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# Representing stress impact in crisis management

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**Abstract.** The crisis management is a special type of collaborative approach in which the actors are subject to an uninterrupted stress. It is quite a significant issue because the consequences of crises can bring huge damages (human and economic losses). Even actors follow training in order to face stress situations but the human condition (familial and life) and the disparity of situations in which the consequences (different types of victims (children, the elderly, etc.) push actors to lose control of situations. The question to answer is can we predict the consequence of a default to this type of situation? Our study try to answer these questions by showing how to represent prediction of the consequences of a stress on crisis management. Firstly, we define a model that represents the impact of one actor to the situation considering the collaborative aspect of crisis and then we study stress consequences measurement. First results of these studies are presented in this paper.

**Keywords:** Crisis Management, Stress, Prediction.

## 1 Introduction

Crisis management is a special type of collaborative approach in which the actors are subject to an uninterrupted stress. It requires succeeding because the consequences are important (human and economic losses). We study the management of crises in the case of disasters, heavy accidents or sanitary alerts (poor meteorological conditions, terrorism, etc.). The multiplicity of actors, the importance of the consequences (deaths, serious injuries), the complexity and the disparity of situations to be managed and their rarity make that the actors are quickly overburdened and do not manage to face up efficiently to this type of event. Crisis management consists in dealing with the complexity and the interdependency of systems and especially with the combination of events [1]. Some researchers define approaches and techniques in order to define criteria to help assess the vulnerability of systems [2]. Others define organizations and communications guidelines in order to avoid vulnerability and deal with the crisis with minor consequences. The several steps of crisis to manage crisis can be summarized as [3]:

- Prevention: Preparation, planning, identification potential risks, definition of crisis cells and means definition of security tools and procedures, etc.
- Formation: Trainings, evaluations, simulations, information and communication, etc.

- Problem solving: Crisis detection, alert, emergency plans and actions, activate protection actions, management actions, events, decisions and consequences, etc.
- Feedback: reporting, debriefing, brainstorming, risk evaluations, experience memorization, modifications procedures and means, etc.

Generally, there is a difference between real activity and procedures in crisis management situations. The events are different from each other and are strongly bound to exogenous parameters such as the political, economic, environmental situation, and societal. This paper shows how we tend to represent prediction of the consequences of a stress on crisis management. Firstly, we define a model that represents the impact of one actor to the situation considering the collaborative aspect of crisis and then we study stress consequences measurement.

## 2 Modelling Crisis Management

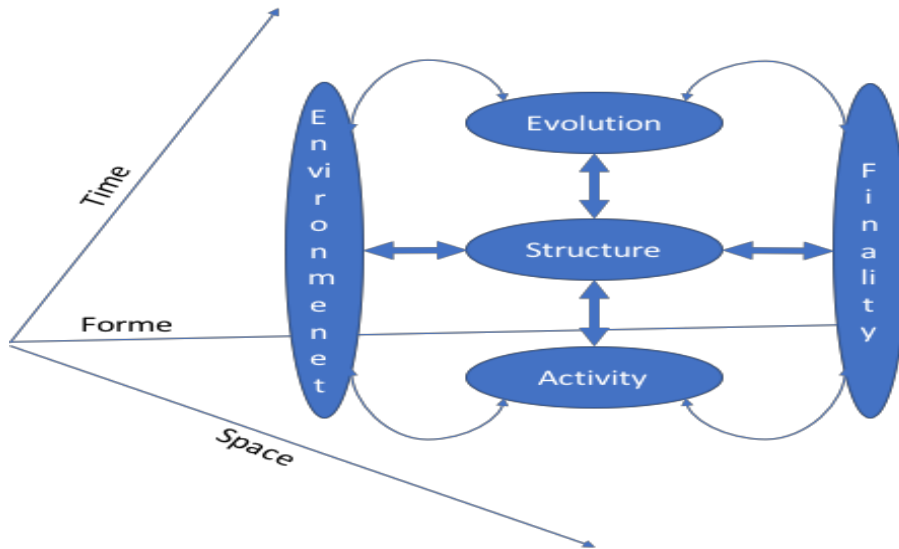
A crisis management is a collaborative situation, through which different dimensions must be studied: coordination [4], communication [5] and cooperative decision-making. In this type of situation there is an important relationship between individual actions and collaborative ones. Even actors follow training in order to face stress situations but the human condition (familial and life) and the disparity of situations in which the consequences (different type of victims (children, the elderly, etc.) push actors to lose control of situations. Note that crisis is defined as a situation out of control [1]. The question to answer is can we predict the consequence of a default to this type of situation? The aim of our work is to show a simulation of this prediction to actors as formation. For that, a model of the interaction between individual and team actions is defined. In this model, we mix systematic and collaboration models.

### 2.1 Crisis definition and crisis management

The crisis is an unstable and dangerous situation affecting individual, group, community and the whole society. It generated a collective stress [6]. It is an exceptional situation. One of the definitions of crisis is: “a serious threat to the basic structures the fundamental values and, norms which under time pressure and, highly uncertain circumstances necessitates making a critical decision” [6]. Many types of crisis exist, as political, the contaminated blood crisis [7]; economic and financial, the Enron financial scandals [8]; technological, Challenger [9]; environmental crisis, Bhopal [10], Chernobyl [11] and, Exxon Valdez [12]. Crisis can have international, domestic and, local dimensions. A crisis request an organization to manage it and, to make pertinent decisions with the aim to request from this situation or to reduce its effect in a short time with minimal damage.

## 2.2 Systemic modeling

Systemic or system science present a system as a complex interrelation between: structure and activity and evolution [13], [14]. This system has a finality and deals with the environment (see Fig. 1) through time and space.



**Fig. 1.** Systemic model

The system has to regulate its operation facing variations. This phenomenon is called regulation. In fact, the system deals with variation by changing its composition and its state by losing members, adaptation and evolution of the structure and the activity [15], [16]. Stress and anxiety of an actor can be considered as a variation of the environment. We try to simulate in our work how the system can change in order to absorb this variation. Prediction techniques [17], [18] are generally used in order to simulate this change. Prediction algorithm is generally based on a nominal functioning model of the system. Based on that, several studies propose simulation of behaviors in crisis management like people behavior facing a problem [19] or actors in crisis [20]. But, as we note above, crisis is defined as the situation out of control. So, nominal function modelling is not possible. Only procedures and rules can be considered as a nominal situation. But, we know the reality is away from procedures especially in stress situations. Some work in prediction use Knowledge engineering and Case based reasoning in order to define a prediction system based on the experience of the use of components in industry [21]. So, we try to use this type of system but in collaborative situation.

### 2.3 Collaborative situation modeling

During a crisis management, the actors come from different organizations. They work, communicate, cooperate, coordinate and, exchange their own experiences. Their main common objective is how to deal with the crisis for reducing its effect? In this relationship, is noted that multiple actors are interdependent in their work. They interact each other to improve the state of their common field. Collaborative activity is largely studied in CSCW [22], this activity is defined as: “distributed in the sense that decision-making agents are semi-autonomous in their work in terms of contingencies, criteria, methods, specialties, perspectives, heuristics, interests, motives and so forth” [23]. Thus, they use resources like computers; plans; procedures; schemes; etc. This distributed activity can be represented as Triple C (Communication, Coordination, Cooperation). Several papers in the literature mention the role of Triple C in crisis management, and their interdependence [24]. The interdependence of the 3C is affected by the regulation. Indeed, the regulation adjusting consists of sending or to receiving information, giving a warning (Communication); using means (Coordination); and the procedure, decision and organization (Cooperation). It can be represented as interdependency between communication, coordination and cooperation. Crisis situation can be so represented as a constant evolution and adaptation of actions and actors as same as the regulation mentioned in systematic (see Fig. 2) This confirm that the CSCW theory go beyond systematic approach because its represent activity as a constant mutual change and adaptation between actors dealing with tools and environment.

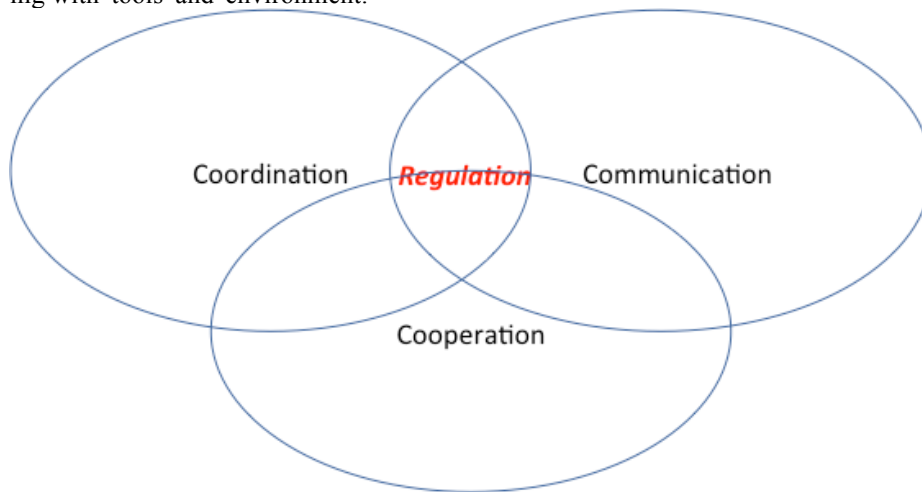


Fig. 2. Collaborative activity

### 2.4 Collaborative crisis management modeling

As we noted above, crisis management is close to a chaotic situation then controlled one. It depends on different factors like situation misunderstanding; previous experi-

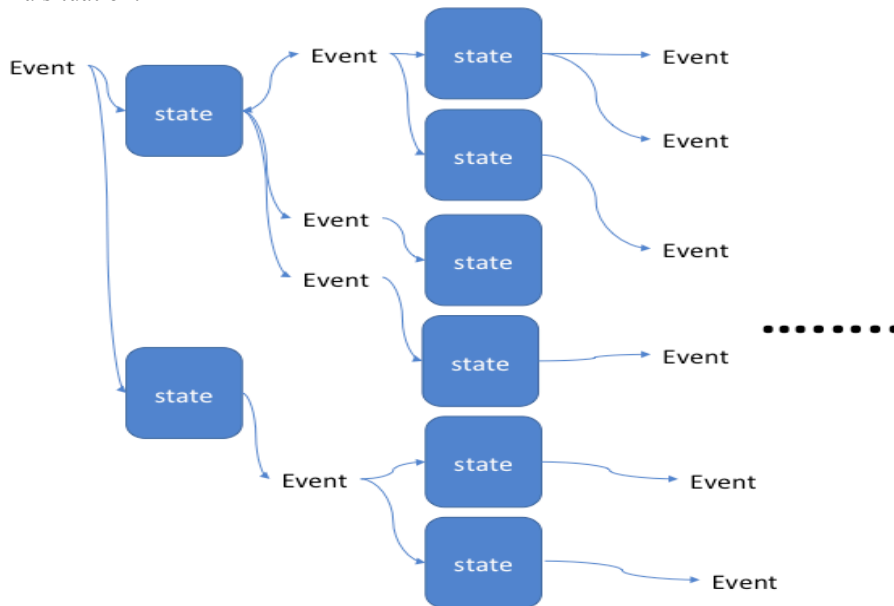
ence missing; actors stress, political and economic environment, etc. The crisis can be so represented as relations between event and states respecting this dynamicity [4] So, to represent real activities, we define crisis situations as several states evolving through time and space. Each state can be defined as event/consequences [4].

- Actor/ role: is the concerned person or unit in each system state (crisis stage).
- Time: is the moment to do an action by the concerned actor according to place's type.
- Place: is the place concerned by the state.
- Data: is the available data for concerned actors in each moment, this piece of information is related to the characteristics of crisis situations, localization, weather and victims.
- Event: can be an action done by an actor or information related to a new environment element.

Actions can concern communication, coordination and cooperation. State can generate events and events can modify states (see fig. 3). Five crisis management efforts are defined [1]:

1. Strategic efforts;
2. Technical and structural efforts;
3. Efforts in evaluation and diagnosis;
4. Communication efforts;
5. Psychological and cultural efforts.

Stress is an important element to consider related to the psychological and cultural efforts. Stress is considered as variations in this environment. We present in the following this notion and how we aim at measuring its consequences as new events in a situation.



**Fig. 3.** Representing situation as a sequence of state and event

## **2.5 Using Experience Feedback in Crisis Management**

In the daily life and, for any problem or situation, experience feedback is used. Yet, knowledge management approaches define some techniques to promote learning from experience feedback. So Foguem et al. present experience feedback as a “process of knowledge capitalization and exploitation mainly aimed at transforming understanding gained by experience into knowledge.”[25]. This process shows five distinguished information: events, context, analysis, solutions and lessons learned. The literature on this domain has highlighted several tools to help companies and organizations, to avoid past mistakes and, to benefit from all the knowledge and the know-how used [4], [26]–[28]. By including experience feedback on technical and organizational means, actors can learn how to face stress in crisis management. Then, an actor or a group of actors can adjust its approaches; policies; procedures; methods; models and its organization, guided by previous experiences, to try to obtain as possible as a nominal situation

## **3 Stress**

### **3.1 Stress and the stress indicators**

the stress is an important factor in the success or the failure of the decision-making in a situation of crisis management. It is a particular relation between an actor and his specific environment. Its evaluation can be weak or exceed the actor resources and can be endangered his well-being [29]. It was noticed that “Some policymakers reveal resourcefulness in crisis situations seldom seen in their day-to-day activities; others appear erratic, devoid of sound judgment, and disconnected” [30]. Several approaches for the stress have been proposed, based on response [31]; stimulus [32]; the interactionism [33]; and the transactional approaches [34]. In the case of this study, the transactional approach is chosen. It is related to cognitive and emotional processes, which gives interaction between a person and his environment [35]. This indicates that the individual and the demand are two components. Those define themselves in a continuous process with a retroactive loop. More concretely, the stress result from the imbalance observed during the cognitive evaluation between the demand and, the capacity to deal with. Indeed, an actor possesses personal characteristics that differentiate him from others. He is under the influence of environmental variables. When there is a stimulus and, when a particular situation can put the actor in danger, he starts a process evaluation. This process has a primary evaluation, the actor wonder, “am I OK? Or I am in a potential danger” and, the secondary evaluation begins where the actor wonders by which way he can go out from this situation. This evaluation orients the strategies of the coping, in whom the objective is either to decrease the tension resulting from the situation, or to modify the situation [36]. [29] defined the coping as “the overall cognitive and behavioral efforts, continuously changing, deployed by an actor for managing specific internal and/or external requirements, which are evaluated as consuming or exceeding his resource”. There are different studies that propose training and mental preparation methods to help actors to face the stress

in crisis management [1], [37]. This paper focus on the impact of stress on decision-making in order to promote learning from fails and guides based on experience feedback.

### 3.2 The Stress Impact on a Crisis

Boswel et al present four classes of indicators that influence stress conditions [35]:

- Task conditions: workload, etc.
- Relational conditions: conflict, harassment, etc.
- Job conditions: Mobility, no promotion, etc.
- Interaction private/profession: husband, children, family, etc.

Different observable indicators of the stress are considered in psychology as manifestations of stress. Some of these are mainly noted:

1. Speech rhythm [38], [39], repetition of expressions and words [40], [41], Using specific words [40], [42], [43][39], etc.
2. Super activity, inadequate movement [44], [45], etc.
3. Silence [46].
4. Ambivalence, self-confidence [41], [46], [47].
5. Hostility and aggression [48].
6. Inappropriate behavior and actions [49], [50].

Some indicators that influence decision-making can be:

- a) Situation and context simplification [51], [52].
- b) Fixation on one possibility without any flexibility and alternatives [51], [53]–[55].
- c) Consulting several opinions without concluding on a decision [56], [57].
- d) Imposing a decision without measuring the impact and the consequences [56], [58].
- e) Missing decision-making and actions [56], [59].

For our work, we select some of these indicators that can be measured directly when actors deal with crisis. Indicators must be measurable without perturbing actions realizations and decision-making. So, stress manifestations as:

- I. Super activity and imposing decision without considering the impact.
- II. Silence, missing decision and actions.
- III. Speech rhythm, aggression and conflict of opinions and decisions.
- IV. Simplification of the situation and inadequate means and actions.

It is noted that different studies propose formation and mental preparation methods to help actors to face stress and anxiety in crisis management [37].

### 3.3 Using feedback in stress situation

A crisis is by definition a stressed situation, outside of control. Therefore, stress is an important element to take into account when dealing with this type of situation. For instance, different manifestations of the stress like silence or aggression are present. In addition, impacts like simplification of the situation or consulting several opinions



without concluding on a decision is noted. These impacts influence the decision-making. Related to each act and decision, stress can be increased or be reduced depending on the result of the decision and, in the state of actors. Here, the negative feedback comes into.

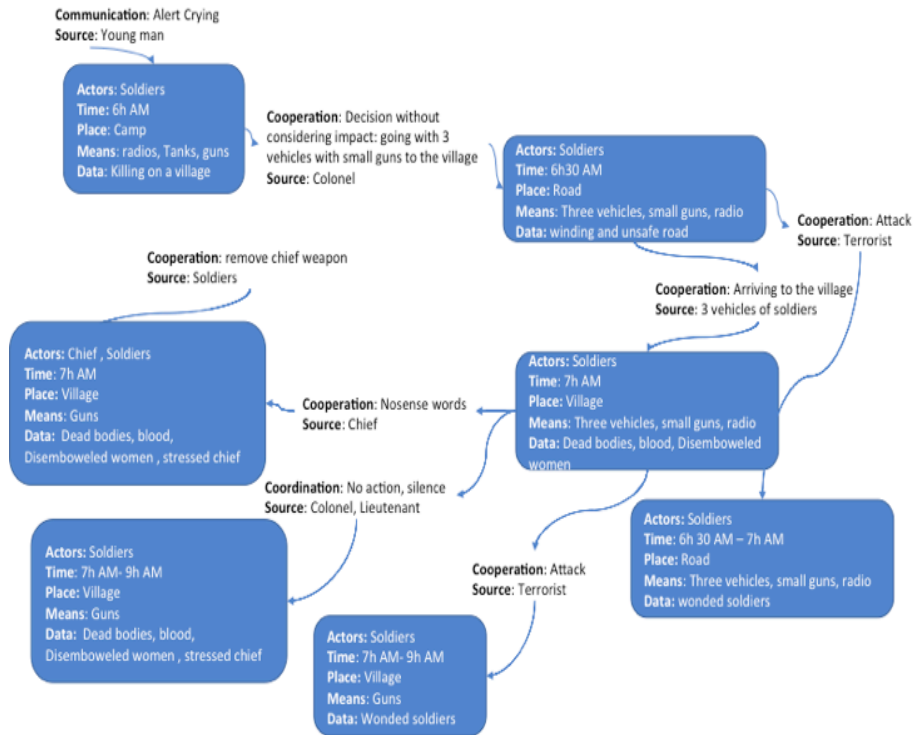
## **4 Example of Stress Impact in crisis situation**

A real case study in a situation of crisis management. The author's observation can reveal some aspects of the impact of the stress during this event. It also provides, a timeline for actors reaction with a general view on errors committed, means used, the places where the event was reported and, different information and data known. For this, a retired officer of the Algerian Army has been interviewed (as an expert) about one of crisis situations he dealt with.

### **4.1 Case Description**

A lieutenant of Algerian Army explains, in this case, his experience about a terrorist attack on two villages “Ramkaa and Had El Chekala” (red circle on the map, Figure 1), in the Algerian mountain. In fact, the army had to deal with a group of terrorists in the area. The tactical command post was installed near the mountain (blue flag on the map, Figure 9), in order to prepare their track. In the morning (6h AM) of a day in February, some soldiers had been awake by a young man running to the camp and crying: “They killed them, they killed them.” Soldiers tried to calm the young man and conducted him to the nursery. The crowd woke colonel and lieutenant. The young man explained then that the terrorists were killed all people in his village. Colonel asked the lieutenant to prepare three cars, and they directly went to villages with only simple guns. They drove on a winding road. Terrorist cloud is everywhere and could be attacking them. Arriving at the village, they discover horrible landscape, “everywhere dead bodies, disembowelled women, blood, etc.” They were shocked and did not believe their eyes. One of the Chief starts to talk nonsense words. Soldiers removed his weapon, they were afraid about his safety. The Colonel decided then to visit the nearby village with the lieutenant and some soldiers. They discovered the same horrible situations, adding that, the school was burned with the nursery and the post-office. The colonel sat on the ground without moving. Soldiers and Lieutenant did not have any idea on how to react and what to do. Their radio did not work. There was no network. They stayed in this state more than one hour and a half. Then, other soldiers arrived at the base of ambulances and radio-communication post. Because they guess that their colleagues needed help after two hours of silence. After that, the colonel recovered his senses and called the government crisis cells. He called the tactical command post to send him fire fighters and medical emergency resources. It was about 10h AM. Crisis Cells were installed at Ramkaa village. Dead Bodies were gathered. They discovered some survivals. They received first aid on site. Helicopters arrived and first evacuations started at 1 PM.

## 4.2 Analyzing the Stress Impact



**Fig. 4.** Case modelling

The case analysis shows us some impact of the stress (see fig. 4): (I) Imposing a decision without measuring the impact and the consequences: The colonel took three vehicles with simple guns and went to the village. He decided then to visit the nearby village with the lieutenant and some soldiers; (II) Repetition of expressions and words: One of the Chiefs started spelling nonsense words; (III) Silence, missing decision and actions: The colonel sat on the ground without moving. Soldiers and Lieutenant did not have any idea on how to react and what to do. (IV) Simplification of the situation and inadequate means and actions: With simple guns, they went to villages. Their radio did not work. There was no network. The impact of this stress during this situation is: time-lost; wounded died (waiting from 6h AM to 1h PM); the first soldiers can be attacked and killed by terrorists on the road and in the villages; no communications between operational and tactical teams. This analysis, show us, how the stress can cause considerable damage during a crisis situation. After analyzing the same case by using experience feedback different regulation actions can be identified.

### 4.3 Representing the same situation with feedback experience

After analyzing the same case using experience feedback and in an implicit manner the negative feedback, different regulation actions can be identified.

#### The correct case description

The corrected description start when the young man gives the alert. At this moment, the Colonel will give the order to:

- A Reconnaissance Unit, accompanied by mine sweepers experts, got ready to go to see what happened?
- The Medical units got ready for a possible intervention in villages (field hospital, ambulances, helicopters of evacuation...).
- The hospitals around the city activated their plans of reception of the wounded victims.

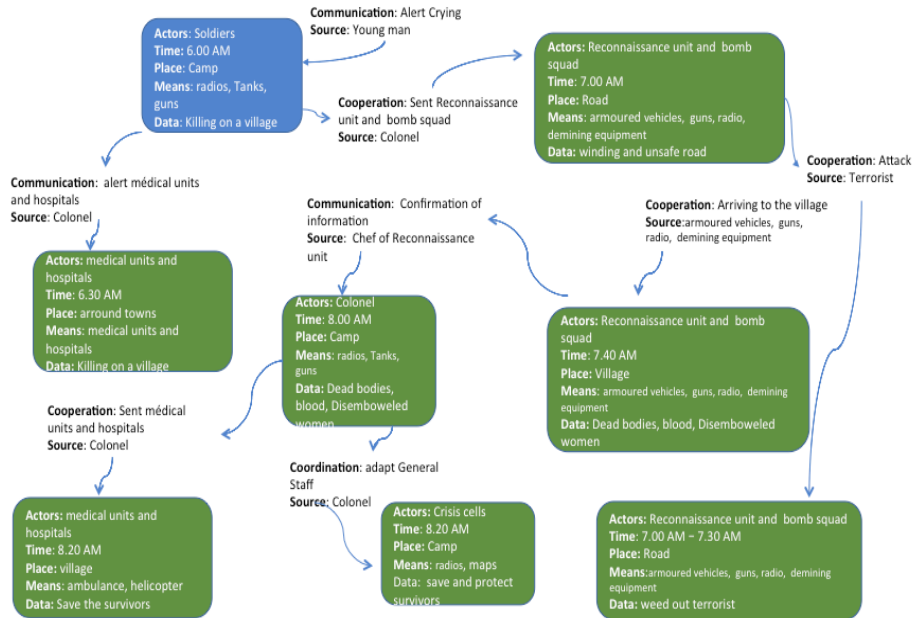
Half an hour after, the unit of reconnaissance was ready and moved toward villages. On the road, this unity had the capability to counter a terrorist attack. Once there, the head of unity confirms the information to the Colonel and begins to secure villages to try to help survivors. The colonel at this moment will give:

- Order to the medical units to move to the village to be able to save lives and evacuate the wounded victims.
- Adapt its general staff to the situation to become a cell of emergency management.

At 9:00 am operations and the evacuations towards different hospitals began.

#### The analyze of the correct case

For this modeling (see Fig. 5), the authors take back the stress impact model by using the same concept event / state. In this model, there was no time lost or moments of fluctuations due to uncertainties in the behavior and in the decision-making. The reconnaissance unit sent to the villages was ready for any terrorist attack. The medical units and the hospitals had the alert at the convenient moment. They had time to get ready. The tactical post command was adapted to the situation to become a cell of emergency management. The most important of all is that the Colonel makes the right decisions at the right time. He did not lose time to save lives. He also preserved his security and the security of his soldiers.



**Fig. 5.** Case modeling with feedback experience

It is evidence that stress will always be present in crisis. The aim of this study is to show at each step: the stress impact actions and, their consequences. And also, the right actions and their consequences in the situation of crisis. By combining the two models (Fig. 4 and 5) and learning from errors, actors try to avoid bad decisions. These should ensure the actors to return to the nominal situation as soon as possible.

The next figure (see Fig. 6) shows an example of one state/event and compare two situations. The process, in the red color, represents the bad actor reaction to events and states. Taking into account the experience feedback, the actors react differently and make the best decisions, which will be saved a substantial time and maybe human lives (process in green). This view of these different situations concerns only the vision of the team of the tactical headquarters and the military engaged in this situation. This type of representation can help to apply prediction algorithms in order to propose a simulation of stressful situations in a learning space. Before presenting our state prediction approach, let us first compare some prediction techniques.

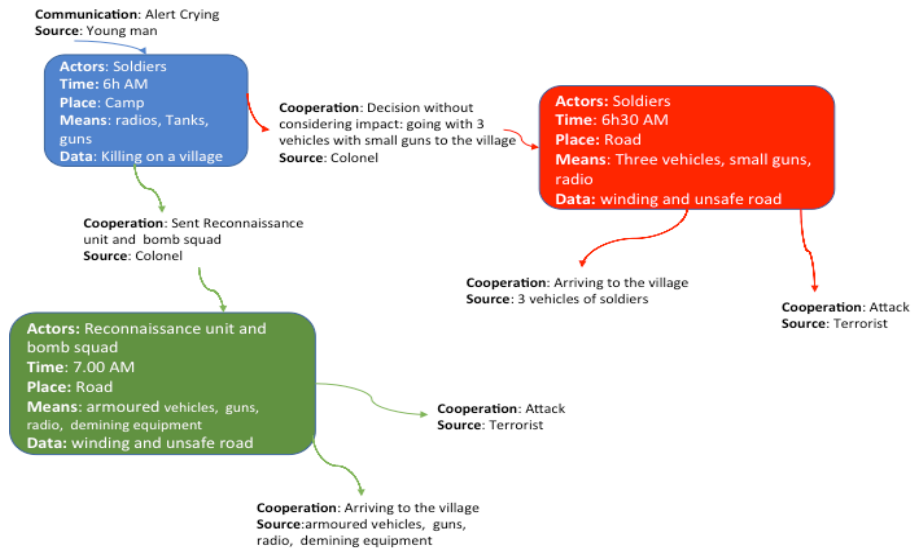


Fig. 6. Case modeling with and without feedback experience

## 5 Conclusion

Crisis management consists in dealing with the complexity and the interdependency of systems and especially with the combination of events. The multiplicity of actors, the importance of the consequences (deaths, serious injuries), the complexity and the disparity of situations to be managed and their rarity make that the actors are quickly overburdened. Several studies propose approaches to prepare actors by training and prevention. Other ones studied the effect of stress in situations. In our work, combining experience feedback and prediction techniques, is proposed in order to simulate the impact of stress in cooperation and its consequences on the situation state. By showing errors and correctness actions, we aim at engaging operational learning close to reality and promoting cognitive checks in order to stimulate reasoning strategy development.

This paper presents our first studies on modelling stress impact in crisis management situations for prediction systems. Afterward, this situation will be reviewed again, corrected and modeled supporting experience feedback. Experience base and prediction algorithms will be developed in order to define simulation environment and test our learning hypothesis.

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