

SOCIAL MEDIA BASED EMERGENCY DECISION SUPPORT SYSTEM

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Abstract

One of the most challenging parts in disaster and emergency management is the inclusion of citizens through social media. The key issue is the trustworthiness of the information posted by citizens and how to efficiently integrate them into the emergency operations. Apparently, the communication has to be two-way, from civil protection service to citizens and vice versa, fostering citizens to be as responsible as possible when tweet about emergency situations. This paper brings the idea which is being developed within Interreg project E-CITIJENS where citizens will be directly involved in awareness raising activities and in virtual communities on risk management. The proposed decision support system aims at enhancing the capacity of Italian and Croatian Civil Protection systems to reduce natural and man-made risks by means of advanced “social media based” emergency management tools. The solution in the project will still rely on human judgment and gathered posts from social media will be checked by emergency operators. The valid tweets will be used by commanders during the decision-making operations.

Keywords: emergency, disaster management, social media, citizens

Introduction

The use of social media in emergency management is ever challenging topic from the first appearance of such platforms in early 2000s. By introduction of smartphones it became even more actual since every citizen with smartphone can be considered as a sensor quickly posting information about an emergency situation with exact location and time. The Haiti earthquake (2010) was the real breakthrough moment when humanitarian organisations used social media for sharing information with affected population.

Reviewing the current global situation it can be seen that entities, which use social media as an integral tool for disaster and emergency management, are:

- emergency responders,
- governments, and
- non-governmental organizations.

The communication usually goes both ways from citizens to institutions and organisations as well as from institutions and organisations to citizens. The Figure 1a shows Twitter communication from Lincolnshire Police to citizens during the recent flooding (UK, June, 2019) about evacuation on certain areas asking citizens to check whether they have to evacuate or not. Conversely, the Figure 1b shows Twitter post during the same emergency where a resident informs authorities about sand bags’ malfunctioning in this particular case, which is very useful information to be considered.

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Figure 1: An example of communication from emergency service to citizens (a) and information sent by a citizen to emergency authorities (b) (Source: Twitter)

In the global and trendy world where technology evolves on a daily basis the key question might be about the best social media platform to follow during emergencies and disasters. At the moment it appears that the most popular social media platforms are:

- Facebook,
- Twitter, and
- Instagram (the mostly used by young population).

Analysing the current situation in emergency management, the most commonly used is Twitter, followed by Facebook. Twitter, which is the most suitable for disasters and emergencies has some features that makes it most convenient in such cases, such as:

- real-time information exchange,
- hashtags effectively support finding and following tweets,
- limited number of characters, i.e. 140-character messages, and
- one-to-many information exchange.

Eventual problems during communication could create abbreviations used during tweeting due to limited number of characters. Figure 2 shows data related to Twitter usage during major World’s crises between 2013 and 2015 (Muhammad et al, 2016). It is obvious that English language is mostly used for communication regardless the country where crisis occurred and war & conflict crisis is the most tweeted one.

Crisis type	Crisis name	Country	Language	# of Tweets	Start-date	End-date
Earthquake	Nepal Earthquake	Nepal	English	4,223,937	2015-04-25	2015-05-19
Earthquake	Terremoto Chile	Chile	Spanish	842,209	2014-04-02	2014-04-10
Earthquake	Chile Earthquake	Chile	English	368,630	2014-04-02	2014-04-17
Earthquake	California Earthquake	USA	English	254,525	2014-08-24	2014-08-30
Earthquake	Pakistan Earthquake	Pakistan	English	156,905	2013-09-25	2013-10-10
Typhoon	Cyclone PAM	Vanuatu	English	490,402	2015-03-11	2015-03-29
Typhoon	Typhoon Hagupit	Philippines	English	625,976	2014-12-03	2014-12-16
Typhoon	Hurricane Odile	Mexico	English	62,058	2014-09-15	2014-09-28
Volcano	Iceland Volcano	Iceland	English	83,470	2014-08-25	2014-09-01
Landslide	Landslides worldwide	Worldwide	English	382,626	2014-03-12	2015-05-28
Landslide	Landslides worldwide	Worldwide	French	17,329	2015-03-12	2015-06-23
Landslide	Landslides worldwide	Worldwide	Spanish	75,244	2015-03-12	2015-06-23
Floods	Pakistan Floods	Pakistan	English	1,236,610	2014-09-07	2014-09-22
Floods	India Floods	India	English	5,259,681	2014-08-10	2014-09-03
War & conflict	Palestine Conflict	Palestine	English	27,770,276	2014-07-12	2014-10-02
War & conflict	Peshawar Attack Pakistan	Pakistan	English	1,135,655	2014-12-16	2014-12-28
Biological	Middle East Respiratory Syndrome	Worldwide	English	215,370	2014-04-27	2014-07-14
Infectious disease	Ebola virus outbreak	Worldwide	English	5,107,139	2014-08-02	2014-10-27
Airline accident	Malaysia Airlines flight MH370	Malaysia	English	4,507,157	2014-03-11	2014-07-12

Figure 2: Data related to Twitter usage during major crises (Muhammad et al, 2016)

Another logical question is about when the use of social media will be the most useful, in which phase of the disaster & emergency cycle? Figure 3 shows typical phases of the cycle: mitigation, preparedness, response, and relief. However, it could be argued that social media is mostly useful when civil protection services want to send citizens vital information, as well as when citizens need to quickly information services about dangerous situations. Therefore, the most prominent areas of usage are the following:

- early warning system,
- situational awareness during relief operations, and
- relief operations.

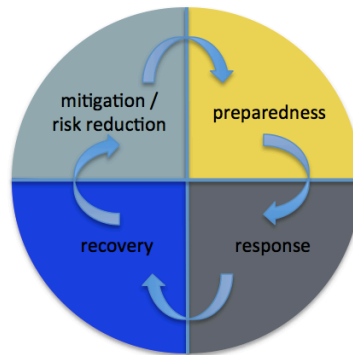


Figure 3: Typical phases of the disaster & emergency cycle

Although social media are great opportunity for improvement of emergency services, there are some issues to be considered. The problems derive from the fact that messages come from outside, i.e. citizens, and if they are not checked and verified they could pose a huge threat in terms of trustworthiness. Problems and challenges can be grouped in the following categories (partially taken from Homeland Security, 2018):

- Incorrect information,
- Inaccurate information,
- Insufficient information,
- Opportunistic disinformation,
- Out-dated information, and
- Useless information.

Incorrect, inaccurate, insufficient and out-dated information categories are quite common and well understood.

Opportunistic disinformation category comes from the situation when people, in order to get attraction, post their information not connected with emergency situation, sometimes malicious, using actual emergency hashtags in Twitter. A specific category is useless information that is posted in bona fide but clogs the communication in a case of emergency. Figure 4 shows the situation when, during the abovementioned flooding in UK, the official hashtag is used to thank the emergency services, which could be considered as useless information.



Figure 4: An example of useless information shared during an emergency situation (Source: Twitter)

An example from Croatia, given by Kević et al, 2018, explains the situation when a message posted on social media brought many citizens to the fire scene and in that way created an uncontrolled situation.

As a conclusion, using social media in disaster & emergency situations is still challenging although citizens' posts provide useful near real-time information for first responders. Moreover, there is always an issue lack of trustworthiness in information coming from social media in spite of constant development of AI algorithms for automatic crawling and search for accurate, useful information on social media.

E-CITIJENS (Civil Protection Emergency DSS based on CITIZen Journalism to ENhance Safety of Adriatic Basin) project attempts to overcome the abovementioned problems and proposes a solution which includes citizens through their social media posts but use it as a valuable information for creation of the comprehensive operational picture of emergency situations in the case of a disaster. The newly establish communication channel will be updated in real time by collecting and using citizens' information voluntarily provided via social media to report hazardous situations and events as well as their progress. Besides research organisations, the project involves Italian and Croatian civil protection organizations and bodies, which will be the crucial actors in creation and implementation of the solution.

Social media based decision support system

As explained in introduction E-CITIJENS project deals with modelling of "social media based" civil protection emergency management system aiming at development of a cross-border model of an emergency management system. The model considers risk scenarios, sensors data, regulatory frameworks, and activation of citizens through social media as emergency active sensor. Figure 5 shows the conceptual model of the system.

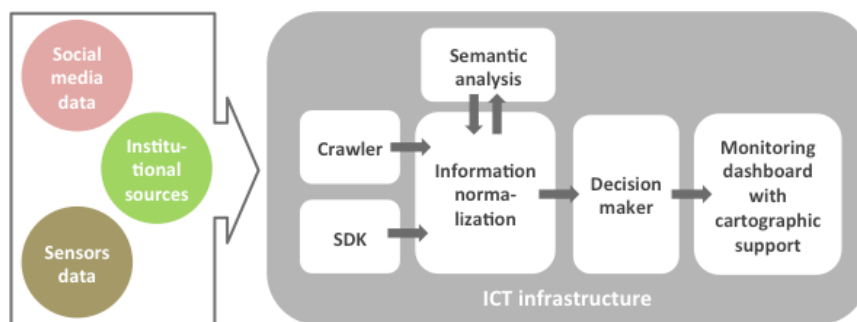


Figure 5: Conceptual model of “social media based” decision support system (adapted from Cardillo, 2019)

The starting point is the survey of current risks scenarios, management legislation and social media and crowdsourcing. Therefore, the three thematic task forces are set up to perform the survey and to report about current situation, best practices, knowledge and experiences from the previous projects and to propose how to use, integrate or harmonize them in a common model. The paper provides the results and potential solutions for the inclusion of social media in decision support system.

The analysis on social media and crowdsourcing covers the following:

- types of information shared on social media according the different crisis or emergency kinds;
- the most suitable and used social platforms;
- examples of Social Media's use during last risk emergencies and adopted by Civil Protection; and
- projects that developed social media and crowdsourcing platforms for emergency management and prevention.

In the following project activities, this analysis serves as a basis for drafting the functional model of "social media based" decision support system, and later on, for hardware and software design.

Methodology

The project the methodology and activities undertaken to carry out the survey on usage social media and crowdsourcing in emergency management and understand the current situation in Italy and Croatia. The objective of the survey is the apprehension of current situation, best practices, knowledge and experiences in using social media in emergency situations. The project involves several Italian and Croatian Adriatic provinces and their civil protections organisations and bodies.

The questionnaire

In order to systematically collect information on usage of social media by civil protection in Italy and Croatia the questionnaire is created. Considering different organisation of civil protection systems in Italy and Croatia, as well as needs for understanding the current situation as a basis for creation decision support platform, the questionnaire covers the following issues:

- types of information shared on social media according the different crisis or emergency kinds;
- the most suitable and used social platforms;
- examples of social media usage during last risk emergencies and adopted by civil protection; and
- projects that developed social media and crowdsourcing platforms for emergency management and prevention.

The abovementioned issues provide enough information for definition of decision support platform's requirements, which have to satisfy both Italian and Croatian civil protection organisations.

Results of the analysis

The main objective of the analysis was to use the questionnaires to understand the gaps and needs of the civil protection services related to the use of social media in emergency situations.

Results of survey for Italy

The questionnaires are filled by regional civil protection organisations in Molise and Veneto, which are partners in the project. The organisations use social media communication primarily for sending information to citizens and other organisations of interest. The information has been typically sent during and after emergency situations. Occasionally, during the recovery phase the communication via

social media is about post-emergency procedures for reimbursement and restoration processes that is quite useful, particularly for citizens.

The Molise Region has activated official social profiles on Facebook and Twitter and published information relates to both institutional communication and communication during emergency events. Likewise, Veneto Region has an official Facebook profile and official Twitter account for institutional communication. However, only the main emergencies are communicated using these channels. Having official social media accounts it is assumed that regional civil protection organisations in Italy have personnel in charge of communication via social media. Apparently Facebook and Twitter are the most used social media platforms and Instagram could only be used if the civil protection organisations have a valid press office with a photographer.

As a conclusion, it could be said that social media is well used for outgoing communication. There are also a number of research and innovation projects (FP7 and H2020) related to the use of social media in emergency management with Italian partners who can share their knowledge and experience with civil protection organisations in Italy. Nevertheless, there is a need for information coming from citizens like alerts, evidence of emergencies or useful information during response phase. This could pose additional work for validation of such information, which could be done by operators in civil protection centres.

Results for Croatia

The questionnaires are filled during the interviews with representatives of civil protection services, as defined in Section 2. In order to better understand services' relationship with citizens, the interviews comprised broader aspect of communication with citizens, not only via social media.

If used in rare cases, social media is deployed to inform citizens about past events and eventual casualties (mainly shared posts from local news portals) and as preparedness information. The analysis per services (fire-fighting, 112, Red Cross, Mountain Rescue Service) revealed different degree of usage social media for prevention and after emergency situations. For example, fire fighters and Mountain Recue Service use social media to inform citizens about fire emergencies after by sharing links to news portals. Mountain Recue Service posts useful information about dangers when going to countryside, particularly during summer season when Dalmatian coast is fully packed with tourist attracted by nearby mountains. 112 service has never thought to use social media so far, because their primary service is oriented to telephone calls and alerting as well as re-directing them to other emergency services.

After thorough analysis, the general conclusion is that the Croatian civil protection services are not used to share information through social media for emergency situations although they believe that this could be a good practice to do. However, there are obstacles, which certainly caused the low use of social media. Namely, three main causes have been encountered:

- Croatian civil protection services are part of Ministry of Interior and using social media is almost impossible due to security reasons,
- they do not have specialised personnel for communication with citizens via social media prior or particularly during emergency situations,
- citizens are not used to send alerts or inform about potential emergency situations using social media since they prefer to call 112 system, which is very well organised in Croatia.

Moreover, it is evident that there is a certain gap between usage of social media for preparedness and after emergency phases, and during response phase including alerts from citizens. In future case of using social media there is also a general concern related to trustworthiness of the citizens' posts.

The concise, main points of the questionnaires' analysis are given in the Table 1.

Table 1: Main points of the questionnaires' analysis

Topic	Italy	Croatia	Common
Types of information shared on social media	Information related to the emergency situation, post-emergency information.	There are not clear conclusions on types of information due to limited use of social media. The assumption is that time and location are the most important ones in a case of emergency.	Information related to the emergency and post-emergency information with accurate time and location.
Most suitable and used social platforms	Facebook and Twitter	If used (in rare cases for other reasons) Facebook is the most used one. There is no clear answer on most suitable one.	Facebook and Twitter
Examples of Social Media used during last risk emergencies and adopted by Civil Protection	Information is shared with citizens during and after the emergency situations.	There are cases when information is shared with citizens after the emergency situations and also for preparedness reasons.	Information is shared with citizens during response and recovery emergency management phases.
Projects that developed social media and crowdsourcing platforms for emergency management and prevention	There are no projects with direct involvement of either Veneto or a Molise region but there are number of R&I projects related to the use of social media in emergency management with other Italian partners.	No projects are identified in relation to developed social media and crowdsourcing platforms for emergency management and prevention.	No projects are identified in relation to developed social media and crowdsourcing platforms for emergency management and prevention where E-CITIJENS partners were actively involved.

Implementation of the survey results

Although all emergency management phases (Figure 3) are worthy to be supported via social media communication, the response phase, including early warning, usually has the priority. Therefore, the solution within this project deals with social media in terms automatic search for social media information posted by citizens and incorporate it in the solution of the decision support platform.

It is also clear from the analysis of the questionnaires that obtaining trustworthy information with accurate time and location should be the goal of the solution. By putting trustworthiness outside the automatic recognition and leave to civil protection operators to decide whether the information received via social media is reliable or not, the final solution will primarily focus on getting potentially relevant information from actual posts on social media. Simpler and feasible solution for automatic search for social media information should include the use of standardised hashtags for emergency & disaster responses and creating keywords for automatic search for valid social media messages. Figure 6 shows an example of suggestions to Twitter users to use standard hashtags during Ebola outbreak in West Africa, so everyone will be on the same messages' threads.



Figure 6: Standard hashtags during Ebola outbreak in West Africa (OCHA, 2014)

Considering the abovementioned the project will go for the following solution:

- definition of semantics that should be taken into consideration for inclusion of social media into decision support platform;
- analysis of data and the communication structure of Facebook, Twitter and Instagram (for a potential future use);
- definition of a structure of the basic thesaurus, which will be used for automatic search in the decision support platform.

Bearing in mind the analysed situation the architecture of the “social media based” decision support system should:

- provide social network emergency miners that will use available software development kits (web APIs) or crawlers to collect and storage non structured data from social networks;
- semantic analysis engine to streamline and normalize heterogeneous data collected from social networks to individuate, extract and classify information relevant for the emergency situations using developed thesaurus;
- decision maker engine that evaluates gathered information against set of defined criteria and alerts in the case defined thresholds are exceeded, which may indicate a critical situation;
- “GIS mapping” engine to monitor the situation, specifying for example, typology, alert level or affected areas by the emergency event and scheduling the search of social networks, providing start date/time, radius of the area in which the citizens' posts has to be located to be relevant for the analysis, any keywords / hashtags to be taken into consideration when extracting data from social media, showing on the maps geo-referenced posts used for the analysis and classification of the emergency events and their evolvment over time.

The envisaged infrastructure requirements for the implementation is shown on Figure 7. The main components are: batch layer, speed layer for near-real time processing and service layer with real-time batch views.

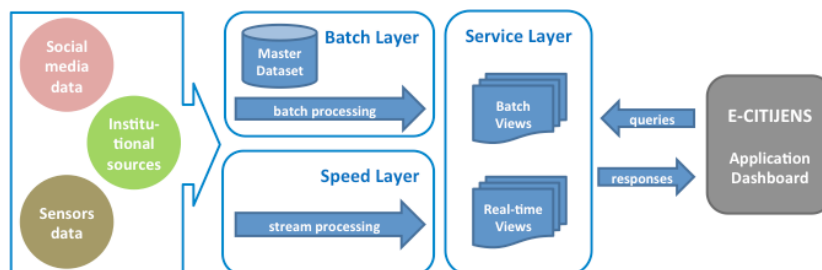


Figure 7 Decision support system’s infrastructure requirements (adapted from Cardillo, 2019)

Conclusion

Apparently, the use of social media in Italy-Croatia Adriatic regions are in a development phase, being more underused and overlooked in Croatian regions than in Italian ones. Considering the fact that the communication via social media has to be bi-directional, namely from civil protection to and from citizens and actual communication in both Italy and Croatia is only towards citizens, this project provides a solution how to collect information coming from population, validate it and effectively use it in emergency management process. The next step in relation to semantic analysis of the social media information will be to create bi-lingual thesauri for both Croatian and Italian civil protection services and set up semantic analysis engine. Still, the real challenge will be the integration of the decision support system into everyday practice of the first responders.

Acknowledgment

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