Towards a Pan-European Information Space

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ABSTRACT

When disasters occur, key factors for minimizing damages and loss of lives are access to necessary information and effective communication between emergency services. In cross-border disaster management, further challenges arise: language barriers, uneven know-how, organisational and technical differences in particular concerning communication and data or information exchange. To address those challenges, the FP7-Project EPISECC (Establish Pan-European Information Space to Enhance Security of Citizens) is working on the concept of a common information space to improve interoperability and efficiency while managing cross-border disasters. This involves researching on a common taxonomy and ontology as well as on interoperability functionalities and tools. A first step on this direction is the analysis of how disasters have been and are being managed. This paper reports on an inventory of disasters designed to consolidate such knowledge and aimed at being the basis for this information space. First gaps identified in communication/information management are also presented.

INTRODUCTION

A disaster is any situation which has or may have a severe impact on people, the environment, or property, including cultural heritage (The United Nations Office for Disaster Risk, 2014). The management of a disaster involves a wide range of activities that can be assigned to different phases according to the disaster management cycle: preparation phase, response phase, recovery phase or prevention and mitigation phase (cp. Figure 1).
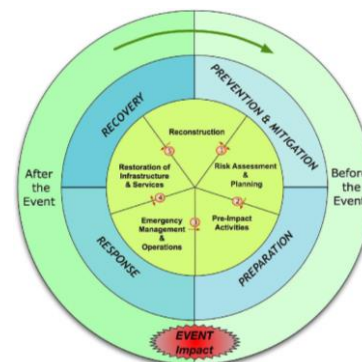

Figure 1. Crisis and Disaster Management Cycle (Lumbroso et al., 2007)

Since the 1990's the number of reported technological and natural disasters increased largely (CRED, 2014). As a result the improvement of all phases of disaster management to minimise damages and loss of lives becomes a major research objective. During the response to a disaster, having the
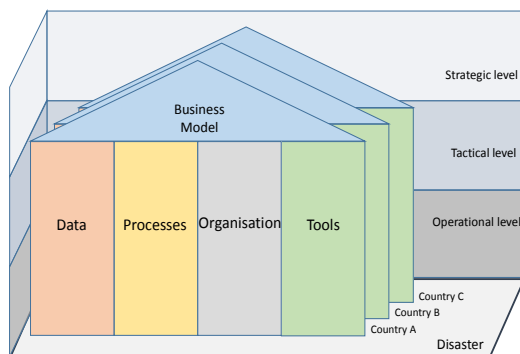
Figure 2. Analysis framework

most of information available about the evolving situation and being able to have the right resource dispatched within the shortest time and at the location with the highest relevance, highly contributes to the effectiveness of the operations. An effective communication, the ability to share information and a mutual understanding of the actual content of messages are essential in disaster management, and particularly challenging in cross-border events where different systems, procedures, standards and cultures must find a common communicating ground. The FP7 project EPISECC, started in June 2014 and lasting three years, focuses on such challenges in cross-border situations, in particular during the response phase. The development of a common Pan-European information space is at the heart of the project, aiming at identifying a set of standard protocols, formats and definitions that will make available to all stakeholders the information produced by any system involved in any phase of disaster management: the definition and implementation of the common Pan-European information space will allow the development and deployment of solutions and tools for data and process interoperability between actors in the emergency management chain. A major objective of EPISECC is also the definition of a comprehensive taxonomy that is instrumental to empowering full interoperability, intended as "the ability of different systems to operate together" (Delprato et al., 2014). The results of the project will eventually support the identification and, where needed, development of a set of standards defining the desired common Pan-European information space.

To set the ground for the targeted development, there is the need to identify commonalities, response patterns and gaps: this calls for the analysis of the past disasters and related responses in terms of (i) time to intervention, (ii) cost of the response, (iii) organisational structures and (iv) communication and information management tools used by first responders. As a first step of the project, a Pan-European inventory of disasters has been created, providing an organised and searchable database of information about the management of past disasters and events occurred in Europe and allowing learning from the adopted procedures. This paper presents the first results concerning the development of an inventory of disasters as a basis for the Pan-European information space.

METHODOLOGY

Analysis framework

The creation of an inventory of disasters as basis for a Pan-European information space requires the definition of a common framework for the analysis of management and response to past disasters. At first, such a framework or guiding structure had been developed. The developed framework follows the ideas of the 'architecture of integrated information systems' (ARIS) (Scheer, 2002) to allow a comprehensive evaluation in a modular approach. The ARIS concept was developed for describing information systems and their integration into business environments and has been adapted for project purposes. It enables a holistic analysis of Public Protection and Disaster Relief (PPDR) management but also allows various levels of detail. As depicted in Figure 2, it structures the analysis into five main areas:

- **Data:** This area focuses on the analysis of data that is processed in and exchanged between emergency management systems (e.g. spatial information about incidents). Entity Relationship Diagrams or similar toolsets such as Unified Modeling Language (UML) data models may be used for modeling results.

- **Processes:** This area focuses on processes of PPDR management organisations which may be modeled with business process modeling tools such as UML or Business Process Modeling Notation (BPMN)

diagrams.

- **Organisation:** This area focuses on the organisational structure (organisational units and their interrelationships) of PPDR management organisations. These structures may be modeled by organisational charts.

- **Tools:** This area focuses on information systems used by PPDR management organisations for managing PPDR missions. A scheme was developed to meet EPISECC's goals in terms of interoperability analysis of tools.

- **Business Model:** This area focuses on the business models of PPDR organisations. Business models may be analysed based on tools such as the Business Model Canvas (Osterwalder and Pigneur, 2010) or the V^2 value network analysis framework (Vorraber, 2012).

Each of these areas may be analysed for different organisations in different countries. Furthermore the framework takes hierarchical PPDR management levels (Lichtenegger and Voessner, 2008; Lichtenegger, 2009) into account. Therefore all five areas can be analysed on a strategic, tactical and operational level. Finally basic information of disasters lay the ground for analysis.

Data collection and structure

Managing disasters requires the involvement of actors on multiple levels of governance as well as on different spatial stages. In this context in EPISECC the relevant aspects of interoperability are investigated by focusing on cross-border collaboration practices.

The term cross-border disaster management can be applicable if a transnational collaboration of disaster managers to respond to a disaster is necessary. Once an event extends to two or more countries or its impact overwhelms the resources of the affected nation, a harmonisation between at least two nations or an involvement of international organisations might be inevitable for disaster management. In cross-border events, the coordination of disaster management might be a crucial point for an efficient response to the disaster. To achieve this goal an appropriate classification scheme for various areas of information is

necessary. In the first step, information can be classified on the basis of its function. Since activities in the field of PPDR require by its nature a cross-linked, inter-organisational and interstate coordination, the analysis will cover aspects of interoperability beginning at the level, where cross-cutting coordination is necessary. Especially coordination of cross-border disaster management is characterised by multiple sender-receiver constellations.

Following (Sagun et al., 2009), there are four channels of information flow during the Disaster Management:

- within a participating organisation,
- between organisations,
- from people to organisations,
- from an organisation to people.

Guiding questions to investigate these relationships concern *Who* – organisations involved in a certain communication process; *Where* – spatial dimension defined by regional, national, cross-border level; *What* – data which is shared/provided; *How* – processes and media to provide information.

To ensure seamless communication in coordination of disaster management, data transfer as well as information exchange across organisational and national borders require a common information space amongst pre-defined stakeholders. Focusing on specific issues in cross-border disaster management in selected countries of the European Union, different implementations of interoperability amongst disaster management approaches are considered as an important matter of research.

Analysing processes, data and standards and relevant stakeholders at various spatial levels should provide the basis for a detailed understanding of the structure and the functioning of the disaster management in Europe. Particular attention is given to information exchange processes beyond national and organisational borders. This elaboration is dedicated to provide definitions of the parameters organisations, processes, data and standards, a description of their interconnectedness and a discussion of their relevance for the pan-European disaster management.

In order to understand the current strengths and weaknesses of disaster management an analysis of the underlying processes is necessary. Therefore, the main working principles for conducting disaster management and assistance in the face of a disaster have to be described.

The presented analysis requires a multitude of information and data that on the one hand will be obtained from desk research and on the other hand will be conducted from relevant stakeholders. Therefore, an approach for the collection of required information was developed. First, a structure for data to be collected was generated. This structure is realised in templates that are either relevant fields of information, areas of information or main information units which have been identified (cp. Figure 3). It has to be pointed out that not all areas of information and fields of information are shown in this figure.
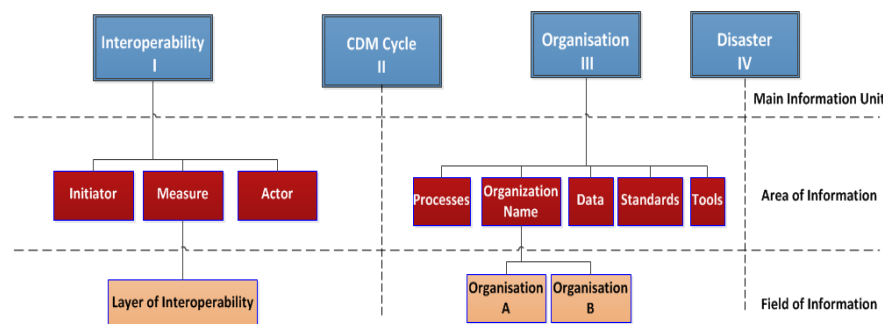

Figure 3. Levels of information within the analysis framework

The templates basically follow the columns defined in the analysis framework. In a second step relevant stakeholders have been pre-questioned to identify relevant information to be integrated in the inventory. Both, from the templates as well as the pre-questions a first architecture of the inventory is developed.

FIRST RESULTS

Interoperability of Information Management Tools in PPDR

As mentioned in the section "Analysis framework" in an early stage of the project prevailing and currently developing information management and communication tools have been investigated with respect to their interoperability potential. The term "tool" in that case does not only cover commercial applications but also research projects and non-commercial initiatives. The occurrence of the tools investigated by the EPISECC consortium is spread across Europe and beyond. Information gathering took place in a two-step approach: firstly, desk research based on publicly available resources and secondly, consulting representatives of companies and/or stakeholders. The tools were analysed by using a classification scheme specifically developed in the project. Amongst the different classification parameters like organisational scope, PPDR phase, or type of stakeholder, three parameters are of special interest for the further activities in EPISECC:

- physical data exchange,

- syntactical data exchange,

- semantic structures.

Based on the result of the tools' classification regarding those three parameters an aggregated "level of interoperability" for each tool was derived.

In total 73 research projects, non-commercial initiatives, and commercial applications have been evaluated. In a first step all 73 tools were reviewed with respect to their relevance to the EPISECC project, especially their focus on collaborative, inter-organisational information management in the area of PPDR. As a result of that review, 32 tools were excluded from further consideration so that finally 41 tools were analysed in detail (see Figure 4).

No.	Name	No.	Name
1	Sahana	22	MIRA
2	Ushahidi	23	UNDAC Mission Software
3	JIXEL	24	UNHCR Refugee Site Planning
4	IDIRA	25	WFP TrackMe
5	REACT	26	OCHA Humanitarian Response
6	Google Crisis Response tools	27	OCHA Relief Web
7	CECIS	28	deNIS IIplus
8	Twitcident	29	MobiKAT
9	Virtual OSOCC	30	ELDIS III
10	FREESIC	31	secur.CAD
11	BRIDGE	32	CRISMA
12	GERYON	33	SANY
13	HIT-GATE	34	ORCHESTRA
14	SECRICOM	35	ARM-OM100/MDG
15	DARIUS	36	3tc Software
16	E-SPONDER	37	Athena
17	DISASTER	38	CLIO
18	GEOPICTURES	39	Command Support System
19	ETC Assessment Tool	40	Erdas Apollo
20	ETC Globalepic	41	WDS-ISAS
21	Humanitarian Data Exchange		

Figure 4. Analysed tools

The tools' analysis revealed that more than 70% of the 41 investigated tools reach physical and syntactical interoperability. Tools can be connected on network level and are able to exchange data on common formats. In contrast to that, semantic interoperability can only be obtained with 14 out of 41 tools (cp. Figure 5). The realization of semantic interoperability requires a structured and somehow standardised approach. Only seven out of the 14 tools claiming interoperability in that field have implemented semantic structures based on official standards or make use of de facto (industrial) standards such as EMERGEL (Emergency Elements), EMS (Emergency Mapping Symbology), or the TSO (Tactical Situation Objects) (cp. Figure 6).
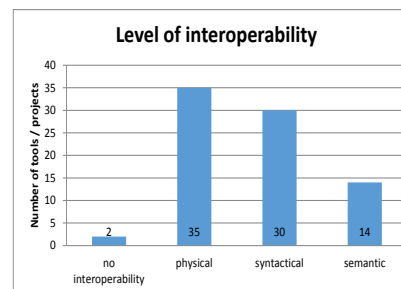
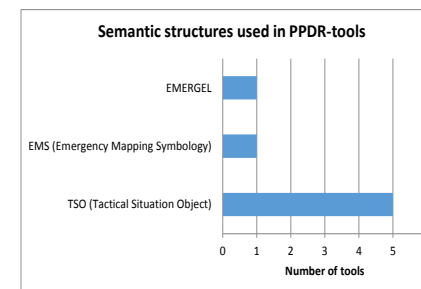**Figure 5. Interoperability levels**

Figure 6. Semantic structures

An efficient collaboration amongst various information management platforms requires a consistent interoperability concept, more specifically the concurrent realisation of interoperability on physical, syntactical and semantic level. The tools' analysis reveals that only 12 tools can live up to those expectations. The majority of tools (a number of eight) was initiated by and/or is used by the United Nations and its agencies and programs (see Figure 7). Beside three pure research projects only one further tool is operationally used on governmental level – JIXEL was adopted by the National Corp of Fire Brigades in Italy.

This clearly identifies a gap in the area of semantic interoperability underpinning the aim of EPISECC to establish a Pan-European information space. Therefore more semantic structures should be elaborated to foster semantic harmonisation and interoperability especially on the European level.
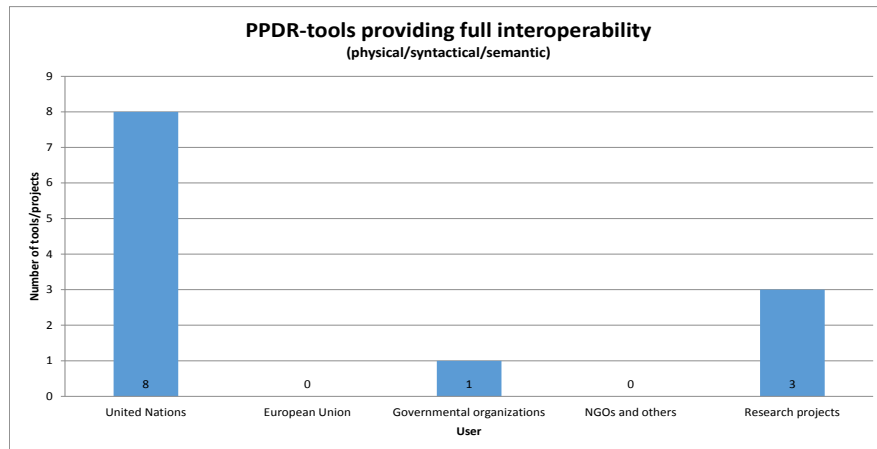
Figure 7. Usage of PPDR-tools providing full interoperability

Inventory of Disasters

As a basis for the inventory's architecture templates from basically the five main areas within the analysis framework were generated. The templates will not only facilitate the data collection but also the structuring and relating of different data. The derived templates contain the following entries mainly following the columns within the analysis framework:

- Organisations,

- Processes,

- Standards,

- Data,

- Disasters.

These entries are subject to be implemented to provide an overall state-of-the-art

of disaster management in particular disaster response in different European countries. The inventory of EPISECC reflects the data base which will be filled with detailed information of past disasters to build a standardised pan-European knowledge platform. Various data management processes like data acquisition (collecting data from various organisations), data visualisation, data transformation, etc. will be available via this inventory. The inventory itself should be able to deal with heterogeneous data sources to establish interoperability or generate reports and maps to support the evaluation process to name a few features.

Following the development of the mentioned templates, a pre-questioning phase has been conducted. The pre-questioning covered seven national and international first responders or other involved stakeholders who delivered a number of interoperability and efficiency related questions focusing on the response phase of the crisis and disaster management cycle. About 120 questions were identified and evaluated concerning project relevance. In the end 30 generic questions focusing on past disaster response were chosen. Examples are:

- How fast can alternative communication solutions provided after the collapse of the standard communication tools?

- How was cross-border response coordination realised in a disaster situation?

Those questions are subject to translation for quantification purposes and eventually transformed into main information units and implemented into the inventory's architecture.

Resulting from the analysis of the state-of-the-art, the templates and the pre-questioning phase a concept for the inventory's architecture is developed and implemented into UML (Unified Modelling Language).

SUMMARY AND OUTLOOK

The paper reported on the methodology adopted by the FP7-project EPISECC for organising the collection and structuring of information about past disasters and related response to manage them. A first result of such approach is the analysis of

information management tools in PPDR targeting the assessment of their potential for a full interoperability.

The architecture of an inventory for the classification and analysis of knowledge and information about past disasters has also been described in the paper. At the time of the preparation of the publication, the inventory is being implemented and will be further adapted to end-users needs and delivered as a tool. It will be then populated with information collected from various sources to offer a versatile and powerful knowledge-base for further studies and developments.

A next step of EPISECC is the design of an online-questionnaire that will be provided to national and international disaster management stakeholders. It will be focused on operations at strategic and tactical level. The collected information will further populate the inventory.

Once the inventory will be completed it will represent both a structured source of information for any research activity on disaster management and a tool for a continuous update and tracking of disasters and responses, allowing a more efficient learning from experiences. Based on the inventory, the identified best practices and the available *de facto* standards, a taxonomy/ontology of terms and processes used in disaster management will be designed and implemented, making available a fundamental tool for developing interoperable applications and solutions. The EPISECC Common Information Space will combine all these elements into a set of procedures, rules and tools for a new generation of interoperable solutions available to Emergency Services across Europe.

ACKNOWLEDGEMENT

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