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TAXONOMY FOR DISASTER RESPONSE: A METHODOLOGICAL APPROACH

Snježana Knezić[1], Martina Baučić[1], Toni Kekez[1], Uberto Delprato[2], Giovanni Tusa[2], Alexander Preinerstorfer[3] and Gerald Lichtenegger[4]

[1] *Faculty of Civil Engineering, Architecture and Geodesy, University of Split, Split, Croatia*
[2] *Intelligence for Environment and Security – IES Solutions, Rome, Italy*
[3] *Digital Safety & Security Department, Austrian Institute of Technology, Seibersdorf, Austria*
[4] *Department of Engineering and Business Informatics, Graz University of Technology, Graz, Austria*

Email: knezic@gradst.hr, martina.baucic@gradst.hr, toni.kekez@gradst.hr, u.delprato@i4es.it, g.tusa@iessolutions.eu, alexander.preinerstorfer@ait.ac.at, gerald.lichtenegger@tugraz.at

ABSTRACT:
The paper proposes a methodology for the creation of a taxonomy for improving information exchange and common understanding during the disaster response phase. The research presented in the paper is being carried out in the EU FP7 project EPISECC (Establish Pan-European Information Space to Enhance seCurity of Citizens). Even though several dictionaries, definitions, thesaurus, and standards exist in the area of emergency and disaster management, the project's approach specifically targets an enhanced semantics of communication between first responders in complex situations like cross-border disasters. The EPISECC taxonomy is designed and will be implemented to support the creation of a Common Information Space, where emergency managers and first responders are empowered to describe concepts (such as needs, events, assets…) and be well understood by all teams during the response phase. To achieve that, the methodology relies on a close collaboration with first responders and applies a combination of hierarchical and faceted structures, so that it can be better adapted to the users' needs. The major contribution from first responders comes from EPISECC Inventory of past disasters, which contains information gathered by interviewing multiple stakeholders working on tactical and strategic level in emergency and disaster management. The paper describes the procedure for extracting information from the Inventory, as well as the procedure for recognition of taxonomy's main concepts and facets, along with the scenario episodes (i.e. real situations) which will serve for the validation of the taxonomy.
The results of the development of the taxonomy will be presented to standardisation organisations for the definition of a future standard and included in the demonstration of the complete EPISECC final solution.

KEYWORDS:
Taxonomy, complex disaster situations, cross-border disasters

1. INTRODUCTION

During disaster response, efficient communication and access to critical information are factors of paramount importance and are key requirements for any Public Protection and Disaster Relief (PPDR) systems, indeed. Inter-connection and cooperation between different rescue teams is essential for saving lives and protecting assets. Especially the first seventy-two hours after a catastrophe are critical to save lives. Providing voice communication and information collection and distribution services within these first, golden hours after a disaster happened, is a major challenge to be addressed. In order to optimally address both natural and man-made disasters typically a multitude of governmental and non-governmental disaster relief organizations are jointly active in all phases of the disaster management cycle, i.e., mitigation, preparedness, response and recovery (Neal, 1997). While in the mitigation phase the collaboration of different organizations need to be synchronized only at the time scale of days or weeks in the remaining three phases of the disaster management cycle a much more closely aligned operation of all involved responder is crucial. Ideally, in the phases of disaster response and recovery, the available resources in terms of personnel and equipment should be used in an optimized manner across organisations, translating to a fast allocation of the same which matches the developing situation at hand to the best extent possible (Meissner et al., 2002). In order to achieve such efficiency, it is of utmost importance to assure timely, accurate as well as syntactically and semantically aligned information sharing among all the organisations involved (Lichtenegger et al., 2015).

As a matter of fact, almost all of them are using different technologies and protocols for communication. These technologies ensure communication between team members and their control centres, but direct communication between different entities from different organisations or foreign countries is very difficult or even not possible. One of the main goals of the FP7 EPISECC European project is to develop the concept of a Common Information Space (CIS) including appropriate semantic definitions by taxonomy. The architecture of the CIS is divided into the following layers:

- Layer 1: Protocol & network interoperability,
- Layer 2: Information interoperability,
- Layer 3: Operational interoperability.

Since information interoperability is an indispensable requirement to enable/ensure reliable and efficient exchange of information the objective of the intended taxonomy for disaster response is to facilitate:

- communication - by building a common structure of crisis management systems understood by all involved parties in critical events/disasters (despite of different culture, practice, expertise etc.);
- interoperability - by building common context in terms of data, processes, management tools and business models used in different events used by all services in the security field, enabling them to work together;
- development of the Common Information Space (CIS) - by structuring data and processes;
- standardisation - by building formal, easy to search models and structures of security services' business models, enabling efficient and consistent transfer of the developed models into standards.

Information interoperability could be seen as: physical (data connection), syntactical (data formats), and semantic (interpretation of the content). Semantic interoperability is crucial for automated information exchange. Therefore, key taxonomy's concepts (like resource type, task mission, event category) have to be translated from the proprietary terms of the information provider to a CIS taxonomy and forward to the proprietary terms of the information receiver (Figure 1). This double-translation inevitably leads to loss of information. Therefore it will be possible to consume the original data in addition to the standardised if both applications speak the same "language".

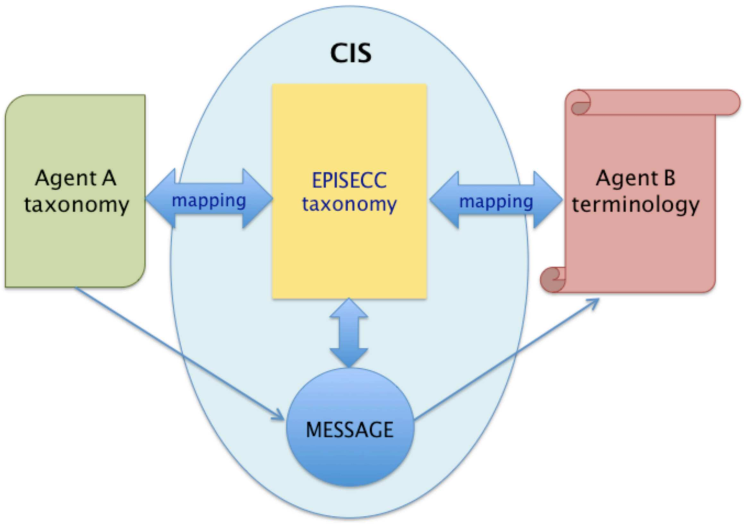

Figure 1: the role of the taxonomy in CIS

This paper presents the methodology developed for taxonomy building. The methodology involves end-users requirements, requirements posed by CIS structure and some aspects defined during the project conceptualisation.

2. METHODOLOGY

When talking about taxonomy, it seems that everyone has a pretty clear picture of what it is, but at the same time no one is able define it comprehensively. Having in mind the vast amount of discussions and available definitions, for the purpose of this research, our description is twofold:

- taxonomy is a mean for translation of agents' practices during the disaster response phase;
- taxonomy comprises situational awareness during the disaster response phase to its maximal semantic extent in an arranged and classified way.

The structure of a taxonomy could be: hierarchy (classification from general to specific); faceted (multidimensional classification) and a combination of hierarchies and facets. The most common type of taxonomy is a single hierarchical taxonomy with simple IS-A relationships between concepts (terms) in the structure. The term is a label to a concept, which is a part of a taxonomy. Facet is one side or criterion of a concept and it may have its own hierarchy of further sub-concepts. A facet may even have multiple top-term hierarchies of similar-type terms on the same subject, and there are no relationships between terms in different facets (H. Hedden, 2010). Facets of a concept should be exhaustive and mutually exclusive. In order to start with building the taxonomy, we defined the main concept of the universe of discourse as: "response to a critical event". It is agreed that response to a critical event is a complex dynamic system composed of actions taken in a certain spatial, technical, organisational, and legal environment during a disaster, including one or more situations which straightforwardly lead to a disaster, as well as handing over to a recovery phase.

The taxonomy is organized as a set of independent, 'orthogonal' sub-concepts (facets) to be used to describe data. According to G.M. Sacco (2009), such concepts, which are mutually independent, are relatively stable in time, so that faceted structure needs almost no maintenance. The relationships between facets could vary, which is much easier to maintain than concepts themselves. Moreover, facets are seen as abstract concepts, with names or terms only as labels. Therefore, when mapping the EPISECC taxonomy onto the end users' dictionaries, taxonomies, terminologies and similar structures, it requires finding same (or almost same) concepts and match labels defined in different languages.

To define sub-concepts of "response to a critical event" three sources of information and perspectives are being considered:

- Inventory of pan-European disasters,
- Common Information Space,
- Concepts defined during the formulation of the project.

The analysis of concepts also includes a study of existing standards and taxonomies developed by international institutions. Existing standards in the field of disaster and emergency management as well as any other structured knowledge may be found as directories or vocabularies of national and international organisations dealing with disasters. The latters include response, recovery or relief organisations (like the Red Cross) that are very important for the recognition of concepts. The purpose of standards is to facilitate collaborative actions by ensuring compatibility and interoperability of components, products and services. Sometimes, laws and regulations may refer to standards and even make compliance with them compulsory (CWA, 2009).

The first step is to describe the main concept with minimum independent individual sub-concepts of discourse. However, the sub-concepts should comprehensively cover the whole main concept. There is no common, unique or most used methodology for recognition of sub-concepts, i.e. facets. It is defined by Ranganathan (1965) and Spiteri (1998) what a faceted structure should have, but there is not a methodology that could be followed to obtain the faceted structure (M.D. Giess, 2008). Since the original idea was developed for the classification in libraries (Ranganathan, 1965), the whole concept and its application is commonly used for social tagging and documentation classification processes. For example Rantagan (1965) in his Colon Classification theory proposes five facets: Personality - Who; Matter - What; Energy - How; Space - Where and Time -When. Spiteri (2010) examines the use of facets to facilitate the efficient organization and browsing of tags and attempts to develop a common methodology for development of facets and concludes that even though a number of studies exists a clear explanation of theoretical frameworks or methodologies for recognition of facets is missing.

Moreover, he states that examined studies do not address any strategies by which to enable end users to evaluate the usefulness and applicability of recognised facets.

It is suggested in the literature that the practical approach in arriving at a set of facets is to identify a set of single criteria, which can be used to subdivide a given concept (L. Spiteri, 1998). Within the procedure for identifying criteria, a system analysis approach will be performed, as follows:

- identification of goals/objectives,
- definition of the criteria from identified goals/objectives.

Apparently, end-users shall provide clear vision of goals with regard to the decision problem, i.e. concepts. In this case, goals become criteria. This procedure is a goal-driven comprehension of the universe of discourse, which at the end will provide end-users requirements in the common information space. This would help to identify end-users needs and to develop future search through the taxonomy using facets (criteria).

For the purpose of the EPISECC project, the evaluation of facets will be performed in three directions. First direction goes toward using the Inventory, as it will contain end users' descriptions of disasters, and consequently depicts their views of the taxonomy concept. The other directions will include direct end users' contribution, mainly through consultations with the project's advisory board and CIS requirements through used standards. The facets should be readily identifiable, particularly those that describe the concepts in the most common way. The objective is to recognise the most descriptive and/or most usable ones. Besides the usual situations where users of taxonomy are general public (like web store, or library), herein there is a pretty much consistent end users community. If the context "response to a critical event" is analysed from all actors that takes place in the major disasters we may face several different perspectives as described in section 2.2. To give a real world example of what is meant by concepts, facets and sub-elements a segment of a taxonomy describing forest fires is given in Figure 2. This concept of "forest fire" and its facets "type", "part", characteristic" and "parameter" was formulated by researchers together with fire service officials from different language regions within the Alpine Forest Fire Warning System Project (ALP FFIRS).

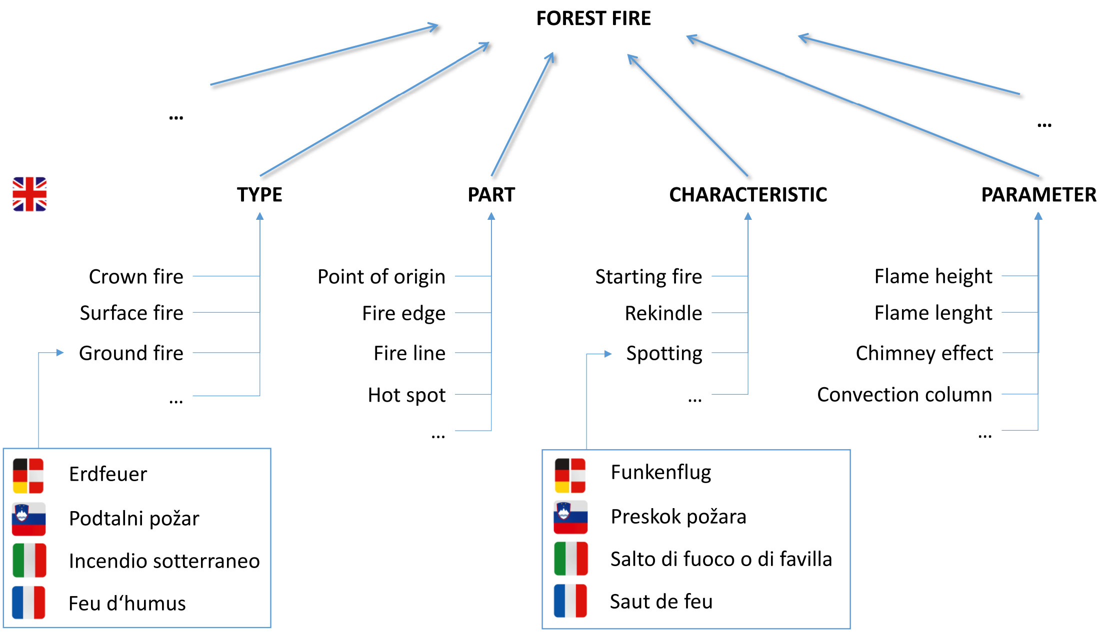

Figure 2: The concept/facet "forest fire" with some of its sub-concepts/facets and their corresponding interoperability terminology, based on ALP FFIRS (2012)

According to the chosen methodology, in EPISECC it is planned to recognise concepts and their terms for taxonomy facets from the Inventory, consultations with project's advisory board and from the standards to be used in CIS, using following rules (Y. Tzitzikas et al, 2007):

- to define appropriate terms and possibly sub-terms, according to defined criteria,

- each term must be valid, in the sense that it applies to at least one object of a concept,
- to identify a number of different aspects of the concept.

Herein, the term is a label for a sub-concept. The basic sources for recognition of terms are past events described by classes in the Inventory content, for example from processes or data. Taxonomy terms could be fields of information of the Inventory: phases of disaster management, management level, material resources, human resources, etc. To define the common characteristics within concepts, the terms are compared within relevant aspects and measure their frequency, like:

- how many institutions/organisations' types are using a certain term,
- how many countries are using a certain term,
- how many events/disasters they are connected by terms.

The overall approach is to define sub-concepts (i.e. facets) wherever possible, and to classify facet into hierarchy when the decomposition comes to phase when only subtypes of the concept is needed. The first step is to find all possible concepts that define "response to a critical event". Once main, preferably mutually independent, sub-concepts are defined, they will be examined for further decomposition or classification to facets or hierarchy, respectively. The process continues up to he terminal taxonomy nodes. Figure 3 shows an example where a concept/facet "disaster" is further described with three sub-concepts/facets each having hierarchical structure.

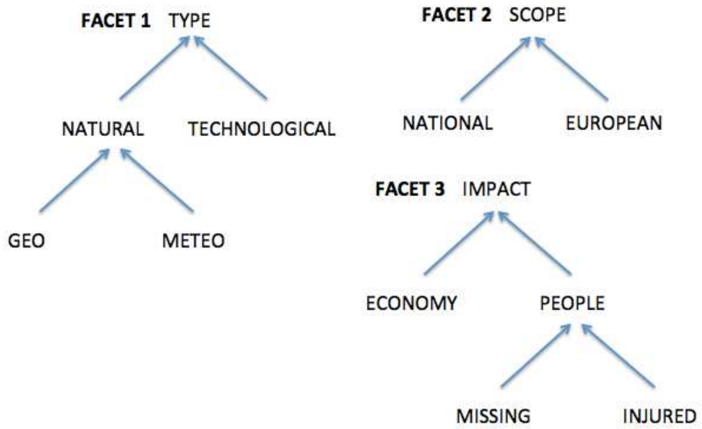

Figure 3: An example - a concept/facet "disaster" is further described with three sub-concepts/facets,

Finally, the methodology includes testing of the taxonomy using three episodes developed particularly for this purposes. The episode is a set of use cases which are logically connected and coordinated in time. Methodology for development of the episodes is given in section 2.2.

2.1 Inventory of pan-European disasters

In order to assist in the improvement and strengthening of the European crisis and disaster management the project EPISECC is aiming at developing a concept of a common information space based on interoperability concepts and the analysis of the response to past disasters. To obtain this information especially designed questionnaires were and will be provided to various stakeholders including the United Nations (UN), the European Union (EU) and national agencies. The EPISECC Inventory questionnaire serves directly as input for the EPISECC Inventory which is a system allowing dynamic connection of different fields of information e.g. interoperability.

The framework of the Inventory was built with the approach of the "Architecture of Integrated Information Systems" (ARIS) which was defined by A. Scheer (2002). The selected and adopted model allows covering an optimal range for gathering information from main information units such as Organization, Disaster, Data, Processes, Standards or Tools. The related areas and fields of information which are a subset of the main information units are also well covered by this approach. The online questionnaire and in further consequence the Inventory focuses on disasters and the cooperation of organisations during the response phase of disasters.

Figure 4 depicts an excerpt of the Inventory questionnaire in which the respondent (interviewed person) can answer questions which cover a multitude of issues in disaster management. After conducting all interviews, the EPISECC Inventory will contain a variety of data that are a priori related to specific events or topics. The target is to combine information out of these data and generate new knowledge on this basis of information fields. Finally relevant information can be extracted (e.g. on a specific disaster) from the Inventory which will provide decision makers a basis for the development of knowledge about a certain best practice, a well-established cooperation framework or a proven tool used in specific situation of an event.

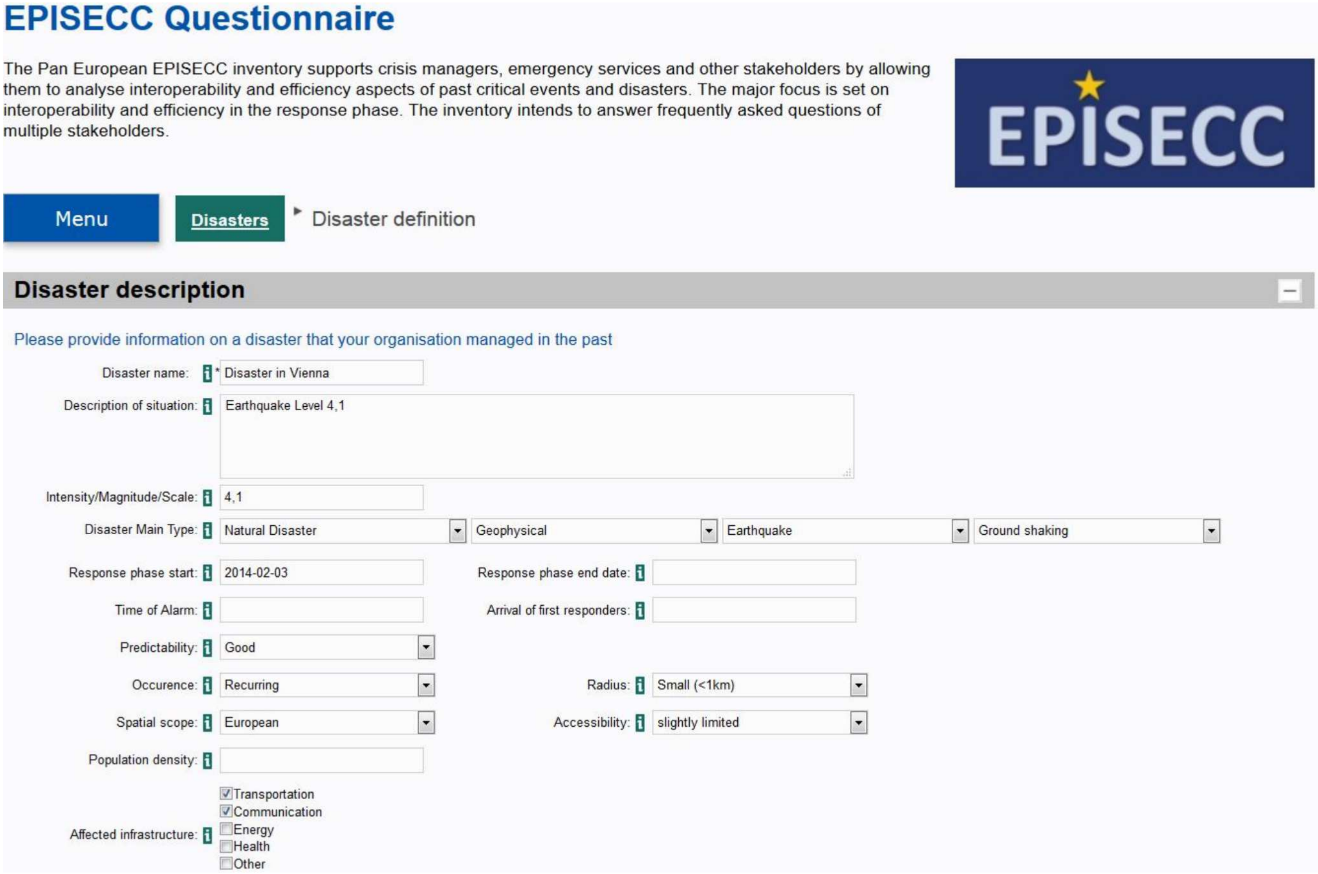

Figure 4: Excerpt from the EPISECC Inventory Questionnaire

2.2 Taxonomy episodes

Taxonomy episodes are specifically aimed to help the understanding of the expected use of the Taxonomy, in specific disaster situations. Different episodes are presented and analysed, they are based on two basic scenarios developed within the project. The main aim of the episodes is, therefore, to show how the actors interact with each other in specific emergency scenarios, their information exchange needs and, as a consequence, the information items which need to be considered in the Taxonomy, having the semantic interoperability aspect as the main focus. The episodes will help to identify:

- taxonomy elements needed to support real emergency situations,
- high level technical functionalities, needed to support the use of the Taxonomy,
- how the actors interact through such functionalities and how they use the Taxonomy.

Input for the definition of the episodes and related use cases are: analysis of the Inventory of pan-European disasters, Standard Operating Procedures (SOPs) and end users experience.
Episodes, and derived use cases, will be described using a predefined template (e.g. in tabular form).

The methodology for extracting episodes from the scenario is following:

- to start from the two scenarios already defined (earthquake with dam break and flood, and wildfire);
- to define a specific incident or situation that needs to be handled by the involved stakeholders for each scenario (e.g. need to evacuate or rescue people after an earthquake);
- to identify the most important sequence of actions and/or sub-incidents within the specific incident; this sequence or flow of actions will represent the episode.

Use cases are derived starting from the description of a specific episode, in the following way:

- by isolating specific actions within the episode itself,
- by developing questions which need to be answered in order to understand information exchange needs; the answers to these questions will be the basis for each use case description.

3. IMPLEMENTATION

Following the proposed methodology creation of a taxonomy begins with the formation of a set of potential concepts, which will be top level facets describing “response to a critical event”. The starting point is a set of concepts defined during the formulation of the project. The set is further enriched with more concepts from the content of the Inventory of pan-European disasters and also from the structure of the Inventory questionnaire, which is being filled by end users who are were involved in past major disasters. The structure of the Inventory questionnaire came from the complex process of transforming questions relevant to disaster response phase posed by stakeholders, being active in disaster management, into fields of information of the Inventory questionnaire (Huebner et al. 2015). This means that the Inventory questionnaire’s structure contains stakeholders’ view into disaster response phase and could be use as relevant source for creation of taxonomy concepts. The third source of the concepts is the data structure of the Common Information Space (CIS). CIS uses certain data standards related to the emergency management. Since the taxonomy serves CIS as an interface between agents it should also include concepts defined in these standards. Even though facets should be orthogonal, meaning that each facet describes the concept from a different aspect, facets that are not independent may be used if they are important from the users’ point of view, or they are part of commonly used standards and/or procedures. Twenty three concepts have been identified from different sources:

1. Concepts defined during conceptualisation of the project:

Concept 1 – term: Disaster

Any situation which has or may have a severe impact on people, the environment, or property, including cultural heritage. (EU Decision, 2013) “Situation where widespread human, material, economic or environmental losses have occurred which exceeded the ability of the affected organization, community or society to respond and recover using its own resources.” (ISO 22300:2012)10. “A serious disruption of the functioning of a community or a society involving widespread human, material, economic or environmental losses and impacts, which exceeds the ability of the affected community or society to cope using its own resources.” (UNISDR, 2009) “Disaster means a serious disruption of the functioning of society, which poses a significant, widespread threat to human life, health, property or the environment, whether arising from accident, nature or human activity, whether developing suddenly or as the result of long-term processes, but excluding armed conflict.” (International Red Cross Society and Red Crescent Society, 2008)

Concept 2 – term: Process

A set of actions, executed by organisational entities, aiming for a certain result. They can be structured into: internal communication, coordination, resources management, interaction with citizens, command and control, communication with other entities, interoperability actions. Processes take data from data storage or in-situ measurements (sensors, devices or human observations) as may be transformed and stored into a database.

Concept 3 – term: Data set

A data set is an identifiable collection of data used by end users during the response to a critical event.

Concept 4 – term: Management tool

Tools facilitate both adequate preparedness as well as effective response to disasters within and outside the.

Concept 5 – terms: Management service / Business model

A set of interconnected processes, which are modelled for: e.g. internal communication, coordination, resources management, interaction with citizens, command and control, communication with other entities, interoperability model, service performance (outsourced, in house) or financing.

2. Concepts emerged from the Inventory questionnaire structure:
Concept 6 – term: Organisation
An organisation is a unit established to meet goals related to disaster management. It is structured along its management, which defines the relationships between responsibilities, tasks and its structure. The organisational structure determines how the organisation performs or operates. Another definition which should be considered is delivered by ISO 22300 (2012): "The organization is a person or group of people that has its own functions with responsibilities, authorities and relationships to achieve its objectives."
Concept 7 – term: Measure
A composition of all activities necessary to realise the goal of the initiator (organisation or a person representing an organisation).
Concept 8 – term: Standard
"A document that sets out requirements for a specific item, material, component, system or service, or describes in detail a particular method or procedure. Standards facilitate international trade by ensuring compatibility and interoperability of components, products and services." (http://www.cencenelec.eu/standards)
Concept 9: term: Interoperability
The interoperability is the communication between the different organisation units during a process and includes the used communication medium, the type of data, the versioned tools, which was used to send and receive the data, and the date. Three layers of interoperability are considered: physical, syntactical and semantic.

3. Concepts defined in CEN standards as required by CIS:
Concept 9 – term: Module
"A self-sufficient and autonomous predefined task- and needs-driven arrangement of Member States' capabilities or a mobile operational team of the Member States, representing a combination of human and material means that can be described in terms of its capacity for intervention or by the task(s) it is able to undertake." (CWA, 2009)
Concept 10 – term: Context
"A set of identified information about a Tactical Situation Object (TSO) instance. It includes a unique ID of the TSO instance, who and when the information was created, the relations to other TSO instances, the type of message and others." (CWA, 2009)
Concept 11 – term: Event
"An event is something that takes place which an agency should respond to (as defined by the agency's objectives), for example, a natural disaster or a fire in a chemical factory. In practice, a major event may be decomposed into sub-events, and require the response of multiple agencies." (CWA, 2009)
Concept 12 – term: Mission
"A mission is an activity aimed at reducing the impact of the event. A mission has a goal and a plan. A TSO should describe all the current missions controlled by the node creating the TSO, and may also include missions managed by other nodes." (CWA, 2009)
Concept 13 – term: Resource
"A resource is something which can be used to support or help in the response to an event." (CWA, 2009)
Concept 14 – term: TSO
"A Tactical Situation Object (TSO) is collection of information summarising an event, as seen by the node creating the TSO." (CWA, 2009)
Concept 15 – term: Agency
"An agency is an organization whose objectives include responding to emergencies (ensuring public safety, saving lives, etc.). An agency may operate at an international level (e.g. UN, Red Cross, etc.) or be limited to national or local levels. The term includes ad hoc agencies, for example, a co-ordination body for a specific event." (CWA, 2009)
Concept 16 – term: Node
"A node is a facility owned by an agency, and which may provide TSO messages to other nodes from the same or other agencies in order to share with them part of the event information held at the node. The facilities which can create TSO messages include, but are not limited to, fixed control rooms, mobile control rooms, and

co-ordination rooms set up fora specific event." (CWA, 2009)

Concepts defined in Oasis CAP (Common Alerting Protocol) standards as required by CIS:
Concept 17 – term: Alert
"The <alert> segment provides basic information about the current message: its purpose, its source and its status, as well as a unique identifier for the current message and links to any other, related messages. An <alert> segment may be used alone for message acknowledgements, cancellations or other system functions, but most <alert> segments will include at least one <info> segment." (CAP-V1.2, 2010)
Concept 18 – term: Info
"The <info> segment describes an anticipated or actual event in terms of its urgency (time available to prepare), severity (intensity of impact) and certainty (confidence in the observation or prediction), as well as providing both categorical and textual descriptions of the subject event. It may also provide instructions for appropriate response by message recipients and various other details (hazard duration, technical parameters, contact information, links to additional information sources, etc.) Multiple <info>segments may be used to describe differing parameters (e.g., for different probability or intensity "bands") or to provide the information in multiple languages." (CAP-V1.2, 2010)
Concept 19 – term: Resource
"The <resource> segment provides an optional reference to additional information related to the <info> segment within which it appears in the form of a digital asset such as an image or audio file." (CAP-V1.2, 2010)
Concept 20 – term: Area
"The <area> segment describes a geographic area to which the <info> segment in which it appears applies. Textual and coded descriptions (such as postal codes) are supported, but the preferred representations use geospatial shapes (polygons and circles) and an altitude or altitude range, expressed in standard latitude / longitude / altitude terms in accordance with a specified geospatial datum." (CAP-V1.2, 2010)

Concepts identified:
Concept 21 – term: Mass media
"The mass media are diversified media technologies that are intended to reach a large audience by mass communication." (en.wikipedia.org/wiki/Mass_media) They are used to inform and alert citizens about the potential threat and related developments during response phase. Within the scope of the EPISECC project we consider the social media to be part of mass media communication. Social media, on the other hand, has to be somewhat differentiated form (outbound) the mass media as it allows responders to obtain data from affected population (inbound) in real time and in this way increase their situational awareness.
Concept 22 – term: Legislation
A set of laws made by governments and set of international agreements related to the disaster management and action during the response to a critical event.
Concept 23 – term: Meteorology
Weather and hydrological conditions observed during the response to a critical event including weather forecast for immediate time period.

The first step is to find out basic, mutually independent concepts, which fully describe the main concept. Analysis is focused on two things: redundancy of concepts and sub-concepts relationship. Some concepts found to be redundant, like Event and Disaster have the same meaning, while some found to be sub-concept of another, like Node is considered as a sub-concept of Organisation. From the set of above described concepts five have been chosen as the minimum independent individual sub-concepts, which comprehensively cover the whole main concept: a response to a critical event (Table 1).

Further development of the taxonomy will focus on the Inventory content. Brief analysis shows that the descriptions of disasters given by the end users in the Inventory may provide additional criteria for distinguishing or describing the disasters. For example, examining the description for flooding it has been noticed that the common part of the descriptions was the way people are affected. Therefore, the conclusion could be to include detailed description of how impact affected not only infrastructure but also people, and perhaps to enlarge the view to general property, environment and cultural heritage, as well, i.e. to introduce a facet "Impact. Frequencies and characteristic attributes of aggregated data from the inventory questionnaire, together with graphical visualisation, will certainly contribute in the same manner to a better understanding of end users' requirements. Furthermore, the end users' objectives, which contribute to a common objective for the EPISECC context, may be used to define some "hidden" facets or criteria. The common objective could be derived from the context: to improve response to a critical event in terms of communication between first responders possibly in cross-border situation.

Table 1: Independent sub-concepts for the main concept: a response to a critical event.

Concept's term	Concept's context
Disaster	What kind of event is happening?
Process	What action has been or will/should be undertaken during the response to the event?
Data set	What data/information has been or will be needed during the response to the event?
Organisation	Who is involved in a response to the event?
Module	What capacities are used to respond to the event?

Furthermore, a good starting point for the identification of further sub-concepts is the Inventory questionnaire structure. It contains the most important terms extracted from questions posed by end users shows the concepts that were identified from the comprehensive analysis during the transformation of questions posed by end users to fields of information in the questionnaire. Standards used by end users during the response to the particular disaster, as reported in the Inventory questionnaire, are also to be used in the further analysis. The most used are: ISO 22300:2012 which contains terms and definitions applicable to societal security to establish a common understanding so that consistent terms are used; ISO 22320: 2011 as a basis for the co-ordination and co-operation amongst all involved parties during an incident and helps to improve interoperability; the terminology on disaster risk reduction developed by UNISDR (United Nations Office for Disaster Risk Reduction) and GDACS (Global Disaster Alert and Coordination System) created to address significant gaps in information collection and analysis in the early phase of major sudden-onset disasters.

For the purpose of the taxonomy testing and based on EPISECC scenarios three episodes have been developed as showed in Table 2.

Table 2: Developed episodes and use cases

Scenario	Episode	Use case
Earthquake in Southern Austria followed by dam break and flooding	Main earthquake, and aftershock causing the partial collapse of the road and rail infrastructures	LEMA collects early warnings and situation assessment info
		LEMA contacts the infrastructure providers and the public for providing SitRep, warnings and recommendations
		Austrian government requests help from the ERCC
	Dam break and flooding	Austria informs Slovenia and Italy
		Slovenia and Italy prepare for the dam break
Wildfire in Croatia and Bosnia and Herzegovina	Collaboration between local (Croatia and Bosnia and Herzegovina) and foreign teams (Italian fire Brigades) for fire control and people evacuation activities	Bosnia and Herzegovina's side calls Croatian side for help
		Calling Police (Croatia)
		Calling Italian first responders
		Croatian side calls for more help due to fire spreading

4. TOWARDS STANDARDISATION

An effective emergency response requires clear situation awareness, achieved through the successful implementation of interoperability solutions on many different layers (Delprato et al., 2015). The building of a common operational picture relies on exchange of information and is based on the integration and assessment of information collected from the different teams of responders and other information sources. This need for defining the way information can be effectively and efficiently exchanged is at the basis for existing standards, covering the way messages are structured, exchanged and how information can be coded for being understood by Computer based systems.

For the application of the CIS, EPISECC will aim at developing a structure of codes organised in a taxonomy, that will cover at the largest possible extent the concepts involve din the situation defined as "response to a critical event". Such work will consider existing codes and taxonomies that, although incomplete or not sufficiently detailed, are being used and have been included in *de jure* or *de facto* standards. A first reference will be the Technical Report ISO/TR 22351 "Societal security – Emergency management – Message structure for exchange of information" approved by the International Organization for Standardization and under publication at the time of the writing of this paper. This reports builds on the contents of the CEN Workshop Agreements (CWA) 15931-1:2009 and 15931-2:2009 "Disaster and emergency management - Shared situation awareness". Part 2 (Codes for the message structure) is a comprehensive attempt to provide a list of codes for the message structure named the Tactical Situation Object (TSO) for the transfer of information between computers based systems in such a way that it can be reliably decoded.

A second reference is the EDXL (Emergency Data Exchange Language) family of standards developed and published by the OASIS ("Advancing open standards for emergency interoperability and communications") Emergency Management Technical Committee. In particular, the Common Alerting Protocol (CAP) standard, developed to facilitate the exchanging of emergency alerts and public warnings, includes in its XML structure a number of coded fields that classify elements of the alerts into a number of categories (such as the type of risk).
Many other classifications related to hazards and meteorological conditions are available throughout the community of practitioners, but none of them is internationally adopted. Nevertheless, they show the real need for a comprehensive taxonomy, making the efforts of the EPISECC project relevant and interesting for the above-mentioned Standardisation Organisations: a taxonomy that would expand the coverage in depth (detail of classification) and width (number of classified concept) would definitely represent a valid proposal for an improvement to existing standards and a robust basis for a number of new tools for information exchange between IT multilingual system making use of the Common Information Space. EPISECC plans therefore to establish links to ISO, ETSI and OASIS aiming at presenting the developed taxonomy and initiating a process for improving the quality of the current standards for structuring the information for an effective situational awareness.

5. CONCLUSIONS

The paper presented the work on taxonomy, carried on in the EPISECC project, which is meant to be used to enhance information and semantic interoperability during the disaster response phase. The research done so far has been focused on the methodology, which includes the taxonomy structure and a way of defining the appropriate concepts. The implementation of the proposed methodology has been started with finding global concepts and their main facets. There are lot of challenges, like choosing the most relevant sources for concepts, finding suitable terms for the concepts and defining the criteria for the identification of facets. Besides creating a full taxonomy structure, a very important future work involves the mapping of the EPISECC taxonomy onto the CIS structure. The mapping of the taxonomies (dictionaries, thesaurus, etc.) used by agents onto the EPISECC taxonomy will be left to the agencies as an adaptation task for entering the CIS. With this in mind, the taxonomy structure will have to be flexible so that the agencies could map their terms and structures easily and efficiently. The existing standards for taxonomies, with their limitations, will be taken into account and results of the work will be presented to European and International standardisation Organisation for future take up.

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