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A Mixed Interaction Platform for Supporting Large-Scale Crisis Storytelling

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Abstract. Crowdsourcing is a distributed approach in which people participate and share information over the Web (e.g. Facebook or Twitter). This distributed model has proved to be helpful in accelerating the perception of what occurred, where it happened, and who needed help in recent disasters such as the Boston Marathon bombs, the Oklahoma tornado or the Central Europe floods. Nevertheless, this kind of sources might provide unreliable, partial, ambiguous and inconsistent information that do not necessarily help to understand the situation. An alternative may be the combination of crowdsourcing activities and more official flows of information to make up a coherent big picture that support the needs of decision makers. This paper introduces a software approach conceived to convey stories created from different sources –official and unofficial- as a way of depicting situations in a collaborative manner.

Keywords: Storytelling, crowdsourcing, formal and informal channels, commonsense knowledge, crisis informatics

1 Introduction

Storytelling has been popularized as a suitable tool to collect views and opinions within complex organizations to share knowledge, avoid misinterpretations, and engage response to multi-layered situations [6,9]. Storytelling approaches have recently been surfaced as useful mechanisms to cope with crisis situations. Crisis situations are characterized by the sequence of critical events, the accomplishment of vital decisions, the participation of heterogeneous groups of people –both professionals and non-professionals- and the existence of numerous social interactions. Under these circumstances, storytelling may help to share tacit knowledge related to crisis situations and to support a multidimensional understanding of disasters enriched by the perceptions that different people have from the way events develop and affect them [13].

Storytelling tools allow individuals to provide and consume information about disasters [10,14], facilitating both the exchange of information among them and the understanding of crisis situations. Storytelling has been frequently used in preparedness [15,20] to analyze complex scenarios as well as to enhance planning, training, evaluation, and improvement of activities. In preparedness scenarios, either

practitioners or professionals usually create stories in order to explain their actions, practices, or procedures as a way of both interpreting and reviewing them. Similarly, storytelling eases the sharing and reification of knowledge in emergency response. During crisis situations a huge amount of data are generated from heterogeneous sources, both formal and informal channels of information. By formal or official channel we mean taken from an authorized source of information, such as police or firefighters; while by informal we mean crowdsourcing information provided by people in general using social media platforms. Regardless of its source, most of the data generated during a crisis event are unstructured and irregular so that understanding the situation to take efficient action is not easy. In this context, storytelling may help to build a whole picture about a crisis [2] that could help to better review and take more informed decisions in further situations.

Nevertheless, storytelling software tools applied in emergency response have so far mainly focused on supporting back-channel communications [12]. This approach, although useful, presents significant shortcomings. First of all, back channels are potential mechanisms to scatter misinformation, rumors, speculations or unreliable information. Secondly, crowdsourcing activities tend to provide partial information in the sense of being biased –emotional participation- and incomplete –intermittent participation. Finally, storytelling is the transmission of events by using different formats, such as text, images, sounds, etc. When these elements are edited from a large collection of media it is not easy to establish relationships among them and build a coherent story related to a specific event that helps to understand how it is evolving. All these drawbacks reduce the effectiveness of storytelling and may even invalidate its potential advantages to deal with crisis situations. An alternative to existing storytelling approaches would be the combination of official and unofficial sources of information as a way of depicting crisis situations. Such an approach would take advantages of crowdsourcing as long as guaranteeing the fidelity, continuity, and impartiality of the information. However, such a solution will easily derive on information overload if we do not provide mechanisms to automate part of the information processing tasks.

This paper presents a software platform conceived to apply storytelling to support planners and responders to understand the situation and its evolution. This platform allows building an overall picture of a developing crisis by using data collected from both formal and informal sources of information. In order to ease the creation of coherent conveying, different IA techniques have been applied. The rest of the paper is organized as follows. The background of our approach is described in the next section. Section three is focused on describing the real scenario that motivated our work. The explanation of our tool is carried out in section four. Section five compares our platform against other storytelling approaches. Finally, conclusions and recommendations for further work, as well as ongoing activities, are explained in the last section.

2 Background

This section describes the main subjects that drove our approach: storytelling, cultures of participation, and commonsense knowledge. Storytelling, as aforementioned, refers to the narrative account of events. Since storytelling reduces the gap between expectations and unfolding of events [4] it can be conceived of as a way of making sense in practice. The implementation of storytelling as a communal effort becomes this activity as an implementation of the cultures of participation approach. Finally, commonsense knowledge is devoted to combine user control and artificial intelligent mechanisms to solve 'wicked problems'.

2.1 Storytelling

Storytelling is defined as the "art of conveying events in words, images, and sounds, or the combination of all of them, often by improvisation or embellishment" [1]. Storytelling is a traditional mechanism to communicate ideas, as well as one of the most powerful creative methods [5]. Stories are a natural method –with which we are familiarized since our early childhood- of thinking about possibilities, understanding abstract concepts, helping people remember, and sharing knowledge and experiences. It is therefore a suitable mechanism to achieve the reification of knowledge and acquire awareness about complex situations. Thanks to these characteristics, storytelling has been used in different domains; from supervising procedures [15] to designing interactive systems [16].

A story has a beginning, middle, and an end –typically, though not necessarily, in that order- and it usually suggests a time and a place. Stories not only describe a sequence of events, but they also provide insight into the reasons and motivations for those events [16]. A sequence of events is essential to elaborate a story -without that sequence, there is not a narration- but just a sequence of events is not enough to have a story. A story requires a context as well as the explanation of emotional attitudes, behaviors, goals or motivations. On the other hand, stories cannot include every single detail or motivation. This means that stories must be interpreted and completed by the audience.

Traditionally, a story has been told by one person or by a creative team to an audience that was usually quiet. However, nowadays with digital media and social networks, this model is changing, becoming a distributive model that yields a series of synergistic effects, including conversations that occur across multiple site and with multiple relationships. The growing signification of mass collaboration [19] and the appearance of new technologies –such as AJAX (Asynchronous JavaScript and XML) and RIA (Rich Interaction Application)- that support this tendency in the web context have led to the profusion of storytelling software platforms. These tools allow the audience to add content into story in a straightforward manner by using different methods: editing narrative, commenting posts, submitting videos or pictures, tweeting, etc. In such a way, emergency planning will be an implementation of the 'cultures of participation' approach [7].

2.2 Cultures of Participation

'Cultures of participation' are grounded in the basic assumption that providing all people with the means to participate and to actively contribute in personally meaningful problems will allow addressing complex systemic problems. The underlying idea of cultures of participation is that groups of individuals can develop better solutions because their collective knowledge is greater than that of a single person [3]. The aggregation of experiences, the sum of resources –actual or virtual-, and the creation of synergies allow these groups to make better decisions, to ideate better solutions, and to develop better products. As Fischer [7] points out, "much human creativity arises from activities that take place in a social context in with interaction with other people and the artifacts that embody collective knowledge are important contributors to the process".

Three main characteristics determine the application of cultures of participation [7]: (1) the active participation of people in personally meaningfully problems, (2) the existence of rich ecologies of participants, and (3) the need of an evolutionary design process. The first one of these aspects refers to the existence of a group of individuals willing to externalize their ideas, to interact with others, and to ideate new solutions to common problems. In cultures of participation, all participants must have opportunities to contribute when they want to, but not every participant must contribute and not all of them will contribute in the same way [21]. Thus, a significant aspect of a culture of participation is the existence of rich ecologies of participation. Individual people have different motivations for doing things, and those motivations create different levels of participation and engagement.

The additional defining characteristic of culture of participation is the need of supporting evolutionary design processes [8]. The significance of applying cultures of participation in ideation process resides on the assumption that future uses and problems cannot be completely anticipated at design-time, when an artifact is developed [7]. During the usage of the artifact, at use-time, users can identify mismatches or realize new requirements to fulfill their needs and objectives. Exposing artifacts to public scrutiny is important for obtaining an extensive coverage of reliable information and designing artifacts best suited to the needs of a community. Supporting this approach to design requires evolutionary process models supporting the progressive evolution of the artifact.

2.3. Commonsense Knowledge

'Commonsense knowledge' is the collection of facts and evidences that an ordinary person is expected to know about a specific issue [17]. This information is represented in a structured way and collected in a persistent artifact known as commonsense knowledge base. A commonsense knowledge base is a database containing all the general knowledge that most people possess about a set of general issues. An example of a commonsense knowledge base is the 'Open Mind Common Sense' [17], it is a huge online database of common sense knowledge extracted from a wide variety of subject contributing to it. The system is growing every day because its users are both knowledge researchers and knowledge creators. In particular, up to

now 1032652 knowledge statements in English language have been included in such database.

However, commonsense knowledge is often inaccurate and incongruent and can generate a huge data set of knowledge. For this reason, and more important, for extracting patterns and story similarities, techniques such as the 'AnalogySpace' technique [18] must be employed. Applying this technique it is possible to perform reasoning within a large data set of knowledge expressed in natural language. In particular, 'AnalogySpace' is able to accomplish different goals:

— Generalize from sparsely collected knowledge. Starting from a knowledge base it is possible to generalize concepts and consequently achieve dimensionality reduction.
— Classify information in a knowledge base. For instance, 'AnalogySpace' is able to distinguish things that people want from things that people do not want.
— Create categories and provide justifications for why things belong to those categories. Starting from objects such as flood, wildfire, and earthquake it is possible to create a category, "kind of crisis situations", that includes all of them
— Confirm or question existing knowledge. 'AnalogySpace' determines which assertions have a good grade of reliability or which assertions are dubious.

The join of all these goals allows combining the information collected from different sources of information as a way of generating a consistent narration.

3 Case Study

REMER (from the Spanish term 'Red Radio de Emergencias', translated as 'Emergency Radio Network') is a national emergency organization sponsored by the Government of Spain. REMER is composed of radio amateurs who altruistically collaborate with the official Spanish emergency agency (Department of Civil Defense and Protection, DGPCE) to assist in crisis situations. The members of REMER provide information about a developing crisis to facilitate the understanding of such situations by emergency decision-makers. As a consequence, the operational workspace supported by REMER must be conceived of as a distributed-collaborative emergency-response environment. The following subsections extend in the description of REMER, present a real crisis situation in which REMER had a fundamental participation, and frame the problem related to the combination of formal and informal flows of information.

3.1 The context

REMER is an emergency community of practice conceived to assist in crisis situations. Although their members are volunteers, they are considered as permanent collaborators whose activity will be determined by governmental authorities. From an administrative perspective, REMER is centrally regulated by the DGPCE; however, from an operational point of view, its members are coordinated by regional Control

Centers according to a distributed geographical model. Specifically, REMER is structured as follows:

— Central Control Center. It is a control center supported by the DGPCE to monitor emergency situations throughout the country.

— Regional Control Center. There are 52 regional control centers, one for each of the Spanish provinces. These operational coordination rooms are in charge of controlling and commanding crisis situations occurring inside their region.

— Area Control Room. Depending on geographical and demographic characteristics, a province will have different control rooms to coordinate responders in a specific area.

— Mobile Control Room. No-permanent control points deployed to provide either communication services or emergency resources to isolated areas. The corresponding Regional Control Room manages their activities.

Consequently, in keeping with this hierarchical structure, Regional Control Rooms are the essential infrastructure to manage REMER. In particular, for each Regional Control Room, there is an 'Operative Coordinator' (OpeC) who is responsible of monitoring crisis situations, analyzing them, and making response decisions. In order to achieve a better understanding of the crisis situations, the OpeC receives information from the members of REMER located in the region.

3.2 The Genil River floods

The Genil river floods occurred at the beginning of December of 2011, mostly affecting Ecija, a forty-thousand-population city in Seville province. Due to the intensive and unexpected rains, the Genil River dramatically increased its flows; as a consequence, around 800 homes were flooded and more than 3,000 thousand people had to be evacuated. The weather alert lasted three days and the river did not reestablish its normal flow until a week later. This real crisis situation shows us how official and unofficial flows of information provide different but complement perspective of a developing crisis situation.

From the emergency management point of view, the crisis started on December 5th at midday. The Spanish national weather service ('Agencia Estatal de Meteorología', AEMET) gave a weather alert for the 'Sierra Nevada' area, where the Genil River originates. At this moment, an orange-level alert was activated by the emergency response services. The OpeCs of the four Spanish provinces affected by a possible flood of the Genil River sent warnings to the members of REMER of these four provinces. On December 6th, at 19:00h, a very heavy storm started over Ecija. This fact was communicated to the OpeC of Seville not by the AEMET but by the members of REMER located around Ecija; as a result, a red-level alert was activated and the evacuation of the population was carried out. The heavy storm rain went on throughout the night, increasing the flows of the Genil River very fast and causing it to overflow. On December 7th, at 7:30h, the Genil River reached a historical depth of 7.5 meters in Ecija, more than four times its normal depth, flooding around thirty per cent of the city. Rain finished on December 7th in the morning but an orange-level

alert remained active for an additional day. During this period, the REMER community was used as the main source of information to track weather forecast. Additionally, with the purpose of controlling impacts from the flooding of the river, first response services were deployed in Ecija. These services were in charge of both the evacuation of the population and watching the evolution of the situation.

Simultaneously, the population of Ecija started crowdsourcing about the developing situation, providing textual and graphical information. This kind of informal information could have helped emergency services to have a large picture of the situation; not only about the evacuation in Ecija or the weather forecast, but also about the flooding across the area and its consequences: which area were more affected, who needed helped, which kind of damages were produced. In this context, informal channels would have been a very useful way of getting additional information about specific events that, in other case, were not acknowledged or were collected long after. Thanks to this information, emergency organizations can review the reponse, analyzing their procedures and decisions to improve further actions. Unfortunately, OpeCs did not have appropriate tools that allow them to collect informal information and combine with formal flows of information in order to have a better understanding of situations.

4 Collaborative Approach for Depicting Crisis Situations

'EmergencyRewinds' (ERewinds) is a distributed collaborative platform aimed at facing the official-unofficial-channel emergency-information integration problem. ERewinds is a web application based on applying common-sense knowledge approaches to assist in the creation of stories. This software tool is able to merge different information extraction mechanisms within structured sources of information -emergency management information systems- and public sources of information -i.e. social networks- as a way of helping decision-makers for creating digital stories of crisis situations. Since the information collected by social tools is usually tagged, captioned or labeled by short descriptions, without included coherent and well-phrased explanations, the usage of common-sense knowledge was considered as the most appropiate mechanism to analyze and combine the different pieces of information. The system employs a process made of five steps: input, extraction, matching, creation, and editing. At the end of the process, a user will be able to create an accurate and structured description of a story by combining both media and textual elements. The following subsections will explain these five steps.

4.1 Input

The first phase consists of prompting the user with three different input possibilities: textual information, media data, and the user himself/herself. The two first data inputs are necessary to perform an accurate search for information extraction from five different channels: one official flow of information (REMERWeb) and four unofficial ones. Fig 1 shows the process of submitting one of these input channels into the

system. As far as REMERWeb is concerned, it provides textual and graphical information about a crisis situation structured as a chronology report. Regarding unofficial sources of information, Facebook and Twitter from which will be extracted textual information, in particular public status for Facebook and public tweets for Twitter. Flickr and YouTube from which the system takes media elements -pictures and videos. Finally, the system requires the users to describe a story goal in natural language. This last input is based on applying human competencies to interpret and evaluate soft knowledge. In addition, a 'user's story goal' must be defined in order to identify and extract the relevant information.

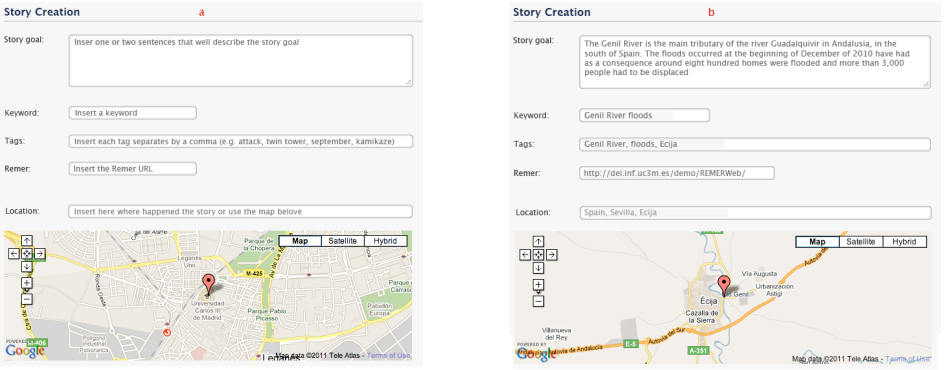

Fig. 1. ERewinds interface: inputs. (a) The interface; (b) example of inputs.

4.2 Information Extraction

Once the input channels have been submitted, the system extracts information from two different sources of information: commonsense knowledge bases and the input channels themselves. As aforementioned, ERewinds is based on mining facts and evidences from 'Open Mind Common Sense'. This database returns evidences in tabular form and stores additional information such as author, ranking, and other associate concepts. Fig. 2 shows the information stored in 'Open Mind Common Sense' for the keyword 'flood'.

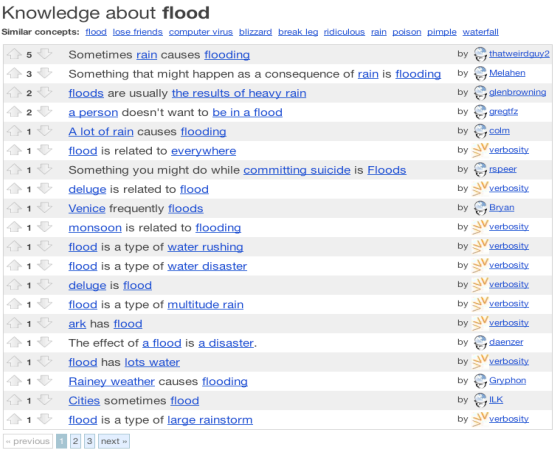

Fig. 2. 'Open Mind Common Sense' UI: resulting knowledge for the keyword 'flood'.

Regarding the input channels, Table 1 represents the different information extraction mechanisms that ERewinds is able to perform considering the input type provided by the user and the characteristics of the sources. Tag, defined as a label attached to contents for the purpose of identification or to give other information, are not available in REMERWeb; however, social tools such as Facebook, Twitter, Flickr, and YouTube provide to users the possibility to set some tags when they create/upload materials. A keyword search is provided for each source, in particular objects for which search is available are the following:

— Facebook: status information;

— Twitter: tweets (messages contents);

— Flickr: title and description of pictures;

— YouTube: title and description of videos;

— REMERWeb: status information, message contents, location and description of the graphical resources.

Furthermore, Flickr allows image uploading from mobile applications. In this case the user is able, during the uploading process to inform the application on his/her personal location (GPS latitude and longitude). Hence, ERewinds tries to refine the Flickr materials by providing also a spatial filter. However, this second filter on Flickr materials is available only if the user gives to the system the location input.

Table 1. Information extraction mechanisms.

Sources	Tags	Keywords	Location
REMERWeb	No	Yes	Yes
Facebook	Yes	Yes	Yes
Twitter	Yes	Yes	Yes
Flickr	Yes	Yes	Yes
YouTube	Yes	Yes	Yes

4.3 Matching

ERewinds exploits 'Open mind Common Sense' for the knowledge base acquisition (Fig. 3a) and then applies 'AnalogySpace' technique to extract story patterns and similarities among knowledge facts (Fig. 3b). The application of the 'AnalogySpace' technique relies on the definition of a semantic network that represents the main concepts collected in the 'Open mind Common Sense' as well as the relationships among them. This semantic network is created by a commonsense knowledge reasoning toolkit known as ConceptNet [11].

ERewinds starts from the 'user's story goal', gained by the system in the input step, and the knowledge base generated by 'Open mind Common Sense' to create a semantic network by using ConceptNet. Once the semantic network has been created, it is applied the 'AnalogySpace' technique in order to define a features vector for each concept in the semantic network. By merging these vectors, the system creates a matrix whose rows are concepts and columns are features. From the matrix, it is possible to calculate the similarities degree among concepts and categorize them in different subset each representing a specific feature's category.

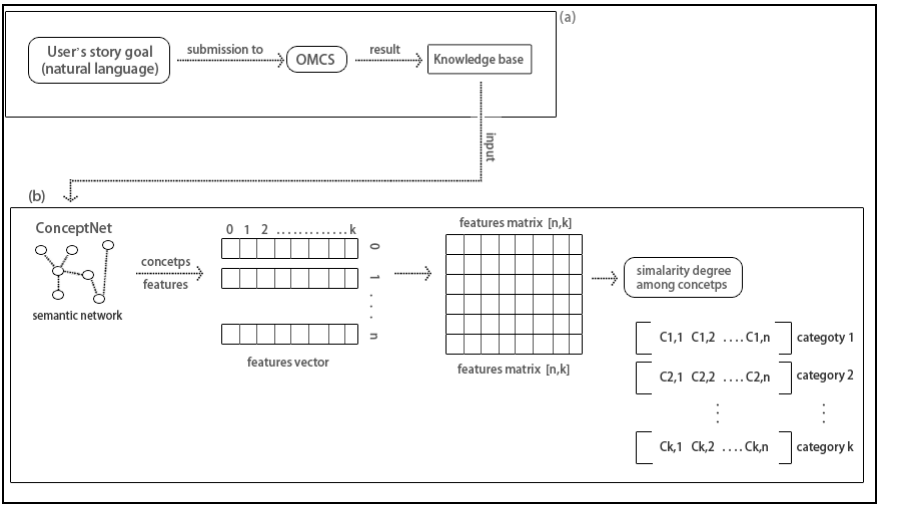

Fig. 3. (a) exploiting 'Open Mind Common Sense' (OMCS) for the knowledge base acquisition; (b) applying 'AnalogySpace' technique to gain similarity concepts and categories

For example for the story goal: "The floods occurred at the beginning of December of 2011 have had as a consequence around 800 homes were flooded and more than 3,000 people had to be evacuated", the system is able to extract four patterns and associate textual elements to corresponding patterns (Table 2).

Table 2. Textual elements categorized within the corresponding patterns.

Context (CX)

• Flood is a type of water disaster. (CX1) • Floods are natural events. (CX2)
Cause (C)
• Floods are usually the results of heavy rain. (C1) • The type of land that is prone to flooding is broad and flat usually situated on the banks of a river or main waterway. (C2)
Action (AC)
• Buildings may prove no obstacle to its power. (AC1) • During a flood the land is covered with water causing catastrophic damages even death (AC2)
Results (R)
• The effect of a flood is a disaster. (R1) • When a flood occurs the evacuation of the population located close to the flood is a common practice. (R2)

ERewind performs the knowledge extraction from 'Open Mind Common Sense' not only for the user's story goal but also for the narrative information extracted from REMERWeb, Facebook, and Twitter. 'AnalogySpace' is also applied within these sources and, as in the previous step, ERewind is able to find similarities among concepts and associates these concepts to the belong pattern. Regarding Flickr and YouTube contents, they will are manually added to the story, because these materials do not have enough textual information available for adopt the 'AnalogySpace' technique. This process is a concrete implementation of mixed-interaction initiatives; on the one hand, the system uses commonsense knowledge mechanisms to extract, combine, and organize information; on the other hand, humans have to analyze such information and complement it with additional knowledge collected from specific inputs.

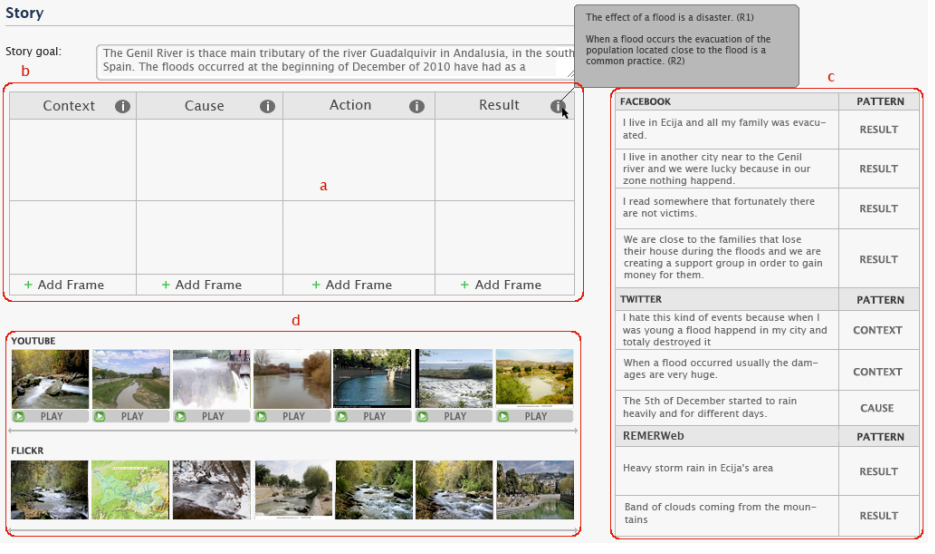

Fig. 4. ERewinds interfaces: (a) empty multidimensional storyboard; (b) pre-formatted storyboard template; (c) social network narrative information; (d) social network media elements

4.4 Creation and Editing

Exploiting commonsense knowledge and the 'AnalogySpace' technique, ERewinds provides to user an empty multidimensional storyboard (Fig. 4a) and a pre-formatted storyboard template (Fig. 4b) that crosses all the story patterns extracted (Fig. 4c) and helps him/her to create a meaningful story. In particular the user is able with a simple "drag and drop" action to fill the storyboard empty frames with both media and narrative (Fig. 4d); these latest are already categorized by the belonging pattern having found and used the similarity's degree through the 'AnalogySpace' technique. The last step in the story creation process is the editing phase. In this phase, the user is able to accomplish adjustment of the story. In particular, ERewinds allows the user to add personal narrative elements when the input information was lacking or inaccurate. Fig. 5 shows a final storyboard built by the user.

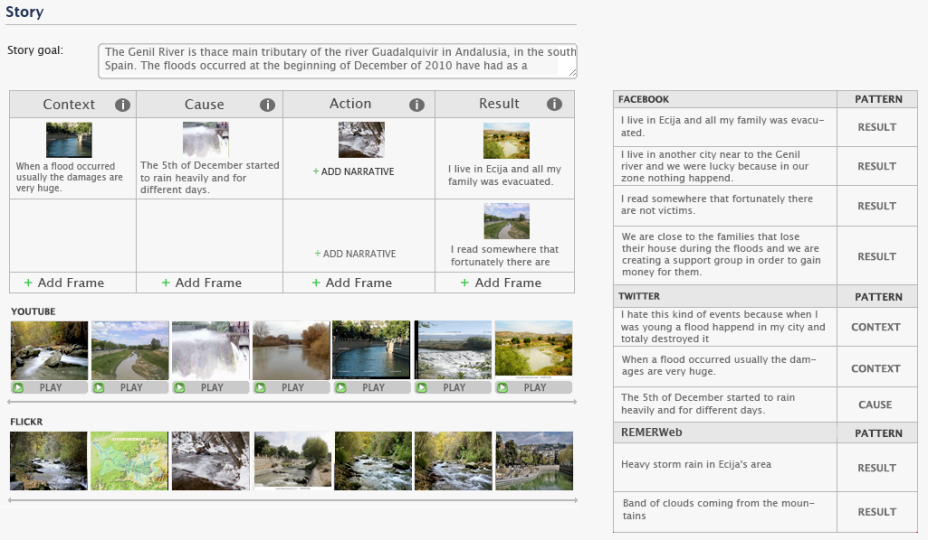

Fig. 5. Storyboard built by the user

5. Conclusions

Building an accurate big picture about a crisis situation is an essential activity to review the performance and provide an adequate response to further situations. Being aware of the situation, inquiring the characteristics of the current state, and predicting future states taking into account the ocurred situation result in a better understanding of the crisis situation, what might imply to learn lessons and make better decisions on how to react. Unfortunately, crisis situation are characterized by the generation of huge amounts of data from heterogeneous sources, including both formal and informal channels of information. In this context, storytelling may be considered as a

suitable tool to collect views, share knowledge, avoid misinterpretations, and engage response to multi-layered situations. To elaborate richer and multidimensional stories of a crisis situation, formal channels –that is, information provided by responders, practitioners, and official volunteers- as well as informal channels –that is, information provided by citizens- have to be combined. However, elaborating such stories requires specific software tools that, on the one hand, automate the management and organization of information and, on the other hand, allow human users to interpret, evaluate, and edit the information so it can be presented to decision makers. 'EmergencyRewinds' (ERewinds) has been designed keeping with this rationale.

ERewinds is a distributed collaborative platform aimed at facing the official-unofficial-channel emergency-information integration problem. ERewinds relies on 'common sense knowledge' and 'the 'AnalogySpace' techniques to perform reasoning within a large data set of knowledge expressed in natural language. Thanks to these artificial intelligent mechanisms, ERewinds can extract data from different sources of information, combine such data, and provide users a pre-formatted storyboard template that crosses all the extracted story patterns. These features make it easier processing information from heterogeneous sources, allowing the combination of official and unofficial flows of information.

ERewind constitutes a proof of concept that the official information collected from practitioners and responders can be contrasted and refined with the official information coming from social networks. Our next steps are oriented towards evaluating the expressiveness of the narrative dimension of the tool by using it within the REMER community, whose communication needs led to the development of ERewind. More specifically, we will delve into the potentials of offering more complex narratives to be used in exploratory phases like recovery, where emergency managers might be more interested on analyzing past events from social perspectives (economical, social, cultural, etc.) to make right decisions.

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