TUNisia-Italy Cross-Border Environment Net platform for emergency response (NETTUNIT): project presentation and early results

Mohamed Hedi Fourati[1,2], Saoussen Cheikhrouhou[1,2], Slim Kallel[1,2] and Mohamed Jmaiel[1,2]

[1]*ReDCAD Laboratory, University of Sfax, Tunisia*
[2]*Digital Research Center of Sfax, University of Sfax, Tunisia*

Abstract

The main objective of the NETTUNIT "TUNisia-Italy Cross-Border Environment Net" project on a 2.5 years period of time (2020-2022) is to propose an emergency response platform in purpose to solve occurring disasters in the border between Tunisian and Italian countries. In this paper, we explain the adopted emergency procedures (mainly; the response phase). To model the emergency response, NETTUNIT combines three modelling languages, notably BPMN, CMMN and DMN. Moreover, in this project we need to model and share data for the emergency process between the different stakeholders, for that, we propose a domain ontology. Indeed, we select and give an overview of three state of the art ontologies. The proposed ontology for NETTUNIT will be built on the basis of these latters and aims to mainly adress their limitations and to further advance the understanding of the emergency response for all involved actors.

Keywords

NETTUNIT project, Emergency procedures, Modeling languages, Ontology

1. Introduction

The entire Tunisian-Italian coastal area is a sensitive site in the face of possible pollution, especially the coastal fringe consisting of nature reserves, breeding grounds of marine species, fishing activity, tourism, port operations and human settlements along the coast.

On the environmental level, Tunisia and Sicily, immersed in the Mediterranean sea, face particularly common challenges related to the degradation of their maritime environment.

The main environmental problems are caused in particular by:

- A high demographic density and urbanization of the coastline accentuated by the development of tourist and industrial infrastructures;
- Maritime transport is one of the main sources of pollution of the Mediterranean Sea due to the heavy traffic of ships in this sea. Ships spill large quantities of oil (80 thousand tons between 1990 and 2005 as a result of shipping accidents);

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mohamed-hedi.fourati@redcad.org (M. H. Fourati); saoussen.cheikhrouhou@redcad.org (S. Cheikhrouhou); slim.kallel@fsegs.usf.tn (S. Kallel); mohamed.jmaiel@redcad.org (M. Jmaiel)
0000-0002-2664-0204 (M. Jmaiel)

Tunisia is still facing environmental challenges related to climate change, industrial pollution, waste management and energy control. Moreover, Tunisia is fragile in the face of the repercussions of the phenomenon of climate change. The forcings of climate change are expected to increase the country's vulnerability both at the socio-economic environmental level.

Several studies developed in Tunisia in collaboration with the World Bank and the OUN program in 2012 assess the cost of climate change on the agricultural sector between 1.3 and 1.7 billion euros until 2030 with a decrease in agricultural growth estimated between 0.3 and 1.1% per year until 2030.

The main objective of NETTUNIT[1] is to strengthen the cooperation between Tunisia and Italy in the confrontation of risks and disasters that can cause serious consequences for humans and the environment in both countries.

This project aims to develop a fully operational platform to minimize the effects of air and marine pollution of such an event (natural disasters, accidental events, extreme weather phenomena) and to promote a rapid recovery of the environment the environment and the activities and uses. A major accidental pollution is characterized by its suddenness, its massive and localized character, the impossibility to foresee with precision its nature, location and consequences; hence the need to gather in a clear information system known to all decision-makers, a maximum amount of information that will enable them, in case of necessity, to necessary, to take the necessary decisions quickly.

The rest of this paper is organized as follows. Section 2 presents an overview of the NETTUNIT project. Section 3 describes the emergency management process. Section 4 displays the used modelling languages. Section 5 explains the domain ontology which combines three existing ontologies. Finally, section 6 wraps up the conclusion, crowns the whole work and provides different perspectives for future works.

2. NETTUNIT Project

The NETTUNIT project aims to develop a fully operational platform with the use of meteorological alerts. These alerts are related to atmospheric pollution and marine pollution intended in particular for Civil Protection services, local health services and other Italians and Tunisians intervention services, in order to collaborate together for a possible intervention.

This project will provide a unique opportunity to respond to the growing threat to the environment, in particular atmospheric and maritime. A solution to this environmental threat requires new, innovative science and requires multidisciplinary collaboration in order to find a common solution to this threat.

NETTUNIT's common challenge is to strengthen cooperation between Tunisia and Italy in confronting risks and disasters that can cause serious consequences for humans and the environment in both countries. For this purpose, it aims to develop a fully operational platform to minimize the effects of atmospheric and maritime pollution from such an event and to promote a rapid restoration of the environment and of activities and uses. The data will be exchanged between the structures of the two countries to model the risks and the necessary responses.

[1] https://www.italietunisie.eu/projets/les-projets/nettunit/

Figure 1: Emergency Management Phases [1]

Finally, this programm promotes the linking of citizens through an application for smartphones that will be used to receive alerts in the form of geo-localized data (maps, text, images, etc.). The messages and the procedures to be followed according to the situations will be translated and adapted for Tunisia and Italy. Depending on the needs, the necessary information will be provided to users.

3. Emergency Management

Emergency management is the organization and management of resources and responsibilities to address all humanitarian aspects of emergencies (preparedness, response, mitigation and recovery). The goal is to reduce the adverse effects of all hazards, including disasters.

The World Health Organization defines an emergency as the state in which normal procedures are interrupted and immediate action (management) must be taken to prevent it from becoming a disaster, from which recovery is even more difficult. Disaster management is a related term but should not be confused with emergency management

Emergency managers consider disasters as recurring events including four phases: mitigation, preparedness, response and recovery [1]. The following diagram illustrates the relationship between the four phases of emergency management.

- **Mitigation**: This phase includes actions taken to prevent or reduce the cause, impact and consequences of disasters. Examples of hazard mitigation include: 1- Tying down houses or barns with ground anchors to resist wind damage. 2- Digging water channels to redirect water and planting vegetation to absorb water 3- Construct permanent dykes or barriers to control flooding 4- Reinforce fences to prevent animal escapes 5- Purchase insurance policies

- **Preparedness** This phase includes planning, training, and educational activities for events that cannot be mitigated. Examples include: 1- Developing disaster preparedness plans for what to do, where to go, or who to call for help in the event of a disaster 2- Exercising plans through drills, tabletop exercises and full-scale exercises 3- Create a supply list of items useful in a disaster 4- Walk around a farm and identify possible vulnerabilities to high winds
- **Response**: The response phase occurs immediately after a disaster. During the response phase, business and other operations do not function normally. Personal safety and well-being during an emergency and the duration of the response phase depend on the level of preparedness. Examples of response activities include: 1- Implementing disaster response plans 2- Conducting search and rescue missions 3- Taking action to protect yourself, your family, your pets and others 4- Respond to public perceptions of food safety
- **Recovery**: During the recovery period, restoration efforts run concurrently with regular operations and activities. The recovery period after a disaster can be extended. Examples of recovery activities include: 1- Preventing or reducing stress-related illness and excessive financial burdens. 2- Rebuilding damaged structures based on the advanced knowledge gained from the previous disaster 3- Reducing vulnerability to future disasters

The NETTUNIT project mainly focuses on preparedness and response phases during emergency process. This project will develop new methods of inter-organizational work planned between the two countries. It includes many elements, including an increase in the number of personnel specialized in emergency emergency preparedness and response, more effective use of information systems, telecommunications and information systems, telecommunications and logistics.

Several studies in the scientific literature on emergency response procedures mainly use three modeling languages: BPMN, CMMN and DMN. In the next section we present the basic principles of each model.

4. Modeling Languages

In NETTUNIT project we use combine the three well known models: BPMN, CMMN and DMN.

4.1. BPMN: Business Process Model and Notation

A business process model and standard notation (BPMN) will provide organizations with the ability to understand their internal business procedures in a graphical notation and give organizations the ability to communicate these procedures in a standard way.

In addition, the graphical notation will facilitate the understanding of performance collaborations and business transactions between organizations. This will ensure that companies understand each other and the participants in their business and will allow organizations to quickly adapt to new internal and B2B business circumstances.

4.2. CMMN: Case Management Model and Notation

Case Management Model and Notation (CMMN) defines a common meta-model and notation for modeling and graphically expressing a case, as well as an interchange format for exchanging case models between different tools. The CMMN aims to capture the common elements used by case management products, while taking into account current contributions to case management research. Known as adaptive case management, CMMN facilitates the decision-making process with suggestions, while keeping humans firmly in the driver's seat. CMMN focuses on living information and relationships, while traditional business processes focus on a priori defined sequences of activities.

This specification defines a common meta-model and notation for modeling and graphically expressing a case, as well as an exchange format for exchanging case models between different tools. It is to case management products what the OMG Business Process Model and Notation (BPMN) specification is to business process management products. This specification is intended to be consistent with and complementary to BPMN.

4.3. DMN: Decision Model and Notation

DMN is a modeling language and notation for the precise specification of business decisions and business rules. DMN is easily readable by the different types of people involved in decision management. These include: business people who specify rules and monitor their application; business analysts.

DMN is designed to work with BPMN and/or CMMN, providing a mechanism for modeling decision making associated with processes and cases. Although BPMN, CMMN and DMN can be used independently, they have been carefully designed to be complementary. Indeed, many organizations need a combination of process models for their prescriptive workflows, case models for their reactive activities and decision models for their more complex multi-criteria business rules. These organizations will benefit from the combined use of all three standards, selecting the one that is most appropriate for each type of business modeling. This is why BPMN, CMMN and DMN are truly the "triple crown" of process improvement standards.

In NETTUNIT, we need to present and share data for the emergency process. For this purpose, we need to use ontologies. In the following, we define the concept of ontologies and we explain explain how we will apply them in our project.

5. Ontology for NETTUNIT

5.1. Ontology Concept

The word ontology belongs to the domain of philosophy, which means "the philosophical study of the nature of being, existence, or reality in general, and of the fundamental categories of being and their relations". Computer scientists have imported this word and defined a whole new definition. In theory, ontology is defined as "an explicit and formal specification of a conceptualization" [2]. There are two important aspects to this definition:

- Explicit: the meaning of each concept is clearly and uniquely defined.
- Formal: the concepts of the ontology are defined by a well-defined language so that machines can easily understand

There are many relationships in the ontology that connect different concepts in a large concept network, which also helps the machine to search through the created knowledge. The meaning of each concept is clearly and uniquely defined.

5.2. Ontology Modeling

Given the definition of ontology, in this section we will illustrate how to build ontology. There are three main steps in ontology construction: ontology capture, ontology encoding, and ontology mapping [3].

In general, there are different types of ontologies that can be constructed [4]:

1. Knowledge representation ontology: It defines the representation primitives in formal language.
2. General ontology: It defines the vocabulary concerning objects, events, time, space, etc.
3. Meta-ontology: It defines knowledge beyond domains.
4. Domain Ontology: Defines the concept and relationship of a certain application domain.
5. Reference Ontology: It defines the higher level concepts and relations for negotiating meanings in different domains.
6. Linguistic Ontology: It defines the natural language or grammatical concepts to link philosophical ontologies with engineering ontologies.

Based on the literature review, in NETTUNIT we select three ontologies on which we will base our resulting ontology.

The first one is CWA ontology [5], the second one is empathi [6] and the third one is polarisco ontology [7].

5.3. CWA Ontology

Events are all kinds of spatio-temporal sets that have differentiated beginnings and ends corresponding to real discontinuities. Incidents are a type of event that is considered "undesirable". The CEN Workshop Agreement (CWA) "Disaster and Emergency Management - Shared Situational Awareness. It provides an example of a taxonomy of adverse events.

Categories specified in the CWA as /EVENT/TYPE/CATEGORY represent types, e.g., Category /FIR/CLA for "Class A" fire. When examining these adverse event taxonomies, it becomes apparent that they differ significantly in their organization and level of detail. While useful for capturing important types of events, the ontological criteria applied to differentiate the types of events are not explicit and they are not associated with the type of resources or actions known to be effective in managing them.

Despite the existence of several proposed ontologies covering events, these ontologies do not provide comprehensive taxonomies or catalogs of adverse events as can be found in taxonomies such as CWA. Furthermore, they do not cover the specifics of connecting these taxonomies to response actions and resources.

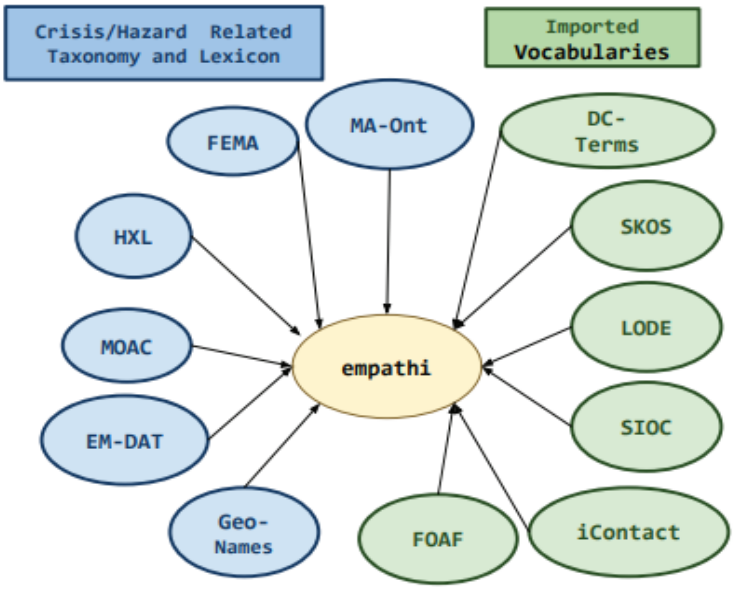

Figure 2: Importing existing ontologies in empathi [6]

5.4. Empathi Ontology

In this section we present an ontology for emergency management and planning for hazard crises (empathi). (Emergency Managing and PlAnning abouT Hazard crIses: empathi).

The ontology will be used in the automatic recognition of disaster concepts mentioned in social network conversations, thus facilitating real-time monitoring by enforcement agencies.

In this section, we list external vocabularies that have partially integrated into empathi. They are not necessarily related to the risk or crisis management domain and reuse generic concepts from well-known vocabularies (e.g., FOAF).

Figure 2 concisely represents an integration to reuse existing vocabularies by following ontology design methodologies (Methodology [8] and NeOn [9]) or by linking empathi to other vocabularies that improve its visibility.

empathi contains 423 classes and 338 relations. In Figure 3, concepts linked to the "Affected Population" via solid lines, form structural concepts ("is-a"/"sub-class"), while concepts linked via a colored dotted line are concepts semantically linked to the "Affected Population". Furthermore, the concept "iContactThing" is taken from the iContact vocabulary presented in Figure 3.

5.5. Polarisco Ontology

The so-called POLARISCO (POLARISC Ontology) aims to semantically capture the knowledge of ERs (Emergency Responders) involved in the disaster response process.

POLARISCO is a constructed domain ontology whose objective is to present the best possible definition of stakeholders' technical vocabularies and to make them understandable, accessible and analyzable by computer. It is developed to establish a shared conceptualization that defines

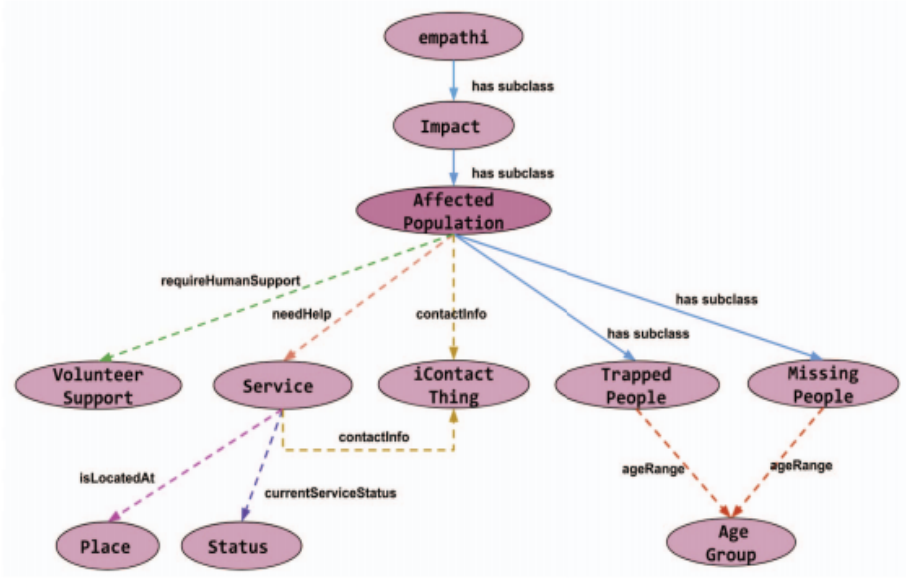

Figure 3: Partial representation of the concept Affected Population in empathi [6]

the classes and their relationships that will be exploited later to promote semantic interoperability between different stakeholders. Specifically, POLARISCO defines knowledge about the data, services, processes, and activities of stakeholders at different levels of disaster response with a greater focus on the operational level.

POLARISCO uses Competency Questions (CQ). The CQs consist of a set of questions stated in natural language, targeting the main elements of the ontology, which the latter must be able to answer [10]. They must cover all the necessary information mentioned in the Domain Knowledge that the ontology must cover.

To do this, we first explore domain knowledge by referring to domain experts (see Figure 4). In particular, POLARISCO considers:

- Different types of disasters, necessary resources and corresponding acts.
- Disasters are events that occur in specific time and space regions. Therefore, POLARISCO also represents the times and places where disasters occur.
- That each RE has its own response process, means, roles, chain of command, etc.
- That each type of RE has its own vocabulary, including: firefighters, police, gendarmerie, health care units and public authorities.
- That each stakeholder has a mastered vocabulary for victim states.

5.6. NETTUNIT Ontology

In this project, we combine the three ontologies presented in the previous section in order to generate a domain ontology for emergency response.

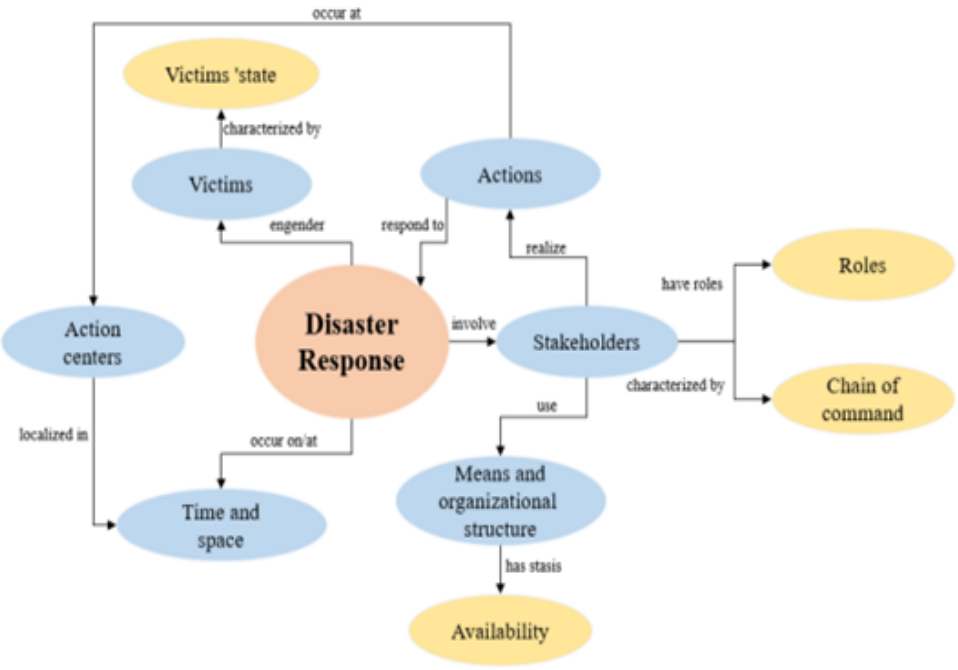

Figure 4: POLARISCO Domain Knowledge [7]

The combination of ontologies is made using CreaDO methodology proposed in [11]. In fact, CreaDO describes a methodology for building domain ontologies that contain only knowledge relevant to a specific goal. The methodology receives as input (a) a set of ontologies called source ontologies (they are obtained from the analysis of single documents), and (b) a merge parameter which is a concept about the domain of the source ontologies. As an output, the methodology provides a domain ontology that represents all the knowledge of the source ontologies related to the fusion parameter. Currently, the methodology only works with knowledge represented in English.

The methodology uses techniques related to ontology reuse, such as ontology fusion and ontology modularization techniques.

- Ontology fusion techniques are used to join the consensus knowledge represented in the source ontologies. However, since the ontologies used were probably built by different people and/or software systems, several problems may be encountered, e.g., the use of different named models, different taxonomies or even poorly designed and structured ontologies. To solve this specific problem, the methodology includes an ontology revision method. This method analyzes the source ontologies with the aim of identifying structural and functional errors and extending the ontology elements with lexical information. It is important to mention that ontology merging must find coincidences between ontologies.
- Ontology modularization techniques are used in this research to reduce the complexity of the merged ontology in order to represent only information of interest to the ontology. To do this, the merge parameter is used to extract ontology modules from each source

ontology. The method used for ontology modularization is an extension of the Doran algorithm presented in [12].

The domain ontology is created by joining the ontology modules extracted by ontology modularization using the subset of mappings selected on the filter mappings. Once the domain ontology is created, a method is applied to evaluate the inconsistencies of the domain ontology and its features.

6. Conclusion

In this paper, we presented a description of NETTUNIT project and its main objective, which is to strengthen the cooperation between Tunisia and Italy in the confrontation of risks and disasters. We also detail the emergency management process composed of four phases: Mitigation, Preparedness, Response and Recovery. This project mainly focuses on preparedness and response phases. Moreover, this paper depicts the essential modeling languages used to model emergency procedures, which are BPMN, CMMN and DMN. Finally, this paper explains the domain ontology of NETTUNIT, which is the combinaition of CWA, Empathi and polarisco ontologies using the CreaDo methodology for ontology combination.

As perspectives, we plan to apply all the components of NETTUNIT on three real use cases: fire in a coastal oil refinery, diffusion of toxic substances into the atmosphere and spillage into the sea. In addition, we plan to integrate temporal constraints on the business process model in order to respond at time and to improve thus the effectiveness of the emergency response in case of detected disasters.

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