reduce the risk of not achieving end-users' satisfaction • Interaction with demo versions stimulates awareness of additional needed functionalities • Open source tool	• It can give a false impression of providing the decision to the end-users while it aims just to guide/support decisions • The need to input much information into the IET could decrease its acceptance. A critical challenge to the successful adoption of the IET could be to reduce the time for scenario creating • Dependency on internet connection availability • Dependency on Relevancy of data that will be used to predict cascading effects • A training seems required before the use of the tool • Currently there is no indication on the results that can be generated by the tool
Opportunities	**Threats**
• Reasonably well-defined requirements • Interoperability/interconnectivity with existing databases and Incident Management tools	• When not user friendly, it might not be used • As a software product, it could show security problems • Emergence of tools derived from other projects focusing on cascading effects

2.3.1.2 Comments on specific aspects

In addition to the observations on the IET prototype as a whole, the following issues were pointed out:

- the User Interface consisted of too many tables, with page refreshes needed to retrieve more detailed information;
- some items (typically situational factors) were judged not relevant at the place they were, and it was suggested to move them to the most appropriate place;
- the display/registration of geometrical objects did not work;
- the properties of some effects (for instance: fire) were judged not to be relevant;
- the 22 categories of systems were judged too generic to be used as such and it was suggested to split them into sub-systems;
- some aspects were not well understood by the participants (e.g. the relevancy of limits or intervals of effects when creating cases);
- the participants listed a couple of features that, in their opinion, were missing, such as search capability, a help option for guiding the users when they feel confused or even get lost while using the tool, etc.

2.3.1.3 Questions

In almost all meetings, the participants asked these two main questions:

- "*As a lot of databases with useful information already exist, will the IET be able to connect to these databases thus reusing this data to avoid re-entering data*?".

  The answer to that question was: "*a linking up of the IET with existing databases is expected to be done at a later stage of development as it can contribute to increase the efficiency of information management*".

- "*Will the IET be able to interface with the existing Incident Management Tools such as ICMS (Belgium) and LCMS (The Netherlands)?"*

  It was answered that: "*the IET will integrate with external Incident Management Tools (IMT) using an open standard for data exchange*".

Some additional questions were also raised.

- Who will be able to use the IET?
- What will be the conditions for using the IET?
- Does one need to purchase it?
- Who can access the IET as some information needed to run the tool may be confidential?
- What will the security be?
- Will there be different permission levels?
- What is the required Technical Readiness Level (TRL) for the IET?
- Who owns the Intellectual property rights (IPR) of the IET?
- Who gets the right to load or remove data?
- Who checks the action of loading or removing data? Is such a person trustworthy and, will him/she be logged?
- When the IET is implemented, what are the legal consequences when an incident commander or policy maker does not pay attention for the information given by the IET or the IET provides a wrong guidance. Afterwards may this be brought to court?

2.3.1.4 Results of the survey

Based on the state of the prototype, it was difficult for the participants to answer the questionnaire. It was considered too early to answer such a questionnaire, but some of the questions were studied during discussions. However, 3 questionnaires were (almost partially) completed by participants from France. Given the number of the answers collected, a statistical analysis was considered not to be significant. Thus, the survey did not generate usable data in the form of numbers or percentages. However, they were analysed for pointing out meaningful aspects to be considered. Globally, the analysis revealed that:

- it was not easy to create cases and systems, mainly due to difficulties when displaying geographical objects;
- the field labels were not necessarily clear thus were not easily understood and
- there was a need for adding further information to refine some characteristics of the systems.

2.3.1.5 Recommendations

This first series of focus groups resulted in a tremendous amount of points that were identified as important issues to be addressed in the upcoming development steps. The

recommendations were upon the improvement of the tool features and functionalities for ensuring a better usability. They included, amongst others:

- make the IET an easy-to-use tool. The interface must be adjusted and more focussed on easy-to-understand and easy-to-use visual information overviews;
- include some general cases that could be used into the tool;
- refine the categories of sub-systems, effects, effects units and impacts;
- pre-set categories of systems, sub-systems, effects, effects units and impacts;
- render all the characteristics of systems editable (modifiable and deletable);
- add an option "other" to the pre-set information to allow the user entering its own information, when it is not provided by the tool;
- allow to consider or not the thresholds of the effects;
- for the map functionality, use other geometric shapes (e.g. circle, point) than rectangle;
- add scale to the map view;
- provide map search and new systems creation options using addresses and geographic coordinates;
- add the missing features (search capability, filtering option to improve the readability of the information provided, help option, etc.).

Some other recommendations addressed broader issues of resonance such as:

- keep all background information hidden from the user. Do not present the user with more information than is needed to execute his task;
- the main objective of impact calculation should be to assist the incident commander with an estimate on resources required for incident response;
- an e-learning course should be made for training users on the use of the IET, what it is intended to do and what not;
- refer to lessons learned from implementation of Incident Management Tools (IMTs) in the IET implementation strategy;
- there is more broad design effort needed on the practical implementation of the IET, regarding training, giving out users' accounts and logging of data. It must be noted that by linking up the IET with an IMT, logging probably already is arranged for a large part, since this is already largely implemented in IMTs;
- it could be very useful to include the Netherlands 24 high impact scenarios as reference cases in the IET database after checking whether they define the same and/or more (sub-) systems as the 22 defined in the CascEff project.

2.3.1.6 Conclusion from the first focus groups series

Although the major difficulty faced by the participants was that the prototype did not work properly, the overall conclusion was that there was a feeling that the IET could be a useful tool.

These first series of focus groups generated a wealth of information on the expectations of potential end-users and the needs for the further steps of the IET development process. Even though the participants suggested a disparate range of issues to consider in the upcoming development steps, a broad consensus emerged on the need to:

- make the IET easy to use;
- avoid manual entering existing data by connecting IET with the databases and
- link up the IET with some existing IMTs.

Furthermore, the findings from this first series of focus groups revealed a delay in the development process, and the consortium agreed on the fact that there is a strict need to obtain, before the second series, a tool able to run simulations with which the participants could interact easily for avoiding their frustration.

2.3.2 Findings from the second focus groups series

For this second series, the consortium provided the focus groups with a prototype of the IET able to run simulations based on the entered data; meaning that the development process reached at least the step 6 (Timelines showing), and that efforts were made by the development team to take, as far as possible, into account the findings and lessons learnt from the first series. Before running this second focus groups series, and to ensure that the available version of the prototype had a minimum quality level regarding users' requirements and findings from the first focus groups series, the project partners implemented an internal technical test for tracking bugs and identifying the defects (see §3 for more detail on this verification process). This helped the development team to fix most of the problems that did not allow the tool to work properly. The focus group moderator of each country prepared a case where the characteristics of the systems and the initiating event were defined in order to obtain the same result for the participants' individual tests. The attendees were commissioned to create a case and to simulate the related cascading effects (from data input to results visualisation). They were asked to give feedback on:

- the added value of the available version of IET for their jobs (in the planning, training, response as well as in the recovery phase);
- the difficulties faced when dealing with the different steps of the IET methodology (case creation and management, systems creation and management, effects definition, impacts definition, initiating event characterisation) and
- the most relevant results representations for the identification of key decision points along the chronology of events.

Some findings emerged across all audiences of the second series of the focus groups and the survey. Most important were:

- the IET could have a great potential in emergency/crisis management or policy. It was questionable if the IET could be used during the response phase due to the large amount of data needed for running a simulation. However, in preparedness phase, the tool could be useful. It was also commented that if the data were made available in advance, the IET could be useful also in the response phase;
- the IET appeared useful for seeing the dependencies between the systems and their variability under different conditions. But, the available version of the IET had a limited added value as it seemed to lack intelligence. For example, the IET only identified geographical dependencies based on distance and not logical dependencies;
- the tree views were highly appreciated; the timelines also;
- the IET was not yet user-friendly as the user had to put in a lot of data manually. Importing data from existing databases and tools was needed to reduce the data entering workload and increase the reliability;
- regarding the setup applied during the focus groups meetings, the IET user needed a lot of time (due to manual input) and expertise (due to knowledge on systems and effects) to fill in the tool;
- there was a need for providing the user with a tutorial to give him/her a guidance on what to do at each step of the IET methodology;

- some labels were unclear and need to be clarified, maybe by using a popup to explain the labels in more detail;
- a lot of bugs still remained in the IET to be fixed before delivering the IET to the users;
- the deciding factor in whether the tool would be used in response phase will be how quickly the user can enter data and immediately receive advice;
- there was limited or no feedback on the identification of key decision points and timelines;
- it was commented that in the planning phase, the IET could be used to structure the vulnerability and dependency analysis that in some situation is compulsory to perform;
- during the response phase, especially for long-lasting incident, the IET could be useful to ensure that relevant information on vulnerabilities and dependencies was transferred to the next officer in charge.

2.3.2.1 Main general comments on the tested version of the IET prototype

The general feedback on the IET was that many participants agreed that it could be of a great utility to their jobs. Indeed, they consensually pointed out that the IET could have a great potential for incident management or policy. However, it was considered much more applicable to the planning, training and recovery phases rather than to the response phase; and for strategical rather than operational management. The main reason for this limitation was the heavy workload needed for running a new simulation from start to finish. This could seem poorly compatible with the response phase where, on one hand, information is gradually added or changing over time and, on the other, reducing response time is crucial. Many participants argued that this weakness could be reduced when the tool will allow the user to import data from existing databases and tools. In the end, it must be possible to use the IET both as a strategic and as tactical tool.

The participants suggested that the tool should be integrated into the current tools used by them, or at least to be linked-up with them.

For the participants, the tool seemed to be not yet intuitive to use without guidance through steps. Most of the participants would like to have more guidance on what to do, what to do next, what not to do and what to do when something is wrong.

The layout of the tool appeared fine for some participants, but for others a more graphical structure seemed to be needed, to limit the number of steps.

When discussing with the participants, it was noticed that incident managers used to operate on a different detail level than the tool did. In certain circumstances, managers used to require much more specific detail levels, whereas in others the tool detail level might be too high or abstract for them. The specific cascades that they could see would also be on a different level of abstraction. Whereas the IET considered systems that affect other systems, with each system producing its own impact, some participants reported being more in need of a tool that would remind them of what they should think of or manage. This could be through helping them provide answers to the following questions: Will this event cause casualties? How many? When? Where? How far will this toxic cloud possibly go? How long do they have before this boiler under pressure becomes a danger? These nuances/reminders did not appear to be what the IET was optimised for. Continuing on this point, some of the participants asked for a completely different flow to using the tool, where more information will be gradually made available, leading to updates to the tree view where different branches will be either

eliminated or added. This in contrast to the available flow of going back in to adjust parameters and then recalculating the simulation every time one wants to modify it.

According to the participants, there were many data fields to be filled in. But it was not mandatory to fill in all the data. At this stage, only a specific outgoing effect or an initiating event needed all the fields to be filled in before being saved. When one leaved some data fields open, the IET would only consider the data which is entered. Thus, the results of the simulation depended on the given data. The characterization of a specific system supposed a perfect knowledge of that system. The reliability of the simulation results depended on entered data/information. It was suggested for further development to add a method or system for keeping track of the information, i.e. how to know that the included data are valid: e.g. date of entry, signed/confirmed in some way.

The participants were concerned about what the tool might do if the initial information for an initiating event were to prove unreliable. Would it produce all kinds of cascades that turn out to be irrelevant later, only because a value was estimated a little too high or low? (Perhaps the tool did not do this, but if users experienced that anxiety, that was still something to take into consideration). For the future use of the tool, the margin of error should be minimal here, and users need to be confident that the tool is helping to protect them against small mistakes. Regarding this issue, a proposal was made to use the internet not just to access systems in the tool, but also to automatically acquire data such as weather, time of day, traffic congestions, etc. (if only to double-check the user's input).

The participants consensually agreed that the IET had great potential as a tool might enable them viewing dependencies between systems under different conditions, and predicting potential cascading effects beyond specific geographic boundaries.

2.3.2.2 Comments on specific aspects

The participants expressed also their comments and thoughts on each of the sections of the tool. Hence, some labels were considered unclear and most of the participants requested that every label would display a small button that pops out with an explanation of this label. Some examples regarding these issues are presented below:

- "**transport service degradation**", "**toxic effects**", "**social effects**", "**animals**", etc. were unclear, perhaps too generic;
- "**public health degradation**", which was an *outgoing/incoming effect type*, was confused with what the IET tool considered an *impact*;
- for "**transport service degradation**", the participants wondered whether this effect would hit public transport and road traffic equally;
- for "**propagation time**", the participants suggested that the Graphical User Interface (GUI) helps them to choose these values.

Cases and Systems

For most participants, it was not so difficult to create a case when one knows how and what to include. Drawing a polygon on the map was difficult for most of them. Especially the combination with also being able to pan the map view, and finishing the polygon by double clicking, was not considered very intuitive. The users had to be shown exactly how to do it before they understood. The creation of the boundary was not intuitive, but it became easy when one knew how to do it, especially in relation to handling the map.

Some participants confused system boundaries with case boundaries, and drew a case boundary as only surrounding the immediate incident; thus, preventing most-if-not-all surrounding systems from triggering. This distinction should be made clearer, and the users encouraged to pick a wider area than just the location of the initiating event.

Other comments were:

- every time a new system/case needed to be defined, one needed to manually zoom in to the right location (country/region) first;
- for its final version, upon entering an address in the IET, the IET must be able to display the address automatically on the map. Even so for the boundaries of a case or system: if the user selects the shape of the boundaries, the distances and the center point (address system), the IET must be able to draw this up;
- when a small part of a system exceeded the defined boundaries of the case, this system was ignored in the list of the systems of the case. It would be great either the IET would automatically accept the presence of the system, since a part is located within the case boundaries, or the user would be able to add this system manually to the case;
- the access to predefined cases to be used as a reference was considered an additional potentially valuable asset within the boundaries of the available version of the tool;
- the white colour of borders when creating a new case (or system) was not very clear. In the other views, it was clearer (other colours);
- when creating a case, the "**time of year**", as related to how crowded the roads were, was considered important but missing;
- the wind direction, considered an important factor in an incident evolution, should not be entered as a general case property;
- the lists of systems (effects) categories were too long. It would be great to be able to mark favorite categories in such a way to access quickly to the most used/specific categories of each user;
- the category "**Business and Industry**" appeared too broad of a category;
- "**Services Mobiles d'Urgence et de Réanimation**" (SMUR that could be translated as Mobile Emergency and Resuscitation Services) was mentioned as a specific sub-category that it would be good to add to the "**Emergency**" system sub-categories list.

Effects and impacts

For the participants, the use of the IET in relation to the effects that could be expected seemed to be relatively easy to achieve, while the difficulty was to know what values to use. Also, to find effects that were not obvious was considered a challenge. One possible solution would be to provide estimates or of guidance on what is sensitive to what.

For some participants, defining the outgoing effects of a system felt a bit too abstract, leaving them without a good mental model of how these effects would affect the surrounding area.

For the participants, several of the listed impacts were not fully clear and needed more explanation. Apart from the lack of clarity of some denominations of effects, the following comments were made about effects and impacts.

- The distinction between effects that propagated between systems and the effect caused by a system collapse was not always clear, and bewildered the users.
- There was also a need for clarification between effect and impact within the IET regarding their basic meaning and purpose.

- Usually, there were differences between *toxic effects in air* and *toxic effects in water* and how these arisen. Hence, these might be defined as two separate effects.
- "**Cordoning**", "**handling of a large amount of evacuating people**", "**disturbance of society**", and "**emergency service degradation**" were mentioned as specific effects that it would be good to add to the effects list.
- "**Mortality rate**", "**morbidity-mortality rate**", and "**bed occupancy rate**" were some parameters that were mentioned as specific parameters worthwhile adding to the "**public health degradation**" parameters list besides "**severity**".
- "**Time spent in emergency room before the consultation by a physician**", "**total time spent at the emergency service**" were suggested as some parameters to characterise the "**emergency service degradation**" effect (in the case where this effect would be added to the effects list).
- It would be good if the effect "**Public health degradation**" could directly be expressed in amount of lives lost/wounded/etc.
- "**Cultural values**" was mentioned as a factor producing specific impact useful to add to the impacts list.
- It would be great if the users could add system sub-categories (or sub-sub-categories) different from those already listed in the tool. If it is not possible to allow the user adding new sub-categories, the suggestion was to create a process through which the user could ask an administrator to add a given sub-category (this could be done in a few months following the implementation of the tool).
- One significant hazard in connection with fires was the "**decreased visibility**", therefore it was suggested to add this effect in addition to toxic effects. Furthermore, it was mentioned that concentration could not be always known.
- Toxic clouds usually expand in an elliptic shape, away from the source with the direction of the wind in contrary to the perfectly radial effect zones with the source in the middle, produced in the IET. Those participants working on the operational side (incident repression) took great issue with this lack of realism in the effect zone.
- When using the tool, the users must be able to select units of effects. The predefined units of the effects were not necessarily appropriate or sometimes it was not clear what unit should be used and in some cases, maybe it should be another unit. It was suggested to make this part of the tool more generic by putting other kinds of units including those that UK and US users would be familiar with. For instance, add "**equivalent mass of explosives**" besides "**KJ**" for energy, "**miles**" besides "**meters**" for distance, or other currencies (like "**GBP – £**", "**Swedish crowns – SEK**", "**US dollars – US $**"), besides "**Euros – €**" for costs, etc.
- The need of an optimization of the terms in impact sub-categories also arose. For examples: participants did not perceive the added value of "**dead animals**" and how they could assess this; some of the subsets of the impact category "**Infrastructure**" were difficult to understand (e.g. available make up capacity in percentage).
- What did the sub-category "**Number of users [%]**" under the "**infrastructure**" category (maximum impact page) mean?
- What did the sub-category "**location**" under the "**infrastructure**" category (maximum impact page) mean? Was that an impact and what information should be entered? What would be the unit of the latter? Was this sub-category needed?
- The impact dialog required numbers to be added, but the default zeros were not always given, which means extra work for the user to fill in the zeros.
- When the unit of an item is "units", it would be good to put **[#]** beside (as **[%]** for percentages).

Simulation and results visualisation

Most of the participants expressed a genuine appreciation of the visualisation aspect of results presentation. However, they would have liked to have a kind of colour coding of the systems based on the severity of a specific (selected by the user) impact sub-category (or similar). Maybe also some kind of prioritization could have been done afterwards.

Their comments on initiating events and results visualisation included:

- some of the information the tool required for an initiating event was the kind the users did not or could not (immediately) have reliable access to. Since the reliability of the results depends deeply on the data input, the obtained cascades could turn out to be irrelevant later only because a value was estimated a little too high or low;
- it seemed that the tool required the user to fill in all data fields (specially for outgoing effect and initiating event) in order for it to work. This could hinder the uptake of the tool because, under real conditions, incident commanders often find themselves in situation where they do not yet have access to all information;
- it would be good to use the tree view as an opportunity to reflect the effect of different choices. For instance, if the user does a specific action or makes a decision, certain branches with related cascades could come in and out of focus. This could be helpful to weigh the pros and cons in the heat of the moment;
- when reporting an initiating event severity, the participants expressed clear confusion as to how they should scale this value: “should one pick 30% or 50%?”, “why?”;
- the use of tree views allowed a smart analysis of the results;
- when analysis the tree view, seeing that a system collapsed for xx% did not clarify how much of the total impact came from the collapse of which system. Seeing how much each system contributed to the total impact would help to decide which system is a priority when making decisions.

2.3.2.3 Usability issues and bugs

Various usability issues and bugs were encountered by the participants when testing the tool during this second series of focus groups. Some are listed hereafter.

General aspects

- Internet Explorer could not be used to access the tool. Instead, the participants were referred to a page that told them they needed to update their browser.
- There was a need for a confirmation message (like “done” or the right sign “✓” even for less than 1 second) to inform the user that the task was performed. For instance, when cloning an element from the list of public cases/systems, there was no message given to confirm that the operation succeeded. As such, the users clicked this button multiple times, resulting in multiple copies. To avoid multiple copies, they were obliged to go to the end of the page to check if the cloning operation succeeded or not.
- There was a need for an undo button for cancelling what has been done when the user feels that he makes mistakes or when something is wrong.

Cases and Systems

- The users must be told to click the pencil for editing a case or a system because they did not figure it out themselves.
- Sometimes, when users selected the line or point option for defining a system location, the option functioned like the polygon option.
- Editing a case or a system from the main menu could only be done by clicking on the pencil icon. Conversely, a system could instantly be opened by clicking it while viewing a list of the systems of a case.
- In a case general properties view, the “date” and “weather conditions” labels were not case-sensitive spaced.
- When one modified the name of a case, the previous name was not changed by the new one on the map.
- When defining a system location, having to double click to stop defining was not intuitive to the user.
- Saving a system general properties returned the user to the home screen. This could be annoying if one wants to keep working on the system.
- It was not possible to finalize the creation of a new case without drawing the geographical boundaries but this was possible for a new system. A system without drawn geographical boundaries could be saved, and its localization corresponded to the one of the latest system saved.
- The overview of available public systems was unwieldy rendering difficult to find specific systems. A filtering or an advanced sorting could be helpful.
- When editing a system, it would be nice to have a button that takes you back to the systems overview right away.
- When using the line option to define a system location, a Z-shaped series of lines caused the simulation to trip up, claiming the system was outside of the case domain.
- It would be good to have a circle/ellipsoidal option in addition to the others.
- Some data fields for systems were very obscure or difficult to interpret. A built-in-help tool to explain some of the labels in more detail would be very helpful.
- The scroll bar for the systems/cases overview was to the right side of the window, with the systems to the left, and with a map in between. The left-hand menu should have its own scroll bar.
- When placing three systems (A, B and C) that affected one another in order, the cascade broke based on system positioning. For example, a power station affected by an initiating event, affected a powerline that went far away, that affected another power station. Due to the size of the powerline the cascade broke as it seemed the outgoing effect of the line was based on its top-left-most coordinate. Only changing the location of the systems to be relatively close to one another caused the cascade to run. Using manual dependencies also seemed to fail in this example.
- When one wanted to change the category of an existing system of which he was the owner, the sub-categories of the previous category were kept in the drop-down menu in addition to those of the new chosen category. For instance, this problem was faced when changing “health care” to “education” (see Figure 4).

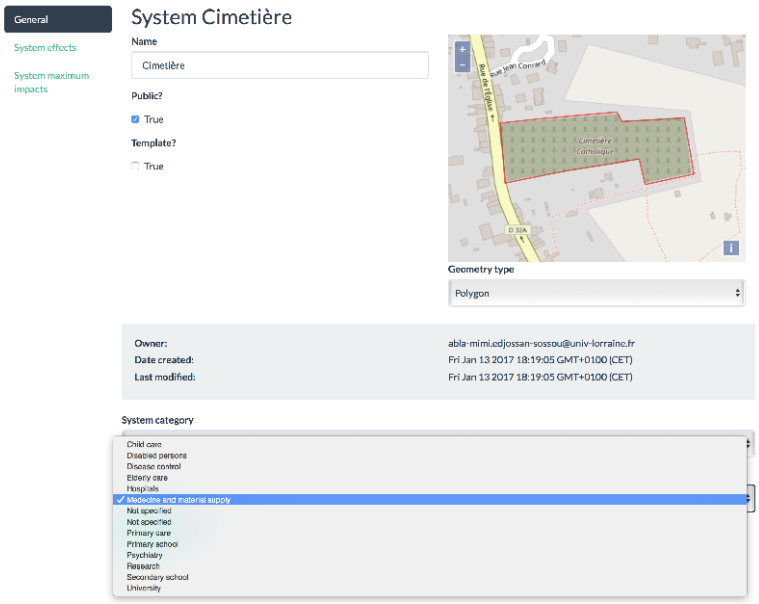


Figure 4: Bug in the pre-setting of the systems sub-categories

Effects and impacts

- When editing a system general properties and clicking on system effects, unsaved changes were lost without a prior warning or prompt.
- Saving a system maximum impact kept the user in the same screen and did not give any confirmation. Hence, the users could not be sure if the maximum impact was saved.
- All the impacts associated with a system got uniformly affected when the system was compromised by an incoming effect, meaning that in reality many systems (such as an airport) were comprised of subsystems, that experience different kinds of impact depending on the incoming effect. Fire, flood, toxic, etc., all have different levels of property damage, repair cost, casualties, etc.
- In the available version of the tool, it was possible to define several outgoing effects for a system, but defining more than one incoming effect to which it could be sensitive to was not possible.
- When changing the location of an initiating event, the effects and impact results were not changed proportionally to the change in distance. The severity of an outgoing effect was not calculated in function of the distance of the source of the event. This led to equal impacts regardless of the proximity to the source of the outgoing effect. Impact degradation by distance would depend on effect type (i.e. for fire: heat, toxic release ppm; for explosion: pressure wave; for power cut: distance seemed irrelevant; for flood/land slide: impact might increase with distance, etc.). This needed to be examined on how the IET could calculate the change in severity based on the information available on effect type, location and environmental circumstances.

Simulation and results visualisation

- Only one initiating event could be defined. For now, multiple effects could be assigned, but not at multiple locations.

2.3.2.4 Questions

These meetings associated with the second series of focus groups also included a question-and-answer section during discussions. The following questions were asked by the participants, and the associated answer by the focus groups organising team follows in each case.

- *"Will the IET be pre-completed with threshold values for typical effects?"*

  Answer: "*in the IET, template (parent) systems will be available where the user can define the typical effects which will then be inherited by all (child) systems. An exact mechanism was under discussion. This will enable the management of global effects through the template and the creation of exceptions (i.e., threshold values or other effects) for an individual system*".

- *"Is it required to fill in all the data? What will happen if you leave some data open?"*

  Answer: "*the IET will only consider data which are entered. A system which has no vulnerability to an incoming effect defined, will be considered by the simulation as not affected. For a specific outgoing effect or an initiating event all values need to be defined to save the effect/initiating event.*"

- *"Can the IET automatically create dependencies? Adding dependencies manually could be difficult in that sense, because the user will only consider the dependent systems within reach of the outgoing effect distance of the initiating event or originating system. The user might not think about dependencies between systems that are located further away (borders case or outside case) and the endurance time (this could be several hours, days, etc.)"*

  Answer: "*the IET only creates automatic dependencies based on geographic reach of effects. The semi-automatic creation of dependencies with non-adjacent systems is something that can be considered as part of the template system functionality. When a user copies a system from a template, its dependencies to other template systems could be used as a basis for prompting the user to fill out the specific dependent systems*."

- *"How can the IET user check if the calculation is done in a correct manner or must the IET user just trust that the calculation model behind the IET is totally correct?"*

  Answer: "*when running a simulation next to a visual output there is a textual output providing step by step results on what system is affected with what impact percentage. There is no further detail available to the user on why or how the IET came to the results. There is a need to discuss about what information would be useful to the IET user to better understand the results.*"

- *"Is the IET only intended for large scale incidents?"*

  Answer: "*no, it could also be used for more day-to-day incidents, provided the systems defined in the database are at a sufficient high level. i.e. not an individual cylinder but a tank or a tank park. The IET is designed to deal with cascading effects at a more macroscopic level*."

- *"Could the output give a better explanation on which system is impacted by which system? The report (output log) contains too raw information. The output log mentions 'no affected systems', what is meant by this?"*

Answer: *"'no affected systems' means that the IET hasn't found any further dependencies between systems, if it would be the case then the IET would have shown an orange line between the originating and dependent systems on the case map, and the affected systems would have been listed in orange colour in the output log."*

- *"Is the IET intended for use for post-incident analysis?"*

  Answer: *"the IET can be used to simulate cascading effects and the effect of mitigation measures through breakpoints after an incident. It can also be used to update the IET database with lessons identified from the incident: i.e. new systems, vulnerabilities, outgoing effects or impacts."*

- *"Can the output of the simulation also be visualised on the map? This is considered as very valuable for the incident commander"*

  Answer: *"this is not possible at this moment. Initially this was envisaged and we will take the suggestion back to see if this can be done within the remaining time."*

- *"What are the limits and requirements for the users to use the IET in the different phases?"*

  Answer: *"the end user will need (access to) knowledge about the systems and the associated risks and dependencies of the systems within the area of a case. Only by maintaining an up-to-date risk inventory in the IET (through proper risk analysis, change management and post-incident learnings) the intelligence of the IET and its value add can be increased. If the IET has little or outdated information on systems, then the value of the output will be questionable."*

- *"Can the IET indicate a probability for the effects and impact?"*

  Answer: *"probabilities have been studied within the project. However, the database of studied events is not enough statistically representative for placing a high confidence level on the obtained results."*

- *"Can users import KML (which stands for Keyhole Markup Language) files for effects so output from e.g. a dispersion modelling tool can be used as an effect area for an initiating event?"*

  Answer: *"this is currently not foreseen. However, as the IET does not replace advanced modelling tools it is a good idea to build an integration path and import an effect area of an initiating event. We will investigate this further."*

Some additional questions were also raised, like:

- Who should be the end-user of the IET?
- Since every incident is different, how will the IET be used during incident response?
- Will the IET flag any system where the threshold of a vulnerability is about to be reached?

2.3.2.5 Learnings from extra-meetings organised besides the second series of focus groups

Separate meetings were conducted in France and Sweden with some people (1 and 2 persons, respectively) which were not members of the focus groups and/or were not able to participate in the focus group meetings, but whose comments on the IET in relation to their experience were of interest. These meetings were structured in a similar way as was the focus groups one. Their comments are summarized as follows.

General comments

- The IET was perceived as a helpful tool for risk and vulnerability analyses. It would need a continuous process with yearly updates. This would of course be a big job for the crisis preparedness (safety) coordinators, but when the systems would be created and included, it would them take less time.
- When trying the tool prototype, it was easy to get lost among the dialogs. Guidance on where you are and where to go would be good.
- There could be operational situations where the tool would be useful, e.g. for recurring events, it would support their analysis by providing answers to questions such as: What happened before? What were the consequences? etc., or for events that are predicted to last several weeks, it would help keeping relevant information available and updating the information according to the evolution of the situation.
- In real time situations, vulnerability analyses are needed and "popular", which means that there is a need for this type of tool.
- During incidents, one sometimes needs to spend much time on finding out relevant vulnerabilities. The IET could be useful both for collecting such vulnerabilities in advance and to make sure that the next person (shift) has the same relevant information (good handover).
- The IET could also be a supportive tool for testing different situations in the perspective of safety by design approach. For instance, if the type of building changes on a territory, the tool could be used to test a planned location of a building in relation to existing risks.
- The included lists of effects and impacts themselves were considered very useful in vulnerability and dependency analyses. The tool could even be marketed towards such application. Once that work is done, one could come far also with the needed information for the cascading effects analyses.

Specific comments

According to the interviewees, it would be good:

- to add "**millibar**" besides the units of the parameter "**energy**" for the effect "**explosion**";
- to be able to see specific areas near the incident (e.g. releases/leakages), to see valuable areas worth protecting;
- to give cadastral information and get the borders of the estate;
- to be able to add new threats to the list of effects;
- to have a search function for the list of cases/systems;
- to have more explanatory text (i.e. help or FAQ option).

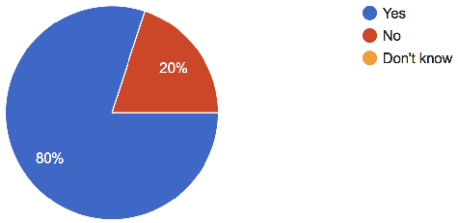
2.3.2.6 Results of the survey done for the second series of the focus groups

The 28 participants of this second series of focus groups were requested to complete an online questionnaire. A total of 15 responses were received and not all were fully completed. The breakdown of the responses by country is presented in the Table 2.4. The most meaningful results are given below.

Table 2.4 Overview of responses per country

Country	Number
Belgium	5 (33 %)
France	4 (27 %)
Sweden	3 (20 %)
The Netherlands	1 (7 %)
The United Kingdom	2 (13 %)

Q1: Is the creation of a case easy?



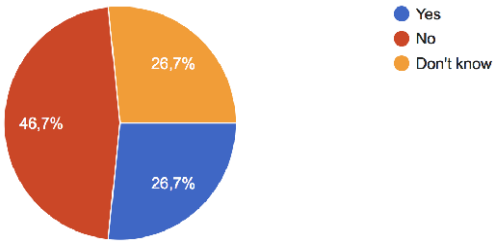
Although 80% of respondents declared that the creation of a case was easy, the following difficulties were mentioned:

- If just a little part of a system was missing when defining the boundaries of a case, the tool did not show the system in the list of the systems belonging to the case.
- It was not possible to create a case based on its X-Y coordinates or address.

Q6: Do you have any other comments on case and case management?

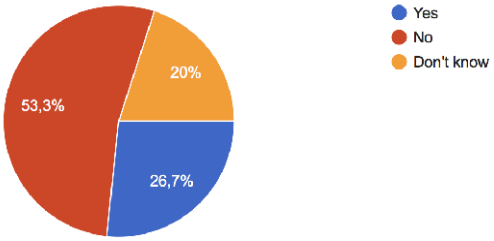
- It should be possible to import systems and data from different sources.
- Units of measurements were not easily understandable.
- The use of the tool could be limited by the fact that some mandatory fields important for calculation of systems relationships may be unknown or not available.
- There was a need to add printing options to all types of results and even plotted maps.
- There was a need to allow automatic geolocation of systems based on their address.
- Categories/sub-categories specific to healthcare were missing.
- Many factors should be considered to get a correct prediction of the cascading effects. Many of them must be filled in by the user. However, one does not always have sufficient expertise to assess these parameters correctly.

Q9: Do systems have the appropriate properties?



Most of the respondents (46,7%) recognised that the systems did not have the appropriate properties because, according to them, the parameters and the thresholds of the effects or impacts might not be relevant.

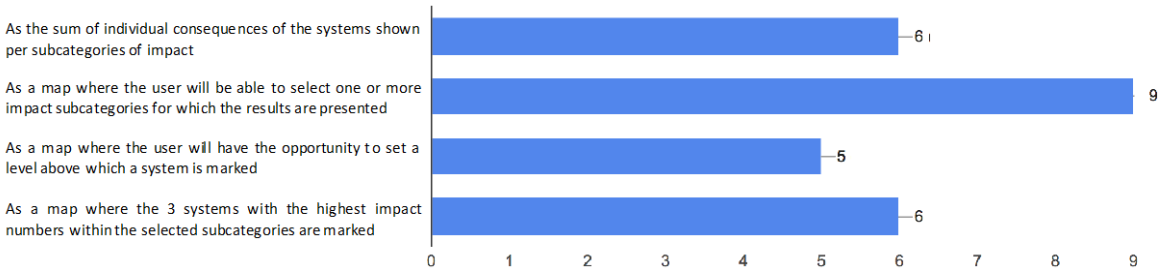
Q11: Do you think the systems as they are now will allow you to model all relevant cascading effects that you will be needing?



More than half of respondents (53,3%) provided negative answer to this question and justified their choice with the following comments.

- It seemed that, the modeled cascading effects were mainly based on distance between systems.
- The time and effort required to model all relevant effects could be a concern, as there would be potentially many different effects for different initiating events. The nature of civil emergencies makes it difficult to prescribe all potential effects (rather than an industrial process which has predictable outcomes and effects).
- There was no information in the IET on interdependencies and breaking points, that was the focus, the goal, the aim from the start, etc.
- All cascading effects could not be quantifiable: media pressure is a highly variable and unpredictable cascade effect.

Q23: How would you like to have the impact results presented?



Besides, respondents provided other wishes on how they would like results to be presented. They suggested also the following recommendations.

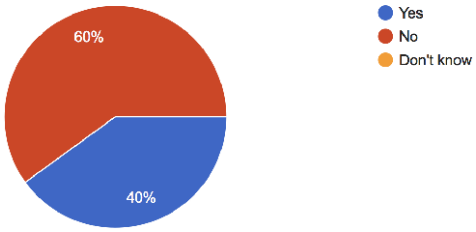
- Make it possible to select or deselect impact categories. Thus, one could be aware of the choices made and only get the categories that are necessary for the incident.
- Provide a cartographic background where each system impacted is clearly highlighted with a color to determine the degree of severity (function of the targets) and the priorities to be considered.
- Explain the process used for calculating impacts (weighting, etc.)

Q25: In what ways is this tool helpful to you?

Respondents mentioned that the tool could be helpful for:

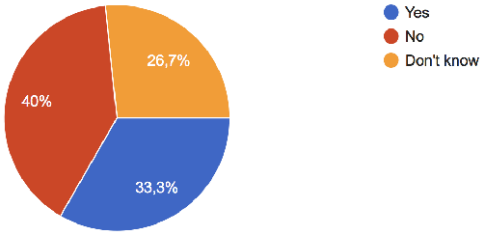
- predicting what effects may appear in time;
- anticipating the consequences of an event and limiting the cascade effects precisely;
- conducting planning/prevention/training exercises (not for an emergency response).

Q26: Is the tool easy (intuitive) to use?



The tool was judged not easy to use by 60% of respondents because of a lack of sufficient explanation on how to proceed with the tool. A such, the tool would require continuous use to maintain knowledge.

Q29: Are there any expectations you have for a cascading effects decision-support tool which are not met by the IET?



Although negative answer was given by most the respondents, an important part of them would also like some features and functionalities of the tool to be improved. This includes:

- a more intuitive tool;
- a less detailed version for the use in the field for incident response;
- an ability to integrate easily data from different databases/IMTs to exploit them for refining the analysis, and
- an explanation on the effects threshold values and on the impacts calculation process.

Q31: Given what you know about this tool, how do you expect to use it in the future?
Almost all the respondents judged that the IET could be a very interesting supportive tool for planning and training purposes because at that moment, the tool seemed too complicated to be used in the field. Regarding response phase, some of them judged that the tool could be useful only for long lasting operations that need anticipation of events.

2.3.2.7 Recommendations

The major suggestions drawn from these focus groups series are summarised hereafter. It would be good to:

- have a popup to briefly explicit the labels;
- start using the tool with planning & preparation phase. As the database of the IET needed to be completed with qualitative data it could be best to first have end-users work with it for a year before considering using it in the response phase;
- link the tool with real-time data. Most of the existing emergency response applications use real-time data. A real-time link would be ideal but could maybe not feasible (authorization, confidentiality, different technical interfaces, etc.). The IET should leverage this at least. The value of the IET would be much higher if it could use real-time data. This could also contribute to ensure the reliability of some of the input data/information;
- link the tool with big data. Big data is becoming main stream. The IET would best use data available in existing databases to gather information on the systems. This could help avoiding manual data input or reducing the time spent for the manual data input. It could also contribute reducing the risk of human error that could have an impact on the reliability of the simulation results;
- provide the users with a kind of “tutorial” or “getting started” for giving him a guidance on what to do at each step of the IET methodology;
- add a method or system for keeping track of the information entered;
- leave a field “other” for everything not captured yet;
- implement a feature for results visualization on the map;
- simplify and reduce the manually input data. The IET must be able to suggest possible produced effects, key properties of systems have to be predefined, IET must be able to get input from other tools automatically (e.g. real-time inventory hazardous materials, real-time occupancy people in systems, real-time weather data, etc.);
- get all bugs fixed;
- validate the method of the identification of key decision points as has been described in D4.2.

2.3.2.8 Conclusion from the second focus groups series

The findings from this focus groups series illustrated that the IET showed great potential to support incident management or policy. Most participants commented on several similar issues referring to the functionalities and the usability of the prototype. One of the tool most prominent strengths is the use of tree views to display results, which was greatly appreciated by the participants. However, the data entering workload, the lack of clarity for some labels, and the lack of intuitiveness of the tool were potential weaknesses. In addition, there were still some bugs that need to be dealt with. Further development should focus on reducing weaknesses and fixing bugs before the IET validation sessions planned to be held in April and May 2017.

3 Internal technical test: IET features verification

Before the second focus group series, an internal technical testing session was conducted (starting from December until the first meeting of the second series of focus group on January 6) to check if all the required functionalities, relying on the conceptual design, users' requirements, and lessons learnt from the first focus groups series, were present and were correctly implemented and if any further features were missing.

This internal technical testing was performed using a pragmatic, yet simple and effective process. Table 3.1 presents the attributes on which IET features and functionalities were assessed. For instance, a required feature that is implemented incorrectly in the tested version is classified as *present*, *incorrect* and *necessary*.

- More concretely, the ability to clone or duplicate cases or systems must be available in the IET because this functionality would help to gain time and avoid errors when one wants to create new cases or systems (with different name or not but with the same characteristics as the previous ones). Thus, this feature is **necessary**.
- During the verification process, several cases or systems were cloned for proving that the cloning functionality was **present** in the tool.
- However, when cloning a case with manually defined dependencies, these dependencies sometimes became corrupted: they appeared correctly in the list of dependencies, but there could be some changes in the systems previously registered when trying to edit these dependencies. It could thus be concluded that this feature was implemented **incorrectly**.

Table 3.1 Attribute for technical test

Attributes	Possible values	Description
Presence	Present or Not present	Does the prototype provide the feature/functionality?
Correctness	Correct or Incorrect	Is the feature/functionality implemented correctly in the prototype?
Relevance / Acceptance	Necessary or Arbitrary or Unwanted	Is the functionality: • necessary (i.e., desired by the users) • arbitrary (i.e., neither desired nor unwanted by them) • unwanted (i.e., it must not be implemented)?

The successful completion of this technical testing was a prerequisite for the second series of focus groups in order to ensure that the prototype will work properly. CascEff partners were asked to as far as possible test all the steps of the tool and to document the identified problems (functionality defects regarding the tool specifications, bugs and other feedbacks regarding the tool features and usability) on a given platform. By doing so, the objective was to allow the development team to solve all the problems that could hinder the effective demonstration and operation of the prototype during the second focus groups meetings.

Unfortunately, not all the problems were solved before the second series of focus groups, and additional problems also appeared during these meetings. Thus, it was decided during the project meeting (held at the late January – early February 2017 in Borås) to classify these problems into three main group according to the priority of solving them:

- high level priority for those of the problems that must be fixed before the IEM validation session in April-May 2017 (during the project meeting in Borås the focus of the validation session was shifted from the IET to the IEM on grounds of the delay in the development of the tool);
- medium level priority (for problems solved before the end of the project) and
- low level priority (for problems solved before the project results exploitation).

After the second series of focus groups, and simultaneously with the internal validation campaign, the IET was again tested to make sure the required improvements were incorporated before using the new IET version in the validation tasks. While the shift in the project from a focus on the IET to the IEM focused made using the IET in these tasks less relevant, these improvements were made and bugs were put to the test. This checking test demonstrated that most of the prioritized bugs from the previous test cycle had been fixed (even if some of them still remained to be solved), some of them remained to be fixed before the end of the project. Furthermore, during this second technical test some new bugs were identified. Even though the most significant of these new bugs were fixed as quickly as possible, a decision had to be made regarding the use of the IET during the validation sessions. This decision would partly rely on the technical impact that the remaining bugs could have while using the IET during the IEM validation session, but also, on the outcomes of the internal validation of the prototype which will aim at controlling whether the outputs of the tool comply with the expected results or not.

If the internal validation test results are approved and all the bugs with high priority are solved, the IET prototype could be made accessible for use by the participants during the validation session. In contrary, if the test is failed and there are still high priority bugs to be fixed, then the IET prototype could be considered as not yet acceptable to be used by the participants. Since the internal validation test was a diagnostic of accuracy of the IET predictions, normally there was no new internal validation test planned by the consortium. However, a new test could be performed if the consortium considers it necessary.

4 Internal validation test

Validation is a crucial aspect of a tool development. Indeed, a tool which does not follow its functional specifications is of limited interest. And in the case of decision-support tools such as the IET, dire consequences may rise rapidly. These tools must provide a high-level of correctness and reliability guarantees with regards to their predictions. Correctness is an essential feature for ensuring a good users' experience, as a tool showing repetitive crashes, lags, or any kind of unexpected behaviour will be criticized by its users and they could stop using it. Validation is the process of delivering documented evidence that a tool performs properly its functions as intended. Hence, the purpose of validating the IET was to verify its correctness and reliability by:

- ensuring that the logic and intent of the tool is correct;
- verifying the accuracy or the validity of the tool outputs with respect to a given real scenario;
- checking that the users' requirements and the design specifications are met and
- detecting and fixing detect bugs, development errors or any other outstanding issues that are needed to be addressed prior to the dissemination of the IET.

However, since the IET was no more the focus of the validation task, it was decided to conduct an internal validation campaign for getting evidence whether the available version of the IET provided the intended results for the users. Prior to make the IET prototype available for the validation session (and following the second focus groups series from which the prototype was under continuous improvement), a historical scenario validation test was conducted between April 5 and 13, 2017. The prototype would succeed the validation test if it could be able to exactly reproduce the historical scenario.

4.1 Internal validation process

The deployment of the internal validation test was performed through the following steps.

4.1.1 Historical scenario selection

To define the validation test predictions, it was decided to use one of the historical scenarios provided in D5.1 "Detailed description of selected scenarios" as a common backbone for a transparent process. Based on information in this deliverable, the Skatås wildfire scenario was proposed as the one to be used for the internal validation test.

4.1.2 Scenario systems characterization

As described in the D5.1, the Skatås wildfire consists of an event that was contained before it caused serious problems, but there were many opportunities for impacting other systems. This scenario was expanded to include new (fictitious) events to create deviations in the real scenario when making management decisions. A storyline presenting the cascading effects (Figure 5) was extracted from the timing of events, and the list of actual consequences as well as possible ones. In this figure, dashed lines represent the potential cascades that could have occurred if the two following decisions were not made when starting to cope with the incident:

- Decision D1: "*Fight the fire later*", a decision that was made by the firemen to avoid the run-off in the Delsjön lakes of used water. This run-off would have contaminated the lakes.

- Decision D2: "*Protect the telecommunication tower that could collapse due the fire*", also made by the firemen.

Table 4.1 describes the dependencies shown in the previous diagram and presents the data provided in the D5.1. *The lines in Italic* (with grey background) represent the potential dependencies that could have occurred if the two decisions were not made.

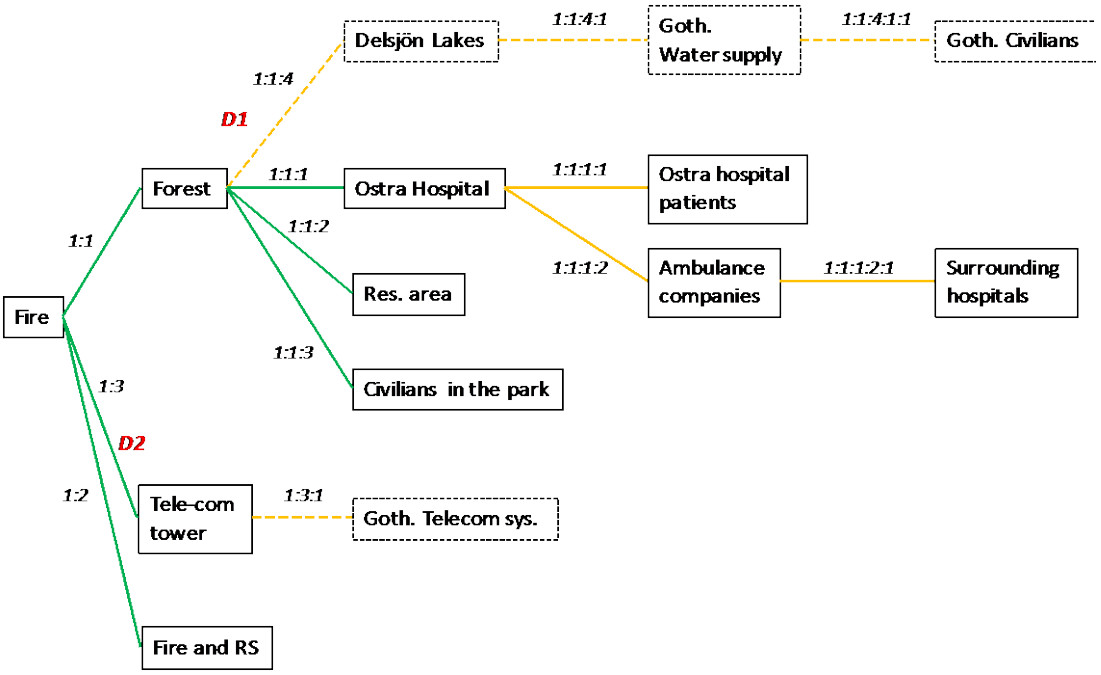


Figure 5: Storyline of the expanded Skatås wildfire scenario

Table 4.1 Dependencies between systems

N° of dependency	Impacted system	Impact time from initiating event (min.)	Originating system	Impacted effect	Generated effect	Consequences
1:1	Forest	0	Initiating event	Fire	Smoke	2,88 km^2
1:2	Fire and Rescue Services	25	Initiating event	Fire	Work force degradation	One fire fighter hurt
1:3	Tele-comm Tower	25	Initiating event	Fire	Service interruption	Turn Off equipment Evacuation
1:1:1	Östra Hospital	120	Forest	Smoke	Service interruption	Ventilation system closed preparation to evacuate patients
1:1:2	Residential area	120	Forest	Smoke		Confinement
1:1:3	Civilians in the park	25	Forest	Smoke		Evacuation
1:1:1:1	Östra Hospital patients	135	Östra Hospital	Service Interruption	Health degradation	Patients about to come to Östra Hospital cannot come
1:1:1:2	Ambulances	135	Östra Hospital	Service Interruption	Work degradation	Ambulances cannot come to Östra Hospital and must carry patients to other hospitals
1:1:1:2:1	Other Hospitals	135	Ambulances	Work degradation	Work degradation	More patients to be accepted
1:3:1	*Gothenburg tele-comm system*	*25*	*Tele-comm Tower*	*Service Interruption*	*Service interruption*	
1:1:4	*Delsjön lakes*	*30*	*Initiating event*	*Contamination*	*Service interruption; Contamination*	*Firefighting run-off water contaminates the lakes*
1:1:4:1	*Gothenburg water supply*	*60*	*Delsjön lakes*	*Service interruption; Contamination*	*Service interruption; Contamination*	
1:1:4:1:1	*Gothenburg civilians*	*1 day*	*Gothenburg water supply*			*Civilians cannot use tap water*

4.1.3 Validation test simulation running

Due to time limitation issues (the other validation participating partners do not have enough time to fully contribute to the test), the validation team from UL decided to execute the most significant part of the test and then to ask the other partners to contribute by checking its case.

The validation team from UL performed the following tasks.

- Create a case using the information on the systems characteristics. The underlying idea was to act as real users and to carry out the steps that a typical user might perform during a given simulation.
- Make initial simulation runs.
- Verify the matching of the obtained results with the storyline of the scenario.
- Verify the matching of the obtained results with the timeline of the scenario.
- Provide developers with comments on bugs and usability issues faced during the test.
- Share the case with the other partners so that they could check the accuracy of the results and identify other potential bugs and usability issues.

4.1.4 Validation results

In the case of the IET prototype, the accuracy of three main elements (attributes) could be tested during this validation task:

- the storyline (or tree view of the propagation of the cascading effects amongst the systems);
- the timeline and
- the value of the impacts calculation results.

However, unfortunately, the validation test did not focus on all the three elements due to unavailability or inaccessibility of accurate data on the scenario used for the validation test. Economic, environmental, infrastructural, human and social consequences of the chosen scenario were not precisely provided in the D5.1, and it was quite difficult to find those information in the literature or online. Thus, fictitious but realistic values were attributed to some consequences types.

Table 4.2 presents the concluding results for the validation test. These results indicate that the test, on the two elements for which accuracy was checked, was conducted twice because of flaws on the prototype functionalities. Finally, the latter worked as expected. It was shown that the IET could correctly produce the expected storyline and timeline (as shown in Figure 6).

Besides, some new bugs and usability issues were encountered. These issues raised some desired features listed hereafter.

- The need to reduce the number of digits after the comma as output data.
- The need to have the option to define a functional dependency between the initiating event and the affected system; the available version of the tool allowing only geographical dependency.

Table 4.2 Pre-validation results

Attributes	Test status	Test result	Remark
Storyline (tree view)	Tested	Pass	The element has been tested twice. The first time the expected results have not been obtained due to flaws in the tool. A second test has been made after the flaws have been fixed and the expected results were obtained.
Timeline	Tested	Pass	The element has been tested twice. The first time the expected results have not been obtained due to flaws in the tool. A second test has been made after the flaws have been fixed and the expected results were obtained.
Results of the impact calculation	Not tested	----	This element could not be tested due to unavailability of accurate data

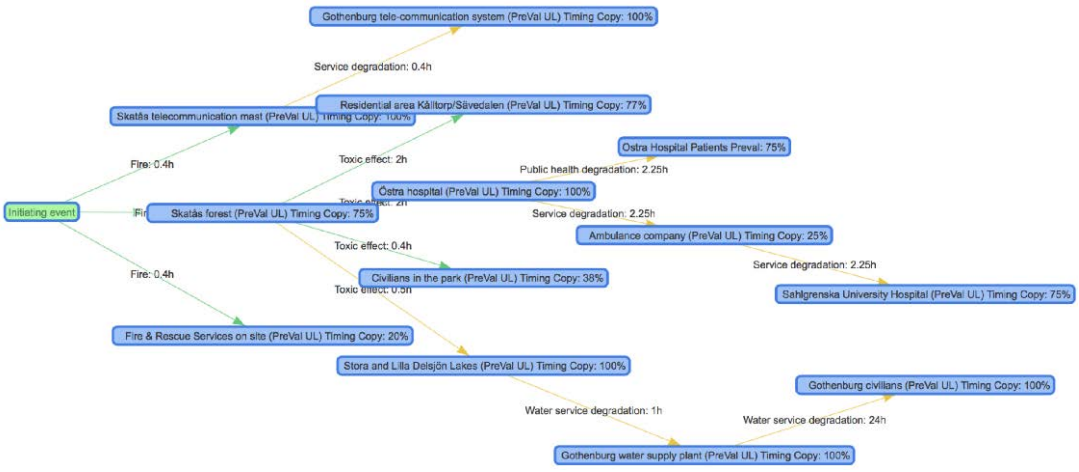


Figure 6: Tree view (storyline) of the expanded Skatås wildfire scenario generated by the IET

4.1.5 Conclusion of internal validation test

The internal validation demonstrated a compliance of obtained results with the expectations given by the historical scenario. However, to avoid the risk of negative influence on the entire validation session resulting from a potential technical failure of the tool as there were still some high priority bugs to be fixed, it was decided to not use the IET as an integrated part of the validation sessions as such, but only show the IET for the participants as an illustration, and how it can be used in relation to the IEM. The impact of this change on the validation sessions was deemed to be very limited as not much effort was spent in preparing for an integrated IET as that was awaiting the bugs checking outcomes and most partners had already accepted the shift in focus at this time, as decided on during the Borås meeting, making the exclusion only more logical.

5 Conclusion

To date, the objectives of the initial testing simulations (focus groups, internal technical verification and validation tests) were successfully achieved: assessing the functionality and the usability of the IET prototype under development. The scope of focus groups was good, as almost all core target audiences (from different countries) were involved. The testing of the IET prototype during focus groups meetings benefited thus from the feedback of the attendees belonging to various disciplines and decision-making levels in the incident management field. This allowed their feedback to span all the main aspects of the tested prototype.

Findings from the progressive focus groups sessions were used to support the development of a functional IET prototype that may help incident management practitioners/stakeholders in their decision-making process (as a supportive tool for the IEM). Iterative changes were made to the conceptual design of the tool in order to align with the focus groups findings. The majority of participants recognised the potential of the tool to improve incident management or policy-making. Particularly, the tool could be useful for planning, preparation, and training purposes. It was also argued that if the data were made available in advance, the IET could be useful also in the response phase. However, it remained questionable for participants if the tested version of the IET was suitable for use during the response phase due to the large amount of data and the associated workload needed. This revealed the need for tailoring the tool to the incident management response phase specific needs, environments and contexts.

Both focus groups, internal technical verification and validation tests revealed that there remained a series of technical flaws and bugs when dealing with the different steps of the IET, leading to the identification of some features and functionalities that required improvement in the short-, mid-, or long-term. Most of the features and functionalities presenting bugs and problems with a high solving priority, were reworked to obtain a better final prototype. The development changes were well appreciated by the users who participated in both focus groups sessions: they saw the differences and progress between the first and second versions. After having tested the new prototype from the data entering to the simulation running, participants stated that one of the interesting features of the tool was the presentation of the results in a visual form (timelines and tree views) allowing the users to quickly have an overview of what is going on. However, the User Interface was judged to be less intuitive. This meant the need for further improvement of the intuitive use of the tool.

As to date, there are some remaining bugs and flaws in the tool, the development team is still working on the prototype to release an optimal final tool, and reflecting on how to increase the eagerness of potential users to try and adopt the IET in their daily operations.

References

Wallach, D., Scholz, S.C., 2012. User-centered design: Why and how to put users first in software development. In: Maedche, A., Botzenhardt, A. Neer, L., (eds) Software for People. Fundamentals, Trends, and Best Practices. Springer, Berlin, pp. 11–38

Appendices

A - Questionnaire for the first focus group (paper-based)

Country:
Company name:
Academic responsibilities:

1 - DATA

1.1 - Cases management

1/ Are there any important information to add?

……
……

2/ Are there any field labels not clear?

……
……

3/ Multiple choice, for certain field, is appropriate?

☐ Yes ☐ No

If no, thank you to specify the changes needed

……
……

1.2 - Systems

<u>when systems already exist</u>

4/ Window with all system already created is adapted?

☐ Yes ☐ No

If no, thank you to specify the changes needed

……
……

5/ System description is sufficient?

☐ Yes ☐ No

If no, thank you to specify the changes needed

……
……

<u>When you have to create a system</u>

6/ Is it easy to create a system?

☐ Yes ☐ No

If no, thank you to specify the changes needed

……
……

7/ Are the categories adapted?
☐ Yes ☐ No
If no, thank you to specify the changes needed
……
……

8/ Does it misses some types of categories?
☐ Yes ☐ No
If yes, thank you to specify categories to add
……
……

9/ System properties are they sufficient?
☐ Yes ☐ No
If no, thank you to specify the changes needed
……
……

10/ System positioning on map is easy?
☐ Yes ☐ No
If no, thank you to specify the changes needed
……
……

11/ Are there some precision to add in system properties?
☐ Yes ☐ No
If yes, thank you to specify field to add and in what system
……
……

1.3 - Incoming / produced effects

12/ Are they adapted and sufficient?
☐ Yes ☐ No
If no, thank you to specify the changes needed
……
……

13/ Are they enough explicit?
☐ Yes ☐ No
If no, thank you to specify the changes needed
……
……

14/ Does it misses some effects?
☐ Yes ☐ No
If yes, thank you to specify incoming effect to add
……
……

15/ The sensitivity thresholds are they adapted?
☐ Yes ☐ No
If no, thank you to specify the changes needed
……
……

16/ Difference between “AND” / “OR” is explicit?
☐ Yes ☐ No

17/ Displaying effects already selected is clear?
☐ Yes ☐ No
If no, thank you to specify the changes needed
……
……

1.4 - Impacts
18/ Categories are clear?
☐ Yes ☐ No
If no, thank you to specify the changes needed
……
……

19/ Impact can be filled up easily?
☐ Yes ☐ No
If no, thank you to specify the changes needed
……
……

20/ Does it misses some information you need?
☐ Yes ☐ No
If yes, thank you to specify impact categories to add
……
……

2 - Ergonomy / Interface

21/ Is the tool easy to use?
☐ Yes ☐ No
If no, thank you to specify the changes needed
……
……

22/ Creation of a case is easy?
☐ Yes ☐ No
If no, thank you to specify the changes needed
……
……

23/ the different map views are adapted?

☐ Yes ☐ No

If no, thank you to specify the changes needed

……

……

24/ name of the tabs is clear?

☐ Yes ☐ No

If no, thank you to specify the changes needed

……

……

B - Questionnaire for the second focus group (online)

Dear participant,
Thank you for agreeing to participate in this focus group which is part of the CascEff project. A key component of this process is obtaining important input from diverse audience, and tapping into your experiences. Following your participation in the focus group on the Incident Evolution Tool (IET) currently being developed there are some questions that we would like to ask you.
Thank you for your valuable input to improve this tool.

General information

Country:
Institution:
Current position:
Total experience at this position:

A - Case management

Q1: Is the creation of a case easy?

☐ Yes ☐ No ☐ Don't know

If not, where did you encounter difficulties?

Q2: Is it easy to position the boundaries of a case on the map?

☐ Yes ☐ No ☐ Don't know

If not, what makes it difficult?

Q3: Are there any field labels or other text elements that are not clear?

☐ Yes ☐ No ☐ Don't know

If yes, please specify

Q4: Is there any important information missing, that needs to be added?

☐ Yes ☐ No ☐ Don't know

If yes, please specify

Q5: Is it easy to add/remove systems to/from a case?

☐ Yes ☐ No ☐ Don't know

If not, how can we improve?

Q6: Do you have any other comments on case and case management?

B - Systems

Q7: Is it easy to create/edit a system?

☐ Yes ☐ No ☐ Don't know

If not, why?

Q8: Are there categories or subcategories of systems missing?

☐ Yes ☐ No ☐ Don't know

If yes, which categories/subcategories do you think need to be added?

Q9: Do systems have the appropriate properties?

☐ Yes ☐ No ☐ Don't know

If not, what do you miss?

Q10: Is it easy to position a system on the map?

☐ Yes ☐ No ☐ Don't know

If not, please specify the difficulties.

Q11: Do you think the systems as they are now will allow you to model all relevant cascading effects that you will be needing?

☐ Yes ☐ No ☐ Don't know

Do you have any comments about this?

Q12: Do you feel that systems can be tweaked to the right level of precision?

☐ Yes ☐ No ☐ Don't know

Do you have any comments about this?

Q13: Do you have any other comments on systems and systems management?

C - Incoming/Produced effects

Q14: Is it difficult to understand how to add effects?

☐ Yes ☐ No ☐ Don't know

If yes, what should we improve?

Q15: Are all types of incoming/produced effects easy to understand?

☐ Yes ☐ No ☐ Don't know

If not, please indicate which effects are unclear to you.

Q16: Are the effects explicit enough?

☐ Yes ☐ No ☐ Don't know

What would you like to see improved?

Q17: Do you miss any specific effects?

☐ Yes ☐ No ☐ Don't know

If yes, which effects would you want to add, and which parameters should control them?

Q18: Is it clear to see which effects have been selected/enabled?

☐ Yes ☐ No ☐ Don't know

Is there anything you would like to see improved here?

Q19: Do you have any other comments on effects and effects management?

D - Impacts

Q20: Are the categories and subcategories of impacts clear?

☐ Yes ☐ No ☐ Don't know

If not, what is unclear to you?

Q21: Is any important information missing from impacts?

☐ Yes ☐ No ☐ Don't know

If yes, why is this information important?

Q22: Can the impacts be filled in easily?

☐ Yes ☐ No ☐ Don't know

If not, please specify where you experienced difficulties.

Q23: How would you like to have the impact results presented?

☐ As the sum of individual consequences of the systems shown per subcategories of impact

Total impact

Economical

Direct economic cost [€]: 212071

Social

People affected by social unrest: 60

People mistrusting authority: 0

Infrastructure

Number of users [%]: 152

Available make up capacity [%]: 0

Expected repair time [months]: 20

Expected repair cost [€]: 726414

Life/property losses: 0

Location: 0

Environmetal

Polluted land [km²]: 0

Polluted forest [km²]: 0

Polluted sea [km²]: 0

Dead animals: 0

Human

Fatalities: 0

Injuries: 0

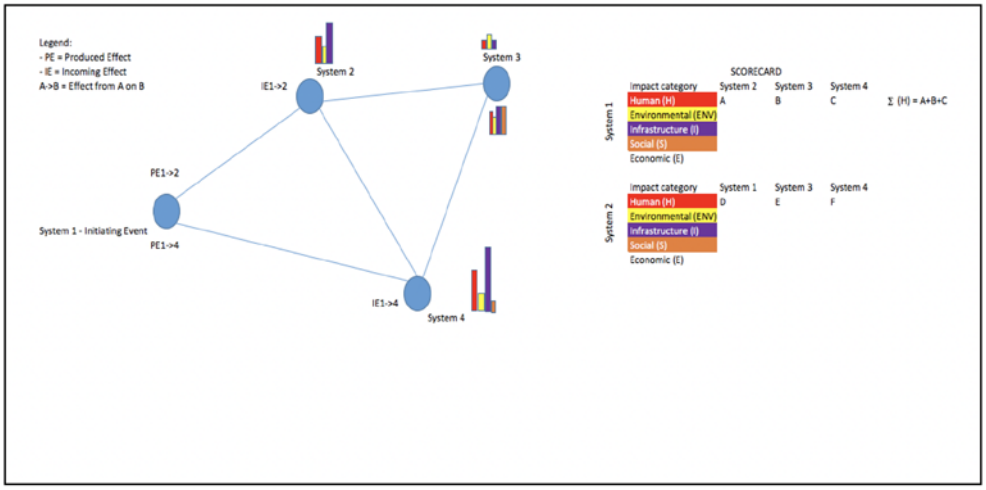
People that has lost critical services: 0

Mental health injuries: 0

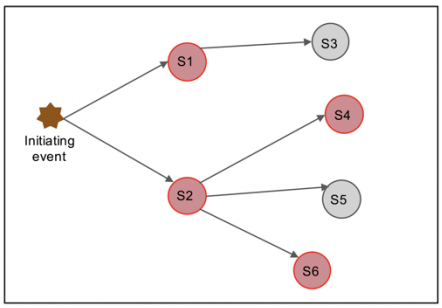
Evacuated: 0

Homeless: 0

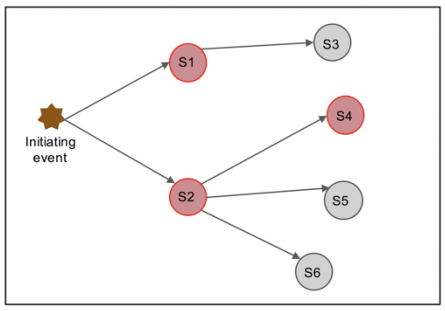
☐ As a map where the user will be able to select one or more impact subcategories for which the results are presented (in the form of histograms) on the screen for each system



☐ As a map where the user will have the opportunity to set a level above which a system is marked



☐ As a map where the 3 systems with the highest impact numbers within the selected subcategories are marked?



Do you have any other suggestions on how the results should be presented?

☐ Yes ☐ No ☐ Don't know

If yes, please specify

Q24: Do you have any other comments on impacts and impacts management?

General

Q25: In what ways is this tool helpful to you?

Q26: Is the tool easy (intuitive) to use?

☐ Yes ☐ No ☐ Don't know

What areas should be improved?

Q27: Is the map tool easy to understand and use?

☐ Yes ☐ No ☐ Don't know

If not, what did you find difficult?

Q28: Are names of the titles and tabs clear?

☐ Yes ☐ No ☐ Don't know

If not, how would you make them more clear?

Q29: Are there any expectations you have for a cascading effects decision-support tool which are not met by the IET?

☐ Yes ☐ No ☐ Don't know

If yes, please specify

Q30: What would you most like to see improved in the tool?

Q31: Given what you know about this tool, how do you expect to use it in the future?

Why?