THE DESTRIERO PLATFORM FOR MULTI-HAZARD DISASTERS AND COMPLEX CRISES RECONSTRUCTION AND RECOVERY

Sandra Frings[1], Christian Knecht[2] and Michele Fiorini[3]

[1] *sandra.frings@iao.fraunhofer.de*
Fraunhofer Institute for Industrial Engineering (IAO), Information Management,
Nobelstrasse 12, 70569 Stuttgart (Germany)

[2] *christian.knecht@iao.fraunhofer.de*
Institute for Human Factors and Technology Management IAT of the University of Stuttgart, Human-Computer Interaction,
Nobelstrasse 12, 70569 Stuttgart (Germany)

[3] *michele.fiorini@leonardocompany.com*
Leonardo - Finmeccanica S.p.A., Engineering Dept., Security & Information Systems Division, Via Tiburtina km12.4,
00131 Roma (Italy)

Abstract

The EU funded project DESTRIERO[1] (a DEcision Support Tool for Reconstruction and recovery and for the IntEroperability of international Relief units in case Of complex crises situations, including CBRN contamination risks) covers the reconstruction and recovery phase after a disaster. It is delivering a platform prototype to collect information through the integration of information sources and third party systems as cooperation tool for reconstruction organizations. The project hypotheses are to improve planning for reconstruction projects through more accurate information from sensors as well as to improve decision making through aggregating information. The framework and its functionality are described herein and a live demo will be shown in the presentation at the conference.

Keywords: information/communication/cooperation platform, reconstruction and recovery phase, decision support for reconstruction projects, CBRN

1 INTRODUCTION AND STATE OF THE ART

In today's world, large natural disasters which have multi-hazard impacts including CBRN (Chemical, Biological, Radiological, and Nuclear) risks are unfortunately not uncommon due to either the increase density of humans activities that require more and more space and power (energy) or the lack of investment on maintenance and upgrade of old systems dated back to last century either civil (power stations) or military (nuclear defenses). It is on recent news that nuclear defenses are exposed to antiquated systems: "America's nuclear defenses rely on floppy discs and 1970s computers, according to audit" [2]. And the disaster at Fukushima (Japan, 2011) [3] or the Chernobyl catastrophe (Ukrainian, 1986) [4] are still in everybody's minds.

Such events impact different organizations from different countries who need to work together to create area and expertise related task plans which often need to be created ad hoc and as soon as possible after the damage event. In this phase it is important to find out what the situation in the affected area is. There is a need for different information types directed towards different first responder organizations deployed

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within the area of interest [5]. Due to the inability to recover a situation effectively by a single (local or even on national level) first response organization, the scale and the severity of the disaster might call for a wider crisis management. This would involve different organizations to act together in a synchronized scenario that should be coordinated by a CCM (collaborative crisis management) at international level often in accordance with over-national organization such as OCHA (Office for the Coordination of Humanitarian Affairs). The impact is huge on economic and social scale. It is estimated that the Sept. 11th terrorist attack in New York resulted in a cumulative loss (in terms of rebuilding) estimated at 105 billion US dollars [6].

The organizations deployed within the damaged area need to cooperate effectively in short time to avoid tasks overlapping on the same area. As a result it is of paramount importance to overcome the intrinsic heterogeneity (either technological or syntactic and semantical) of information and procedures belonging to the multiple crisis management organizations. The making use of DESTRIERO overcomes this obstacle by providing an information, communication and cooperation platform to be initiated at the start of the reconstruction and recovery phase.

The following chapters give an overview of the DESTRIERO project and platform (its scenario, use cases and functions) as well as of the usability tests and their evaluation.

2 THE PROJECT DESTRIERO

DESTRIERO aims to facilitate the knowledge of real time on-field situations offering a systematic, holistic, inter-governmental and multi-disciplinary approach to the collaboration of heterogeneous first responders when managing large-scale disasters [7]. The middleware platform prototype for crisis information systems was designed and developed to fit crisis management recovery and reconstruction needs to facilitate cross-border information exchange and to support decision makers in the selection and prioritization of the activities to be conducted on the field where the disaster has occurred. A schematic architecture is presented in Fig. 1.

One of the key priorities in case of a disaster is the possibility for heterogeneous and distributed legacy systems to share their information in a coordinate way interacting and cooperating with each other without interfering one another. This is possible by the means of the proper legacy interfaces (Adapter) and services available on the platform.

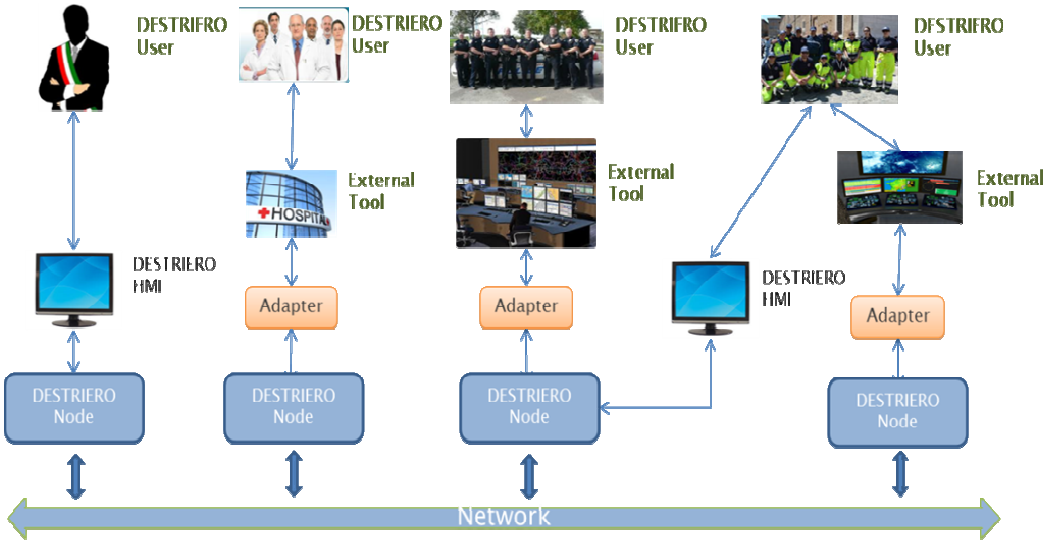

Fig. 1: Schematic representation of DESTRIERO deployment

The DESTRIERO platform is derived from the Leonardo - Finmeccanica experience on Mission Critical Systems such as Air Traffic Management [8] and Border Control and

Surveillance Systems [10]. It adopts a super-peer architecture so as to limit changes to legacy solutions, where a special node acts as gateway for the communications towards other systems.

Fig. 2: The DESTRIERO network architecture proof of concept

3 DESTRIERO PLATFORM

The functionality of the platform – interface to the end user – was derived from end user needs which were collected in a requirements analysis; they were evaluated and prioritized. This process was necessary to differentiate between nice-to-have functions and really needed functions to reach the objectives of the projects.

From these requirements a scenario and specific use cases where defined. Research on and the selection of relevant information sources were performed as well as on relevant third party systems. In the next steps, the DESTRIERO platform architecture and its adapters and the HMI components were designed and implemented. The core components were integrated and tested, the HMI (human machine interface) components which make up the platform were usability tested, and during the final DESTRIERO project event (in June 2016) the functions of the prototype were demonstrated to end users. During the conference in September 2016, we can report on this demonstration and the estimated added value the platform gives to end users.

The following sections summarize the scenario and its use cases. Then selected HMI components are covered in more detail using screenshots of the software.

3.1 Scenario and use case overview

The simulated DESTRIERO scenario [9] can be summarized as follows: In Spain, the Buendía dam broke due to an earthquake and that caused a flood which broke the nearby Bolarque dam. This broken dam caused another flood through the Tajo River which reached the José Cabrera nuclear plant. The water entered the power plant due to ruptures caused by the earthquake and led to a black out in the power plant affecting the cooling system and also affecting the structure of one of the reactors. A radioactive leakage was produced.

The DESTRIERO use cases concentrate on collecting and discussing the relevant information on the crisis situation as well as on planning and prioritizing the reconstruction projects. All use cases start three days after the disaster according to DESTRIERO scope. This makes it clear that DESTIERO is focusing on the reconstruction and recovery phase and not on the response phase.

3.2 Description of selected platform functions

In Fig. 3 the top navigation bar of the platform can be seen. To the right of the main menu (tabs) there are four symbols that represent the system menu. It allows the user

to display and filter notifications (e.g. due to the creating or modification of objects, log in or out of users), define own settings, modify the user profile or log out.

Fig. 3: Top navigation bar and function overview

The first menu item is the dashboard which displays general information on the scenario.

Reports (see Fig. 4) allow the user to view, modify, upload, and retrieve relevant information and reports on the crisis. External information services like ReliefWeb [11] and WHO [12] are directly connected to the system.

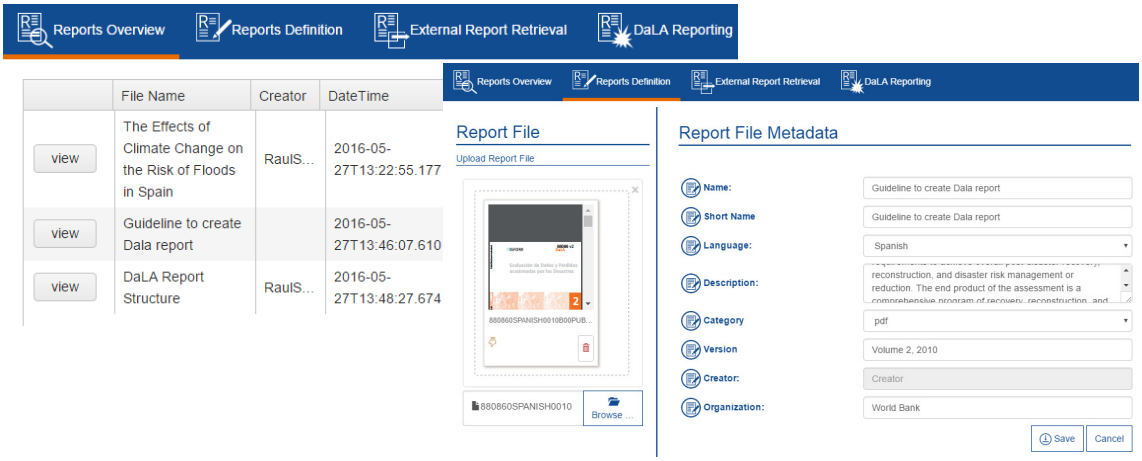

Fig. 4: Screenshots of the HMI Reports Component

In the communication function (see Fig. 5) the user can create, modify and delete user contacts as well as user groups. These can then be used in case the user wants to initiate a conference call using the stored telephone numbers. Furthermore, the user can send a message to selected users or groups. These messages are sent via the standard SMS (Short Message Service) text messaging functionality (through an integrated third party system) and are listed in the platform for later reference.

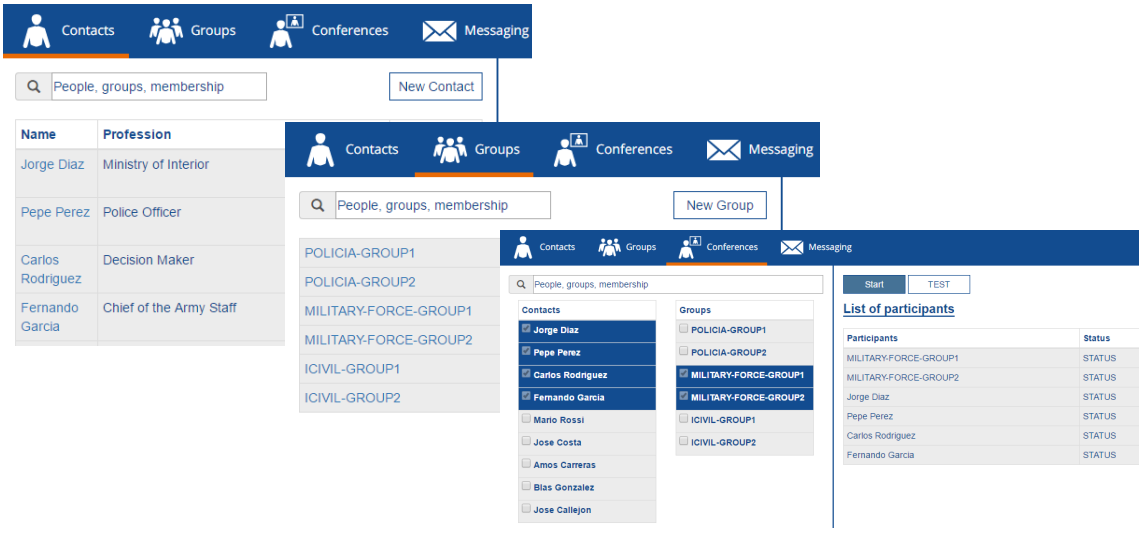

Fig. 5: Screenshots of the HMI Communication Component

The user can manage tasks within the platform which are defined in so-called plans (see Fig. 6), e.g. for performing assessments or placing sensors assigned to teams and defined for specific locations previously defined.

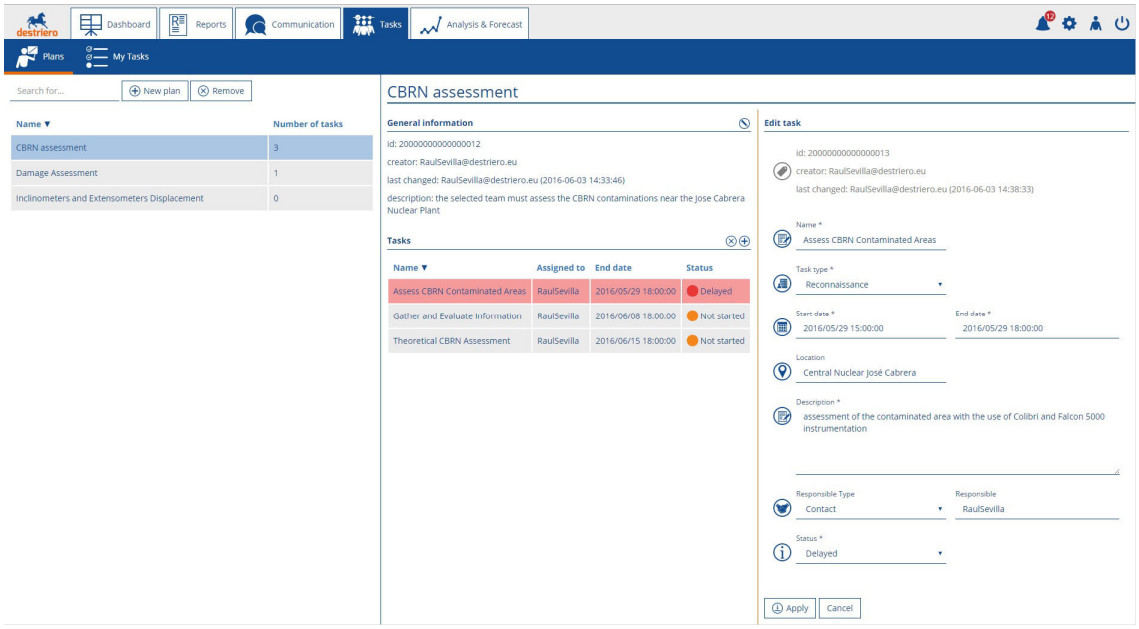

Fig. 6: Screenshot of the HMI Plans and Tasks Component

Through the Analysis&Forecast functions the user can specifically use map functionality (see Fig. 7) to place and display different objects on a map (e.g. area of interest, reference data, previously defined plans and radiological events, weather information), get detailed weather information for a selected city (through an integrated external information source) as well as crisis relevant twitter messages through the Geo-CrowdSourcing function.

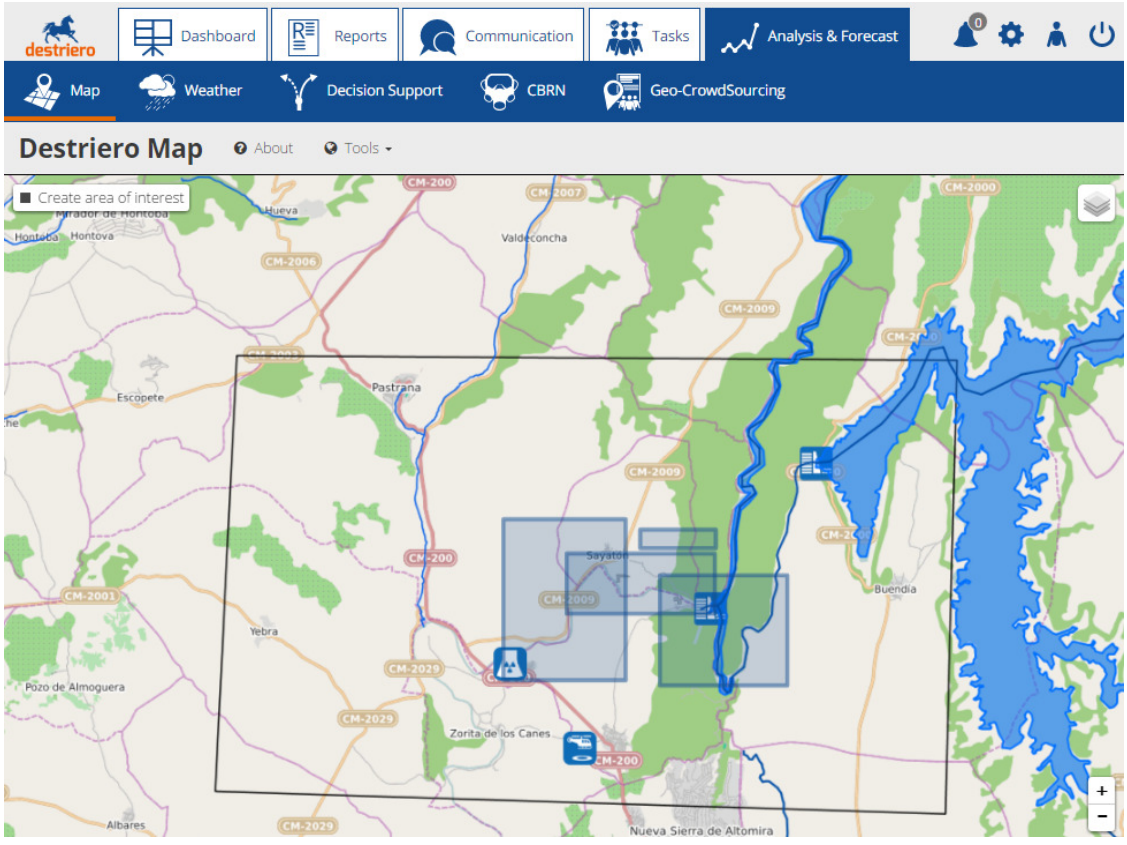

Fig. 7: Screenshot of the HMI Map Component

With the CBRN functionality (see Fig. 8), the user can define and analyze CBRN activities through inputting data for prediction or using real-time data (through sensors)

and then analyzing this data using the third party Command and Control system ne.on advance [13].

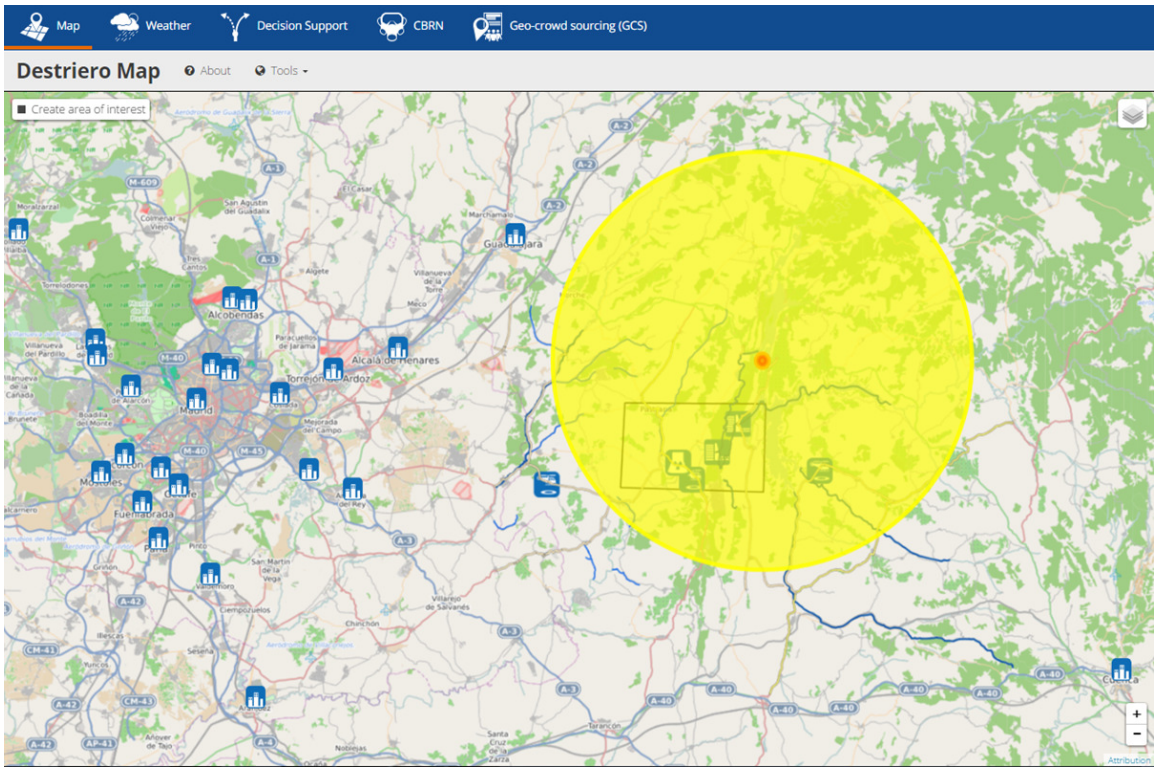

Fig. 8: Screenshot of the CBRN analysis

With the decision support function the user can define and prioritize reconstruction projects using the integrated third party system MYRIAD [14], which is a multi-criteria decision support tool to handle complex decision situations by supporting risk-based assessment of scenarios (situations) and possible courses of action.

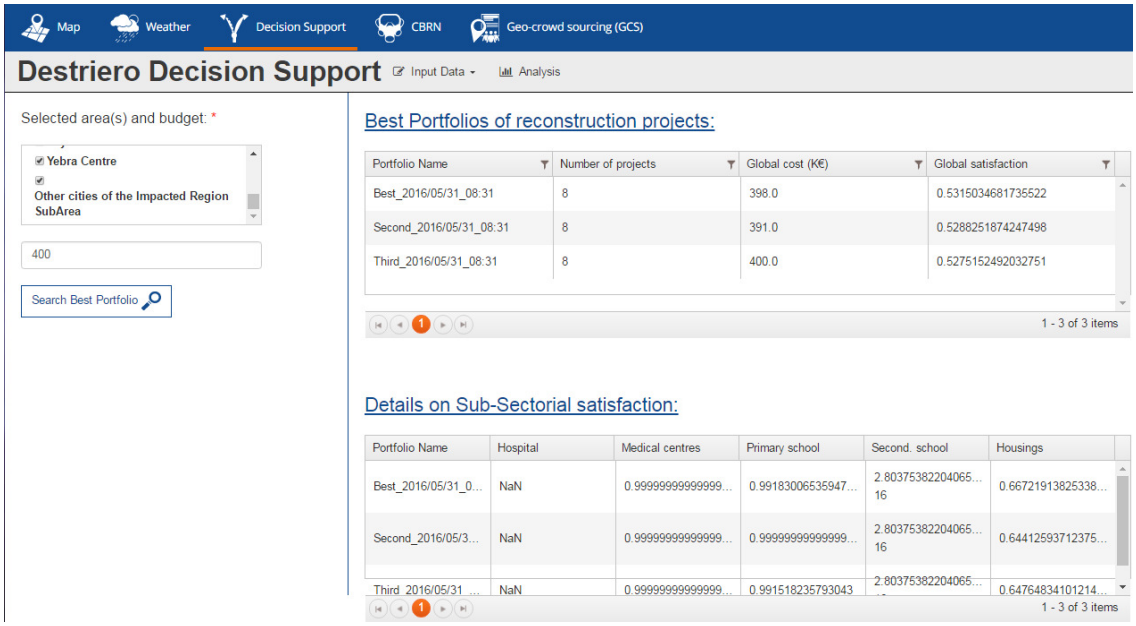

Fig. 9: Screenshot of the decision support for reconstruction projects

3.3 Usability testing and evaluation

The setting in which the DESTRIERO system is intended to be used can be described as follow: in the reconstruction phase different organizations work together and want to use a common information platform. One organization starts with an empty platform since all its information will be added to by the users who may be no experts in using the platform. Therefore, the project goal was to provide a tool that is simple to be used by persons with all kinds of background. This quality criterion was tested in April 2016 during usability tests with ten end users led by the Fraunhofer usability experts. The aim of the test was to find out if the visualization interface is intuitive and clear even if the user has had no training at all.

The usability tests were performed online (telephone and screen sharing) by a moderator who gave tasks to the test person according to the DESTRIERO scenario, as well as an observer, who documented answers using a specific recording tool [15]. Furthermore, the test person filled out different questionnaires (before and after the test [16] and [17]) which gave detailed information on the test persons' opinion regarding the usability of the platform. The presentation at the Future Security 2016 will go into detail regarding the evaluation. Some final statements by the test persons are as follows: "the prototype platform is easy to use; intuitive; friendlier than expected; nice and clean; and some improvements are left".

4 CONCLUSIONS AND OUTLOOK

The paper described a post-crisis needs assessment tool for reconstruction and recovery planning, including structural damage assessment through advanced remote sensing enriched by in-field data collection and related data integration and analysis in combination with an advanced multi-criteria decision analysis tool and methodology for multi-stakeholder information analyses, priority setting, decision making and recovery planning. It is a prototype, not yet fully mature to be used in operation by final users. Nevertheless, the usability and end user tests as well as the project final demonstration held in June 2016 in Madrid with end-users of DESTRIERO have shown that it is very promising platform. It has been pointed out that there is a strong need for such next generation of systems based on international standards, novel (automated) data and information interoperability across organizations and systems, which are very relevant to support everyday life for the end users while planning for and performing reconstruction and recovery projects.

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