An intelligent decision support system based on collaboration and case-based reasoning

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Abstract: This paper presents an intelligent decision support system as a real contribution to solving key disaster management problems. The objective is to reach the stage of collaboration and identification of the availability of human and material resources for the various modules of the emergency organisation plan. The collaborative environment supports the various actors in the process of planning and implementing disaster emergency preparation by using videoconferencing for real-time analysis and decision-making. We propose the system architecture, including several modules such as case reasoning, ontology and similarity measurement and we integrate videoconferencing to facilitate exchange on disaster information such as text, image, or video between experts. The interest is to provide an essential environment to define a structure plan, actions including an updated inventory of available resources for disaster management. Some experiments have been carried out in a province in western Algeria to evaluate the effectiveness of the proposed platform.

Keywords: intelligent decision support system; IDSS; disasters management; case-based reasoning; CBR; disasters ontology; videoconferencing; ORSEC plan.

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1 Introduction

Natural and technological disasters have been and remain a major concern for all human societies. Algeria, like many of these countries, continues to pay a heavy price for these disasters, both in terms of human lives or material damage. In the history of our country, we can found many disasters for example; the earthquake in Boumerdes in 2003 (2,278 dead people, 180,000 homeless people, 19,800 houses damaged including 16,715 destroyed and 222 billion DZD of material damage).

Since 1985, the Algerian Government has adopted a national 'ORSEC'[1] plan for the prevention of major natural and technological risks, mainly involving the organisation of interventions and relief in the event of disasters. This plan identifies all the human and material resources to be put in place in the event of a disaster and sets the conditions for this implementation.

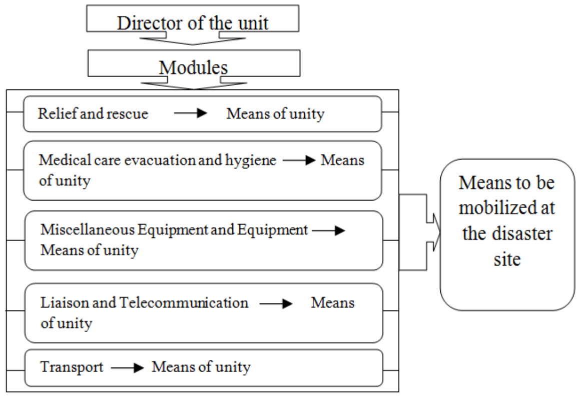
Upon receipt of the information or alert, the civil protection officer immediately gathers its members and is responsible assessing the extent of the disaster or event on the basis of the data of the other teams (see Figure 1) on the scene at the same time:

- assess needs
- determine the human and material resources in order to mobilise and deploy to implement the operational organisation

Each module manager must create a file containing the following documents:

- document no. 1: contact details of the module managers
- document no. 2: identification of the units containing the means enabling the module to accomplish its mission
- document no. 3: identification of the means provided by the units

Figure 1 Means[a] of intervention at the unit level.



Note: [a]The means of unity represent all the human and material resources used by the unit (Directorate of Civil Protection for example) to deal with disasters.

Several researchers highlight the importance of knowledge sharing and conversion, of high-level management in four phases of disaster management, mitigation, preparedness, response and recovery. In each of the sectors, an inventory of existing staff and equipment resources is carried out by the ORSEC service. In this article we propose a solution to the problem of immediate meetings of the various officials to facilitate the identification of the documents mentioned above and ensure an investment in travel time to meet.

1.1 *Major contribution*

Emergency preparation is based on sound disaster risk analysis and good links with early warning systems, and includes activities such as planning, storage of equipment and supplies, coordination mechanisms, evacuation and public information, training and field exercises. These must be supported by institutions and legal and budgetary capacities. The term ‘readiness’ describes the ability to respond quickly and appropriately if necessary. The contribution presented in this document is a collaborative platform for disaster management in Algeria such as the ORSEC plan is a document that lists:

- prevention: measures to avoid an accident (disaster) or to limit its consequences
- at the intervention level: the means of the system to be implemented.

Each unit must develop its own plan in collaboration with civil protection authorities, for this purpose, those responsible for ORSEC plan at the national level must meet to take a certain number of measures and means of the system to be implemented to deal with a disaster.

This article proposes a platform that essentially includes:

- A domain ontology that is dedicated to disaster management in Algeria, the most important knowledge is formalised thanks to this latter.
- A collaborative tool that integrates case-based reasoning (CBR) and videoconferencing. The purpose of using videoconferencing is to ensure an easy and

fast meeting. Indeed, during the traditional meeting (calling and travelling for a meeting), participants spend a lot of time travelling, through this collaboration tool, participants can exchange information and documents with each other in a relatively short time.

1.2 Paper organisation

The rest of the article is organised as follow: Section 2 is devoted to the related work and context. The proposed approach and disaster management organisation chart are presented in Section 3. In this section we describe the emergency preparation phase of disaster management and the videoconference collaboration phase and explain the difference between the current disaster management in Algeria and our proposal. In Section 4, we present a case study and some interfaces of our VISIO-ORSEC platform (rescue organisation by videoconference) platform and a discussion on the results obtained. Finally, Section 5 provides a conclusion and some future work directions.

2 Background and related work

This section discusses some of the work that integrates collaboration and knowledge-based systems for disaster management. In this study, we address the following overview.

In general, an effective collaborative process is positively associated with perceptions of improved disaster risk reduction practices, as already mentioned (Sawalha, 2014). These perceptions can be summarised in three key points: individuals must individually take full responsibility for crisis and emergency management to protect themselves and their property, organisations must join forces with other organisations in the same or different sectors, and governments must seek external collaboration to protect their economies.

In Rodríguez-Espíndola et al. (2018), disaster management attracts many organisations that work together and share their resources to respond to an emergency situation. Therefore, the success of operations depends to large extent on the collaboration of various organisations on the one hand. On the other hand, disaster management involves cooperation between multiple organisations from multiple sectors. Organisations involved in disaster management achieve their objectives through the creation of a network (Zaw and Lim, 2017).

Kapucu et al. (2010) point out the high expectations of the public and stakeholders in emergency and disaster management require effective use of resources by collaborative networks. They argue that the use of ICTs can help to produce information and make better decisions for an effective disaster management system. In this context, the objective of the document presented in Aydin et al. (2016) was to increase disaster resilience by using mobile technologies to enable citizens to play an active role in disaster management.

Another important key word to consider is the timely sharing of disaster management (DRM) knowledge, which is obviously vital, but remains a challenge. The roles involved in human resources management processes often cross organisational boundaries and are dynamic. The knowledge at stake is enormous and diverse. As presented in Othman and Beydoun (2016), the authors proposed a crucial contribution to meeting the challenge of knowledge sharing by providing a knowledge-based systemic approach to facilitate the structuring, storage and reuse of knowledge in knowledge management. We believe that adequate emergency preparation, response and recovery are necessary to cope with and survive large-scale disasters; unfortunately, the institutions responsible for providing emergency response services form a heterogeneous whole that often malfunctions due to a lack of appropriate interoperability and collaboration. Noran (2014) argues that the necessary artefacts can be built using an interdisciplinary, industry-based paradigm made possible by advances in the disciplines of interoperability, collaborative networks and enterprise architecture.

The work described in He et al. (2017) proposes a mobile post-disaster management system (MDMS) mainly used to collect, share and disseminate disaster-related damage/risk. MDMS has been successfully developed under a combination of native and web application technologies (called hybrid technologies) using various open source and open source software such as GeoServer, Openlayers, Cordova and jQuery Mobile. The authors presented in their work a smartphone application (D-AID) that aims to help volunteers and rescue teams map and quickly help victims of a disaster. It has been proven that through visualisation techniques, everyone can easily obtain information on the number of victims, their needs and the main dangers after disasters (Schunke et al., 2015).

In addition, multi-agency disaster management requires collaboration between geographically dispersed public and private organisations to enable a rapid and effective response to an unforeseen event. Janssen et al. (2009) examine the role of information, enterprise architecture, coordination and related human efforts to improve multi-agency disaster management, and conclude that, although there is a common body of knowledge, disaster management is still a poorly developed area. It is necessary to link practice and theory using people-centred approaches so that disaster management can achieve its full potential.

More specifically, decision making in emergencies requires a non-traditional approach and tools that are characterised by non-hierarchical structure and flexibility. The dynamic disaster environment requires investment in intersectional and inter-agency cooperation and coordination (Kapucu and Garayev, 2011).

Based on the experience of various disasters, Badpa et al. (2013) assume that one of the main problems is the lack of an accurate and efficient identification system to identify victims, especially those under the debris, and first propose a radio frequency identification system that is used in coordination with Oracle as a database management system with a dedicated network system. A model of a knowledge management system is also proposed.

Non-governmental humanitarian organisations (NGOs) play an increasing role in responding to natural disasters, the authors presented in their work a decision support system (DSS) to assist humanitarian NGOs concerned with natural disaster response. Such an SSD has been designed by avoiding sophisticated methodologies that can exceed the infrastructural requirements and constraints of NGO emergency management. A two-tier, date-based knowledge method to assess damage caused by multiple disaster scenarios was presented to solve this problem. Further details are explained in Rodríguez et al. (2010, 2012).

The work presented in Yun et al. (2012) used spatial information on disaster characteristics, digital images, digital topographic maps, cadastral maps and geological maps for effective disaster maintenance through scientific analysis and rapid surveys to build the information system and evaluate the application of the disaster management system.

Coffrin (2015) explained that the hybrid optimisation technology can produce decision support tools for emergency routing, power infrastructure restoration only and the joint restoration of interdependent natural gas and power infrastructure. These hybrid methods use mixed integer programming for infrastructure modelling, large neighbourhood searching for repair team routing and random adaptive decomposition for scaling optimization algorithms to practical sizes. The proposed hybrid methods significantly increase the quality of restoration compared to current practices in the field and surpass traditional technologies, which cannot find feasible solutions within operating time constraints.

A quantified and accurate assessment of the effects of disasters is not realistic in the context of highly uncertain and time-constrained decision making that takes place immediately after a disaster. Instead of a numerical assessment, Rodríguez et al. (2013) explains that it is more plausible and realistic to classify the severity of the consequences of a disaster according to scenarios relevant to the NGO's decision makers. In order to carry out this classification and to ensure the linguistic adaptation and comprehensibility of the proposed solution, the methodology of classification systems based on descriptive fuzzy rules has been adopted in their work.

Looking at the literature on the subject, CBR is a very rich field of research. The current literature focuses mainly on solving new problems by comparing them to the source cases that are recorded in the case database. There are a multitude of requests for decision support based on CBR (Benkaddour et al., 2016). The authors presented a comparative study between some semantic similarity measures; they combined the two approaches to benefit from speed calculations with the multi-agent system on the one hand and also from the quality of the solutions that are based on the similarity measure of Wu and Palmer (1994). Another research conducted by Benamina et al. (2018) combined a fuzzy model for knowledge base systems based on case-based reasoning. The objective was to improve the modelling of uncertain and vague concepts of natural language.

We can note several works that use CBR for disaster management, such as (Liu et al., 2012) which presents a method for predicting the demand for emergency resources using CBR in combination with the traditional risk analysis procedure. The authors laid the groundwork for a reserve of emergency resources and a future allocation.

The adaptation stage is a difficult and fundamental process of CBR. Zhang et al. (2015) proposed a new case adaptation method for emergency situations in the power grid in the event of a wind disaster. They have improved the multi-objective adaptive genetic algorithm for performance.

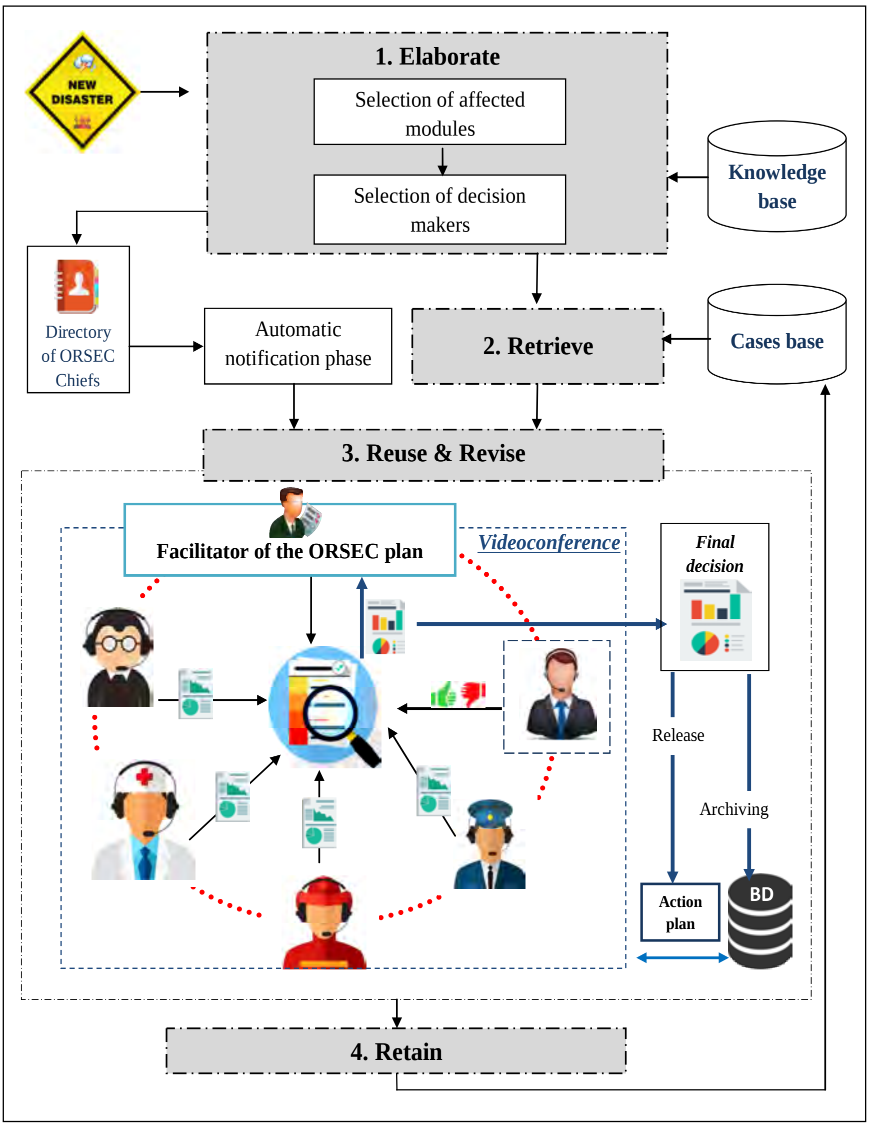
Amailef and Lu (2013) presented a mobile emergency response system by developing the ontology-based case reasoning methodology (OS-CBR), its implementation and to help emergency decision makers respond effectively to emergencies.

From our in-depth analysis of the most relevant work, we can say that knowledge bases, case-based reasoning and collaboration between different sectors are essential for better preparation and more effective management of major disaster situations.

3 A brief description of the proposed method

In this section, we present the main part of our contribution. The CBR process consists of three steps (elaboration, retrieve and retain). We propose the modules identification according to the type of disaster in the elaboration phase. For this purpose, the similarity measure of Wu and Palmer (1994) is used. We have chosen to apply this measure because of the quality of solutions mentioned in Benkaddour et al. (2016). We propose to use videoconferencing as a collaborative tool to adapt and review the case by the decision makers and experts.

Figure 2 Our suggested approach to disaster management through collaboration using CBR and videoconferencing (see online version for colours)



The general architecture of our approach, which is based on the integration of videoconferencing into case-based reasoning, is presented in Figure 2. CBR allows the integration and use of past experience in managing current issues. As there are many situations where users, as human beings, use some form of case-based reasoning, they can understand the reasoning and explanations of a CBR system, and can participate and improve problem solving through real-time collaboration and will therefore be more convinced by the validity of the solutions they receive at the end of the process.

3.1 Meeting preparation phase for disaster management

In this phase, we present an ontology that we have built manually and modelled according to the concepts of the ORSEC plan. The integration of this ontology into our system allows us organising domain concepts and solves the problem of semantic confusion between the different actors of disaster management. The construction phase can be divided into three stages (Gargouri and Jaziri, 2010):

- Conceptualisation: we have collected the necessary documentation for the development of concepts that are related to disaster management. We attended with the experts of the ORSEC plan precisely the heads of civil protection (Directorate of Civil Protection of the City of Oran) and the chief administrator of the ORSEC service to make knowledge identification.
- Ontologisation: at this stage, we formalised the conceptual model obtained from the knowledge gathered. We present some concepts and relationships in Table 1.
- Operationalisation: this phase consists of the transcribing of the ontology into a formal and operational language of knowledge representation. We have implemented this ontology using OWL language in Protégé 4.3. Figure 3 illustrates an overview of this ontology.

Figure 3 A part of ORSEC ontology (see online version for colours)

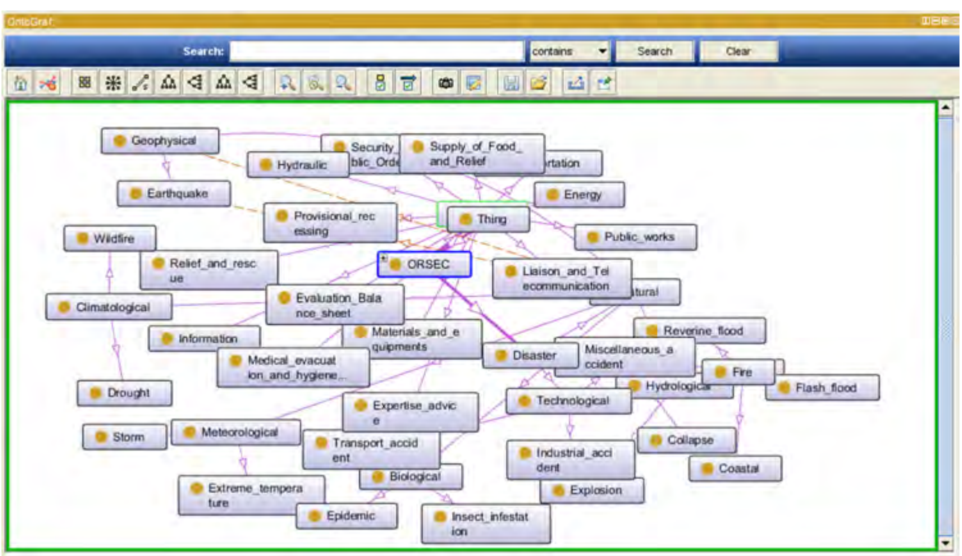


Table 1 The relationship between concepts from the ontology

Concepts	*Definition*	*Relationship(C1, C2)*
Disaster	Very bad accident	Is_disaster_subgroup_of (Geophysical, Natural)
Natural	Disaster resulting from natural processes of the Earth	Is_disaster_type_of (Earthquake, Geophysical)
Technological	Disaster that is caused by human error in controlling technology	Is_disaster_subtype_of (Ground movement, Earthquake)
Biological	Disaster caused due to natural outbreaks of epidemics or intentional use of biological agents	Is_part_of(province, city)
Epidemic	A rapid spread of infectious disease to a large number of people in a given population within a short period of time	Situated in(Unit, Province)
Industrial_accident	An accident in a factory	Belongs to (Fire_extinguishers, material_resources)
Explosion	Accidents which occur when natural gas or coal dust reacts with the air	Has_resource (Unit, machinery)
Means	Planned steps taken to minimise the effects of a disaster, and to be able to proceed to business continuity stage	Membre_of_the_module (Personal, Module)
Material_resource	The physical and concrete means that are useful in the event of a disaster	Has_name(Personal, Name)
Fire_extinguishers	A portable device that discharges a jet of water, foam, gas, or other material to extinguish a fire.	Has_Function(Personal, Function)

Thus, we present a knowledge base that contains:

- Rule base: depending on the type of disaster; the execution of these rules gives all modules and leaders involved in the emergency meeting the opportunity to identify the human and material resources available.
- A database on the history of disasters in Algeria (case base); specifying the cases in which the ORSEC plan was triggered.

For all improvements and changes to the knowledge base, we give experts the opportunity to update disaster management rules in our approach. Once the detection of the modules concerned has been completed; the managers and assistants will be notified by email. This notification provides information on the current disaster; the date and time of the meeting, the participants of the meeting, and a request to produce a document that must contain: the human resources, the material resources of the module that can be immediately committed, estimate the time required to mobilise resources. The document should be presented at the meeting.

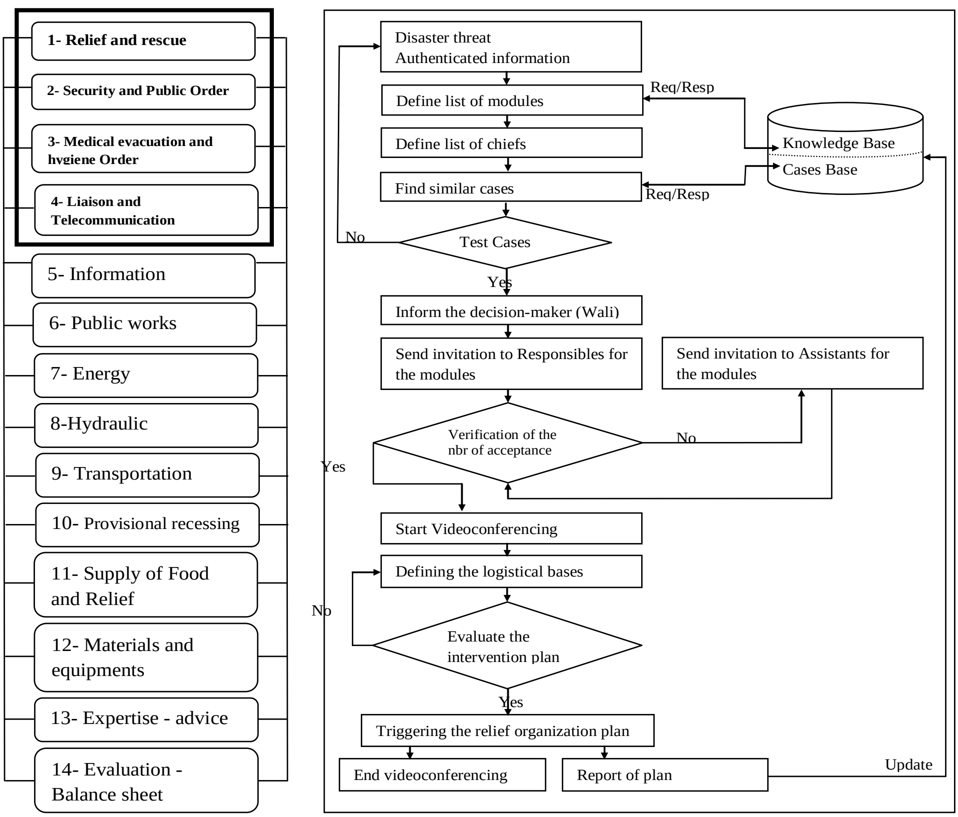
For a quick notification, we have integrated in ontology a directory containing all the coordinates of the managers of the modules of the ORSEC plan, their replacements and the assistants.

3.2 Collaboration phase based on videoconferencing

The plan for the organisation of interventions and relief in the state is composed of 14 modules of intervention.

Under the authority of the Wali (the president of the city), it is developed by the Directorate of Civil Protection, with the heads of modules. We propose collaboration between these by videoconference. It allows hearing and seeing employees located at a distance and in different places without having to move (saving time, reducing travel costs, etc.). It also makes it possible distribute digital or handwritten documents (diagrams, graphs, videos, photos, etc.). Figure 4 illustrates the main steps taken to execute the emergency organisation plan.

Figure 4 Videoconferencing for emergency organisation plan



We propose four different profiles:

a Facilitator (the technician or technical manager): which main role is to:

- schedule video conferencing
- initiate video conferencing
- connect all the sites
- distribute speech to different sites

- collect the documents sent by the different sites
- create the action plan from the information collected
- inform the sites by the decision to trigger the pan ORSEC
- disseminate the plan to the sites
- finalise video conferencing.

b Moderator (module leaders):

- request the facilitator to agree to speak
- explain the role of its module
- send the document that contains the human and material resources
- ask (or answer) questions to experts
- give the floor to the participants of his module if necessary
- recover the final action plan and alert its triggering.

c The speaker (expert): the role of the expert (speaker) is essential in disaster resolution. Based on his expertise, information on capitalised disasters, and documents sent by module managers, it defines and plans the inventory and indicates rehabilitation methods. It manages expert meetings with various stakeholders and offers a quick conclusion.

d Decision maker (Wali):

- ensures the installation of the operational command post (OCP) by the Director of Civil Protection
- consult the intervention plan specific to the nature of the disaster
- consult the plan of actions to be carried out by the operational command
- keep the central authority regularly informed of the evolution of events and gives a first estimate of the situation as soon as possible
- orders the partial or total release of the ORSEC plan.

4 Implementation and discussion

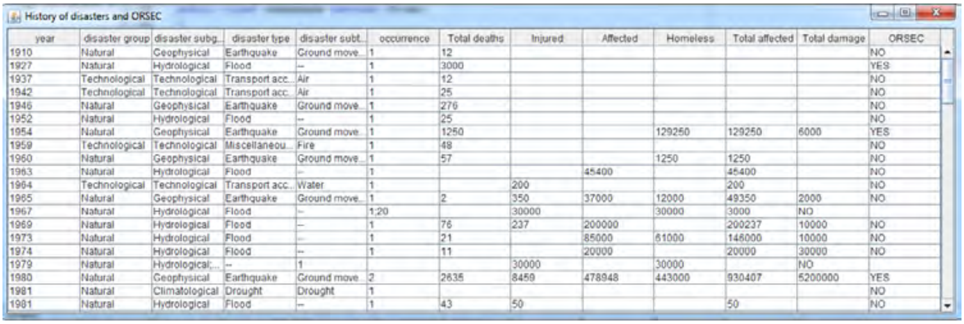
This section is divided into three parts; the first part is dedicated to the graphic platform that allows the technician to present the characteristics of the new disaster, update the rules of the knowledge base, update the contact details of the participants and schedule a videoconference using notifications. In the second part, we present a comparative table between some videoconferencing systems. The third part presents a simulation to test the time saving of the disaster management by our proposal.

4.1 Preparatory phase

In our case study on disaster management in Algeria, we used the history of disasters in Algeria. EM-DAT contains essential data on the occurrence and effects of more than 22,000 mass disasters worldwide from 1900 to the present. The most relevant cases (107 cases of disasters in Algeria) are presented in Figure 5. After a study with the

ORSEC plan experts, we added a descriptor 'ORSEC' which defines the cases from which the ORSEC plan was triggered.

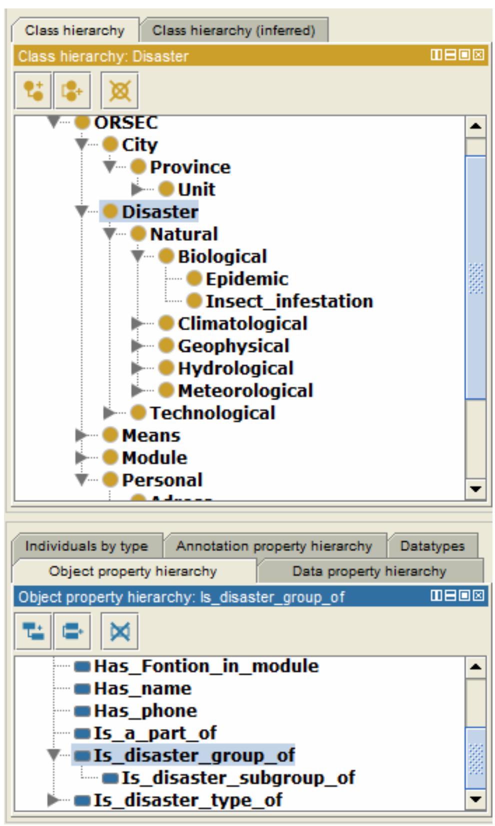
Figure 5 A source case extract (see online version for colours)



History of disasters and ORSEC

year	disaster group	disaster subg...	disaster type	disaster subt...	occurrence	Total deaths	Injured	Affected	Homeless	Total affected	Total damage	ORSEC
1910	Natural	Geophysical	Earthquake	Ground move...	1	12						NO
1927	Natural	Hydrological	Flood	--	1	3000						YES
1937	Technological	Technological	Transport acc...	Air	1	12						NO
1942	Technological	Technological	Transport acc...	Air	1	25						NO
1946	Natural	Geophysical	Earthquake	Ground move...	1	276						NO
1952	Natural	Hydrological	Flood	--	1	25						NO
1954	Natural	Geophysical	Earthquake	Ground move...	1	1250			129250	129250	6000	YES
1959	Technological	Technological	Miscellaneou...	Fire	1	48						NO
1960	Natural	Geophysical	Earthquake	Ground move...	1	57			1250	1250		NO
1963	Natural	Hydrological	Flood	--	1			45400		45400		NO
1964	Technological	Technological	Transport acc...	Water	1		200			200		NO
1965	Natural	Geophysical	Earthquake	Ground move...	1	2	350	37000	12000	49350	2000	NO
1967	Natural	Hydrological	Flood	--	1;20		30000		30000	3000	NO	
1969	Natural	Hydrological	Flood	--	1	76	237	200000		200237	10000	NO
1973	Natural	Hydrological	Flood	--	1	21		85000	61000	146000	10000	NO
1974	Natural	Hydrological	Flood	--	1	11		20000		20000	30000	NO
1979	Natural	Hydrological;...	--	1			30000		30000		NO	
1980	Natural	Geophysical	Earthquake	Ground move...	2	2635	8459	478948	443000	930407	5200000	YES
1981	Natural	Climatological	Drought	Drought	1							NO
1981	Natural	Hydrological	Flood	--	1	43	50			50		NO

Figure 6 A partial view of the ORSEC ontology created in Protégé 4.3 (see online version for colours)

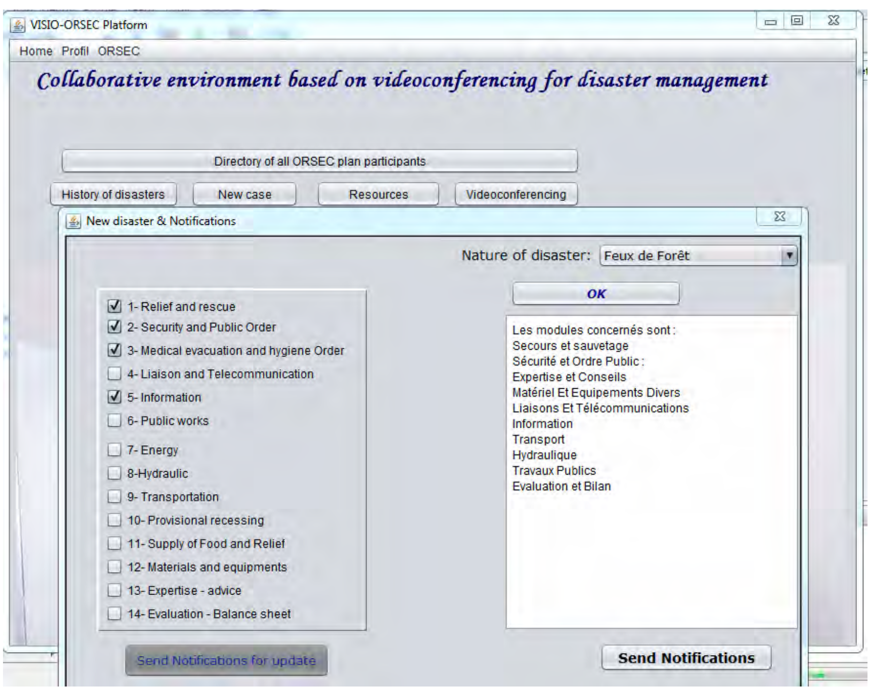


Once authenticated, the person in charge of the ORSEC plan in civil protection can access it:

- the publisher to describe the new disaster
- the history of disasters in Algeria
- execution the rules to know the modules concerned by the relief according to the case of disaster presented
- the directory: here he consults the coordinates (ID, name, first name, function, function in the module, address, phone, email) of all the participants of the ORSEC plan, and updates them
- the table which contains the human and material resources and the possibility of the update.

We have implemented this interface with the Java language and the Netbeans 8.0 IDE environment. To evaluate our application we used the data of ORSEC 2018 plan of province MISSERGHIN of the ORAN City. The data is confidential. We have implemented Ontology in Protégé_4.3.

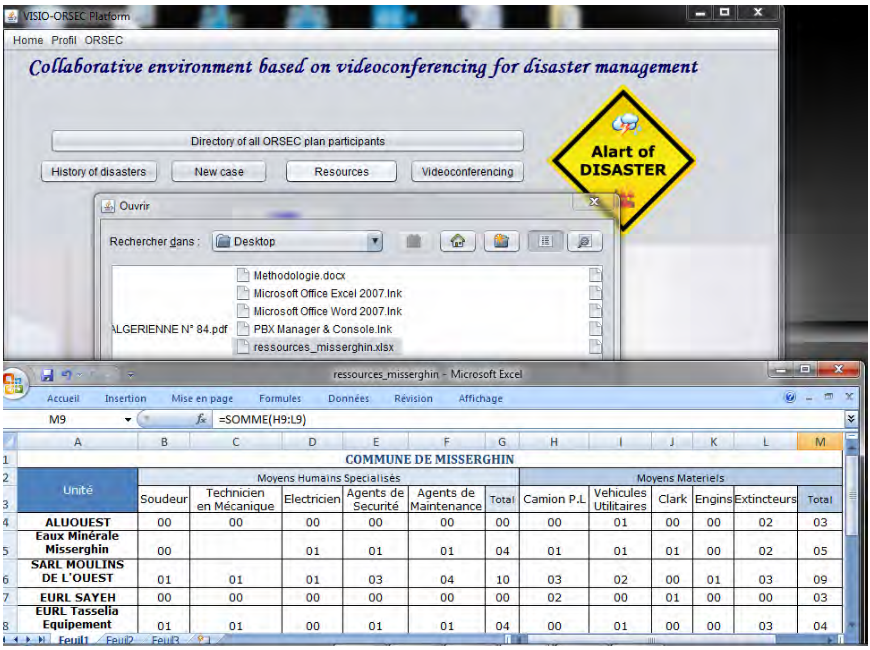
Figure 7 Send notifications to request either updated contact information or resource statistics and notified by videoconferencing appointment (see online version for colours)



The interface 'New Disaster and Notification' (refer to Figure 7) allows the user to ask the managers of the modules to send updates of the data (the coordinates of the members, the statistics of available resources, etc.) as well as to notify him for meeting by videoconferencing.

To facilitate access to the tables of human and material resources, we have integrated the 'Resources' button. The user can quickly access the resources. An example of an Excel file contains the resources is shown in Figure 8.

Figure 8 Human resources and equipment MISSERGHIN Province (see online version for colours)



4.2 Videoconferencing

Before beginning our research on videoconferencing, we contacted the managers of the liaison and telecommunications module to determine the reliability of the internet. The Ministry of Posts and Information and Communication Technologies has acquired and set up two (02) networks: wired and radio as part of the ORSEC plan, which aims to ensure permanent communication in the event of natural disasters (earthquakes, floods, etc.).

The ORSEC Plan network consists mainly of two mini phone networks with a total capacity of 9,000 phone lines.

To choose a collaboration tool, we compared some free video conferencing solutions on the net. The comparison was made according to (see Table 2):

1 the security

2 the maximum number of the participant in a meeting

3 the maximum duration of a meeting

4 the possibility of sharing screen

5 as well as files

6 last criterion is the existence of a version for mobile phone.

We have integrated the Google Hangouts into our platform thanks to its security and ease, as well as its integration with other Google applications (Google Doc, Google Sheet, Google Slide, many participants can work together, at the same time, on the same document, spreadsheet, or in the same presentation) by clicking on the Video Conferencing button, a Google Hangouts web page is automatically opened.

Figure 9 ORSEC participants collaborate on videoconferencing (see online version for colours)

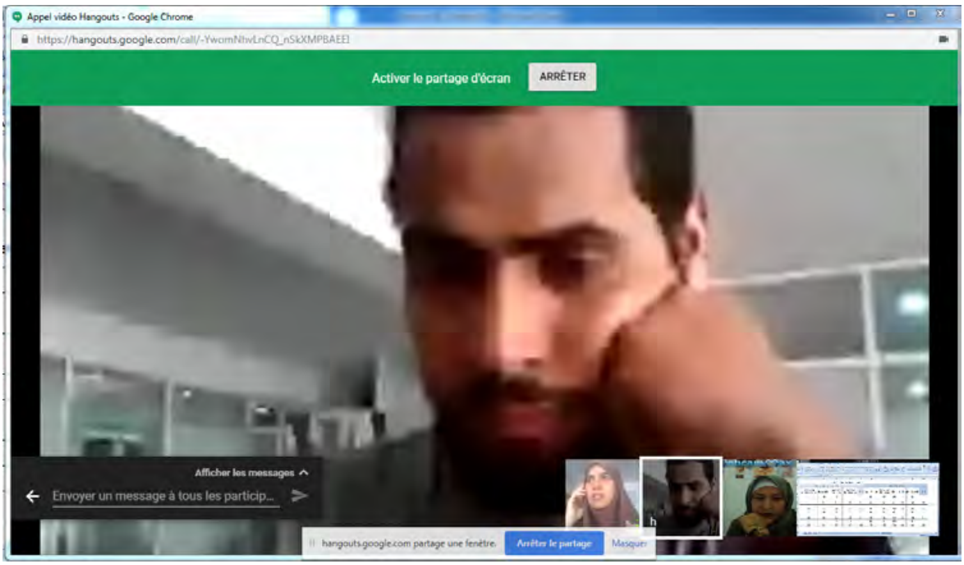


Figure 10 ORSEC participants collaborate on videoconferencing and use screen sharing

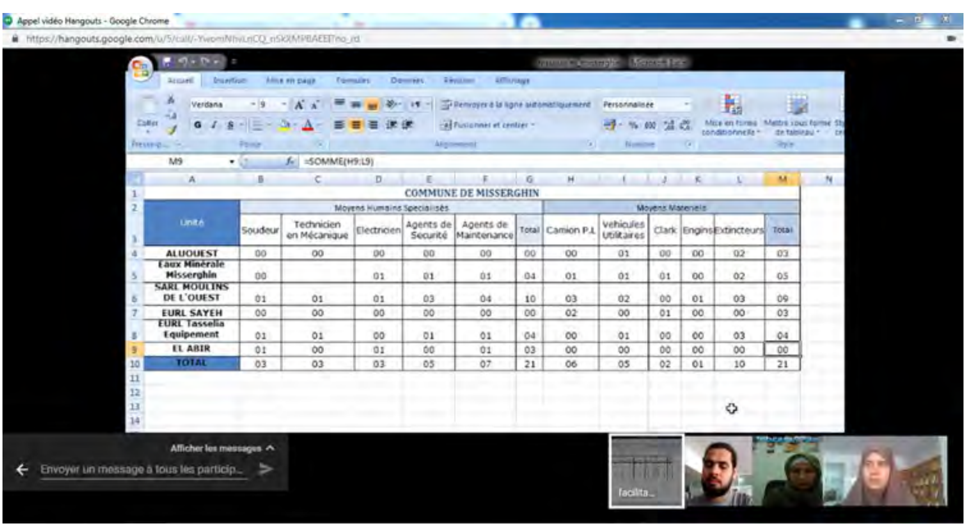


Figure 11 Discussion among participants on real-time traffic (see online version for colours)

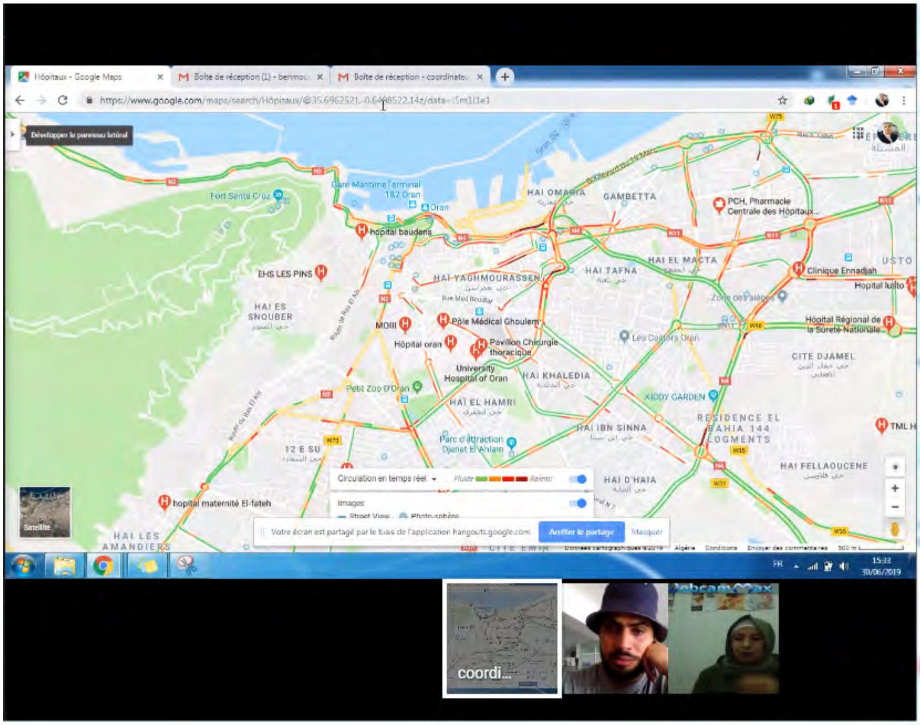


Table 2 Comparison between free video conferencing systems

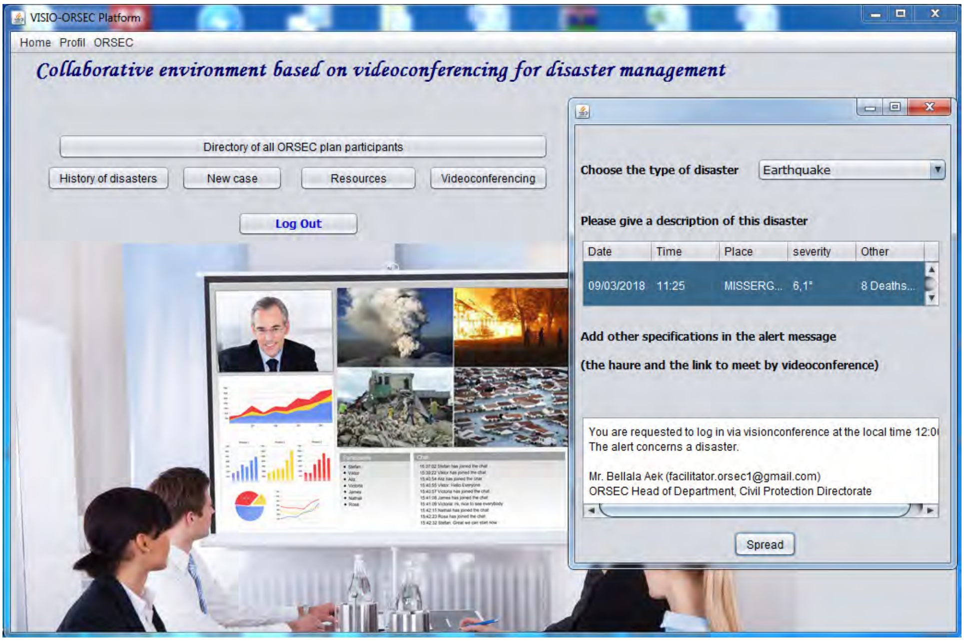
Id	*(1)*	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*
Skype	Yes	25	4 h	Yes	Yes	Yes
Google Hangouts	Yes	10	-	Yes	Yes	Yes
Apear.in	Yes	8	-	Yes	Yes	Yes
Talky.io	Yes	15	-	Yes	No	Yes
Hubl.in	Yes	9	-	No	No	Yes
FreeConference	Yes	10	-	Yes	Yes	Yes
Join.me	Yes	3	-	Yes	Yes	No
Oovoo	Yes	12	-	Yes	Yes	Yes
TrueConf	Yes	10	-	Yes	Yes	Yes
ezTalks	Yes	100	40 min	Yes	No	Yes

4.3 Evaluation and estimation of time

Due to its location in a convergence zone of plates, Algeria is a region with high seismicity. Throughout its history, it has suffered several destructive earthquakes; in this scenario we give an example of collaboration between intervention teams using our 3-step collaborative platform.

Firstly: the development of a group of collaborators. The head of the ORSEC Civil Protection Department will identify himself with his user name and password. He will present the new case because he must meet the characteristics required in the form shown in Figure 12.

Figure 12 Elaboration step and broadcast of the alert (see online version for colours)



By clicking on the 'broadcast' button, an email will be sent to the heads and deputy heads of the modules concerned by the intervention in the event of an earthquake. This message must contain a description of this disaster, a request to send the current status of human and material resources, the date and time of the videoconference.

Figure 13 The message sent by the leader to the collaborators (see online version for colours)

Dear collaborators,

You are requested to log in via visionconference at the local time [12:00]
The alert concerns a disaster.

[earthquake] [09/03/2018] [11:25] [MISSERGHIN] [6,1 °] [8 deaths 14 wounded]

Confirm your presence with an acknowledgment of receipt and send me an indicative list of all the human and material resources available to you.

ORSEC Chief

Secondly: we have the collaborative session by videoconference: the ORSEC manager receives acknowledgments of receipt and requested information. At the time specified in the message sent, this person will initiate the videoconference, which is considered a collaborative session. In order to make the decision on the need to trigger the ORSEC plan, the ORSEC manager shares his screen and launches the ‘VISIO-ORSEC’ application and triggers the reasoning from case, the first step is the development of the case is already done previously so that the system goes directly to the second step to recover similar cases to the current case which is described by 13 parameters. For more information, refer to Table 3.

Table 3 Similar cases

Disaster group		*Disaster subgroup*		*Disaster type*		*Disaster subtype*		
Natural		Geophysical		Earthquake		Ground movement		
Year	*Occurrence*	*Total death*	*Injured*	*Affected*	*Homeless*	*Total affected*	*Total damage*	*ORSEC*
1910	1	12	-	-	-	-	-	No
1946	1	276	-	0	0	0	0	No
1954	1	1,250	-	0	129,250	129,250	6,000	Yes
1960	1	57	0	0	1,250	1,250	0	No
1965	1	2	350	37,000	12,000	49,350	2,000	No
1980	2	2,635	8,459	478,948	443,000	930,407	5,200,000	Yes
1985	1	30	-	-	-	-	1,000	No
1987	1	1	7	3,145	-	3,152	1,000	No
1988	1	-	57	-	200	257	-	No
1989	1	22	184	12,000	-	12,184	-	No
1992	1	-	-	2,250	-	2,250	-	No
1994	1	171	289	12,500	-	12,789	-	Yes
1999	1	22	175	-	15,000	15,175	60,929	No
2003	2	2,275	10,461	-	200,000	210,461	5,000,000	Yes
2004	2	-	315	-	-	315		No
2006	1	4	9	160	150	319	-	No
2014	1	6	420	-	-	420	-	No

The measure used for this study is the ‘Wu and Palmer’ arc-based semantic similarity measure which uses the ontological concepts detailed in the preceding section.

$$Sim(c1, c2) = 2 * N3 / (N1 + N2 + (2 * N3))$$

$N1$ the number of arcs between concept 1 and the subdivision concept.

$N2$ the number of arcs between concept 2 and the subdivision concept.

$N3$ the number of arc between subdivision concept and the root concept.

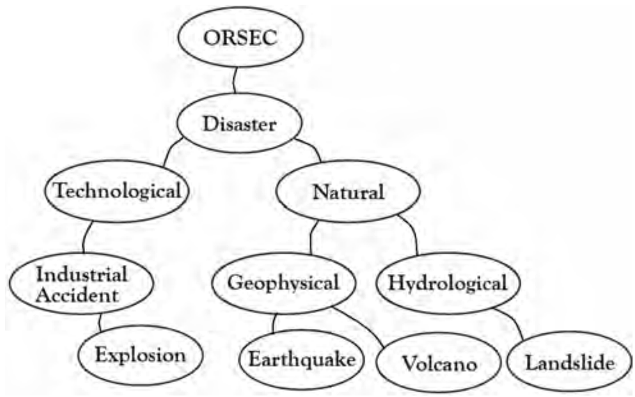
For example:

$$\text{Sim(Earthquake, Landslide)} = 2 * 2 / (2 + 2 + 2 * 2) = 0.5$$

$$\text{Sim(Earthquake, Volcano)} = 2 * 3 / (1 + 1 + 2 * 3) = 0.75$$

$$\text{Sim(Earthquake, Explosion)} = 2 * 1 / (3 + 3 + 2 * 1) = 0.25$$

Figure 14 A part of our domain ontology



Finally: the decision making and end of session: the members of the group constitute an action plan that is considered to be the solution to this new disaster. The final decision represents the launch or not of the ORSEC plan. The new case and its validated solution will be added to the case base to complete the CBR process. The person in charge will send the action plan to the members and complete the collaborative session for an effective response as soon as possible.

In order to assess our platform in terms of organisation, usability and response time, security and updateability, functionality and efficiency, clarity and ease of collaboration, we have prepared questions so that users are aware of the platform's qualities and to help participants organise meetings without wasting time and be periodically updated, and make collaborative and real time decisions. Some of the evaluation questions are as follows:

Question 1 Do you agree with the collaborative platform?

Question 2 What do you think about the organisation of interfaces?

Question 3 Do you find the directory on the platform useful?

Question 4 Are there any problems with notifications?

Question 5 Do you seek help to manage the uses?

Question 6 Are there contradictions in the research results?

Question 7 Does videoconferencing save you time?

Question 8 Is it preferable to carry out an annual update of the coordinates if not to choose periodic updates established by our platform?

Question 9 What are the difficulties encountered when using this platform?

Question 10 Do you have security issues?

Synthesis of responses:

Answer 1 Collaboration is fundamental in disaster management, and it is essential that this collaborative interface meets our needs.

Answer 2 Indeed, each button represents a specific function (directory: to access contact information, videoconferencing to access Google Hangouts, etc.).

Answer 3 The key to contacting employees is to have a directory at their disposal, usually have searched to find the number of a particular person, it is a manual search in the printed files, in this interface just click and all the contact details are displayed.

Answer 4 As far as sending notifications is concerned, it is clearly very easy and fast, but we have a problem with receiving the acknowledgement. Currently, ORSEC plan employees generally do not check their e-mail frequently to see if they are used to receiving phone calls in this circumstance.

Answer 5 Sometimes access to assistance is mandatory to verify that operations are carried out in accordance with regulatory texts (e.g., roles of the staff, modules involved in each type of disasters, etc.).

Answer 6 There is no contradiction with the regulations, they are well defined, but there is a lack of maps.

Answer 7 Yes, it avoids delays, travel problems, organisation and secure collaboration.

Answer 8 The periodic update eliminates all contact problems, sometimes the contact details change during the year and we do not know, the day we want to contact the person, we do not arrive, so the implementation every day avoids these problems.

Answer 9 Some employees who are not used to working on a computer, or even using a smartphone, find that phone contact is more than enough to collaborate easily, another problem remains with the equipment, including ORSEC plan simulations made by the WLL, so there is not enough equipment to do the video conferencing.

Answer 10 The platform is secure because we access it with a username and password, emails are secure, and Google Hangouts and also secure, so we are secure in this platform.

In Algeria, all the information in the ORSEC plan (coordinates of coordinators, resources, etc.) is updated once a year but during this year the information changes and if there is a disaster notification, ORSEC officials have great difficulty connecting, collaborating and making the decision. In our platform, managers can update information (for example, change a manager’s contact information or improve resources, etc.) and facilitate the organisation of meetings and decision making in a short time and without travel.

5 Conclusions

Based on the results of our research, the work presented in this article is a real contribution to disaster management in Algeria. Indeed, time and collaboration between relief teams are essential and therefore any delay or disruption in interventions can be considered a failure. In order to design a collaborative platform that saves time and allows a successful meeting between decision makers and close collaborators and to concretely follow the recommendations and explanations exchanged with the experts.

As part of this project, we have carried out some experiments with our tool developed to evaluate its performance and the quality of its suggestions by implementing the ORSEC plan which is applied by the city authority and by designing a user-friendly interface for a collaborative tool based on videoconferencing. The results obtained are promising.

After an in-depth study of the ORSEC plan that is adopted in Algeria in the event of a disaster and its current state by organising interviews with the managers, we are building from scratch a directory and a rules base in order to reduce the search time in printed and archived directories in non-digital files. Thus, the novelty of our approach is the use of videoconferencing as a collaborative tool for conducting meetings. The use of this communication tool saves time, money and, above all, avoids mistakes that can be made. The result presented in this document forms the basis for future research to improve the platform according to the needs of the collaborators.

First, integrate a geographic information system and add all provincial maps with information on roads, railways, ports, airports, heliports, heliports, guys, etc. Secondly, improve and dedicate versions only to communication between the fixed and operational command posts by integrating algorithms to find rapid response solutions. That is why we aim to develop a comprehensive disaster management platform that aims to collaborate and respond to disasters as quickly as possible.

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Notes

1 ORSEC: Organisation des secours (Relief Organization).