CRISIS MANAGEMENT: IMPROVEMENT OF KNOWLEDGE AND DEVELOPMENT OF A DECISION AID PROCESS

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The catastrophic events of these last years such as the catastrophe of AZF in 2001 or the various terrorist attacks lead to an evolution of the concept of risk by integrating dimensions of crisis and threat. The damages which result from this are not present on a delimited area but impact the whole society. The crisis organizations are destabilized by the unusual features of these situations. The managers must anticipate these situations as soon as possible; react efficiently and in a fast way in order to avoid the consequences of the crisis. However, the decision makers need a fast, clear and structured expertise allowing a reduction of uncertainties related to the crisis and to increase the knowledge about the situation. The objective of this paper is to present, after a state of the art on the crises, a methodology of decision-making aid to help the competent authorities through the assessment of a potential of crisis usable in vigilance and during the emergency phase.

KEYWORDS: crisis management, industrial risk, lessons learnt, decision-making aid

INTRODUCTION

The major risks which are caused by man made events or natural events, are always inherent in our modern's societies but their apprehensions have changed at the beginning of the eighties with the first researches on the subject. The catastrophic events of the last years such as the industrial disasters in 2001 in France or the various terrorist's attacks have brought about some changes in the concept of risk by integrating dimensions of crisis and threat in a more important way. Nowadays, the European and French policies point out the necessity of the improvement of crisis management in the aim to deal correctly with these news and delicates situations and to protect the populations. The objectives of this study is to propose the development of an expertise usable in a continuous way, to anticipate on a trigger event while detecting the warning signals but also to avoid a crisis of great scale by taking into account the aggravating factors. This methodology of decision making aid will help the decision-makers to anticipate a crisis but also to manage a crisis of great scale by the assessment of a crisis potential index.

The paper is organized as follow. The first part, through a state of the art, puts forward the characteristics of a crisis in the aim to increase the knowledge about this particular situation. Then, the paper presents the different means to learn about a crisis and a case study to illustrate this purpose and the last part will strive to provide the principal phases of the methodology of decision-making aid.

CRISIS CHARACTERISTICS

As for the risk, the notion of crisis is a concept due to the fact that each actor taking part in the crisis management has a different vision according to their perception and their domain of competencies. Indeed, a same situation can be perceived as a crisis for some of them but also, as a simple emergency situation for others. Several definitions of the crisis exist and this notion is used and abused (Shrivastava, 1993) in several domains. Some characteristics reported in the literature allowing to defined a crisis as a situation due to a *sudden, surprising and unexpected event* (Boon, 2006), called also *triggering event* that the probability of occurrence is low (Mitroff, 1988) and that causes severe consequences on human, environment, properties, large economics and socials cost (Shrivastava, 1993). But the main characteristic of a crisis lies in the impact on an organization which presents some difficulties to manage them. Indeed, the decision-makers must face to negatives effects as the stress, the lack of information, several uncertainties and a great complexity in the roots causes, in the consequences and in the dynamic of the extreme situation.

A crisis can be understood as a process (Roux Dufort, 2005) that takes place in space and time. In this study, two types of crisis can be defined as an abrupt crisis (1) versus a cumulative crisis (2) in comparison with an accidental situation (3) (Figure 1).

1. The abrupt crisis results from a trigger event, of which the kinetic is instantaneous and of which the hazard potential is high, causing a crisis that develops under the actions of aggravating factors.
2. A contrario, in the case of a cumulative crisis, the situation appeared in a gradual way (during several days or months), after a trigger event, under also the action of aggravating factors.
3. In the case of accidental situation, an immediate response takes place. The management of the situation is without main difficulties. This type corresponds to a classical process of emergency.

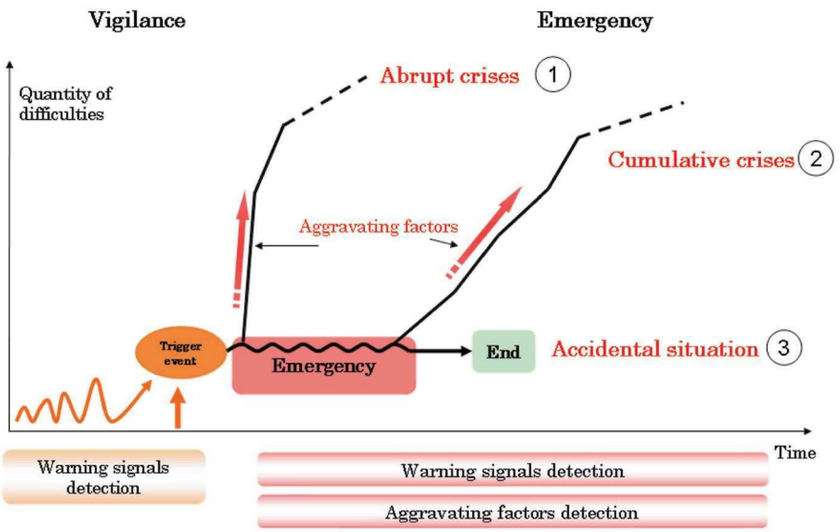

Figure 1. Conceptualization of dynamics process of major accidents and major crises

Various numbers of stages can be defined allowing understanding the crisis process

- **The warning signal or incubation period** (Turner, 1978): This period corresponds to an accumulation of little events or incidents that can be advertised if the organization is able to detect the warning signals. They correspond to indications that can inform about the occurrence of a trigger event or a crisis. Two type of signals are defined as the weak signal (information imprecise and early that the quantity is poor but that the time of anticipation is greater) and the high signal (quantity of information is important but the time of anticipation is reduced). Generally, various means of detection or alert are set up to inform the population but also the employees of industrial plants of the occurrence of a trigger event. But several crises can be preceded of warning signals but it is noted; after an analysis of lessons learnt from past, that some signals have not been detected or no take into account in time.
- **The trigger event**: The nature, the intensity but also the numbers of event can initiate an abrupt crisis or a cumulative crisis. As soon as possible, different emergency plans are prompted. A command chain and a crisis organization are set up in order to deal with the situation and to limit the consequences. An emergency phase takes place (Cf. Figure 1).
- But, under the action of **aggravating factors**, the accidental situation can amplify in different steps of time either in abrupt manner (1) or in a slower way (2). They correspond to parameters that amplify (Gatot, 2000) an initial situation to lead to a crisis. They can be many origins as, for example, technological (collapse of communication), organizational origin (lack of coordination). These parameters contribute to create a complex situation and to affect the decision aid process. The decision-makers have to implement news actions and news plans according to these news parameters in order to quickly get out of the crisis.
- Other important phase corresponds to the **resolution and the end of management**. During this transition phase before the return to a normal situation, decision makers should maintain their vigilance and even should strive harder than ever in order to avoid the occurrence of news events inducing a new crisis situation (Lagadec, 1991).

For this reason, this study aims to develop a decision-aid process in order to improve the crisis management but also to reduce the impact of the situation on the decision process. The increase of performance must be based on the lessons learnt because that allows to determine and integrate the warning signals, the aggravating factors but also all the negatives and positives parameters that contribute to create a crisis.

HOW LEARNING? LESSONS LEARNT, EXERCISES AND SIMULATIONS

The risk management and particularly the industrial risk assessment can be based on the lessons learnt after an event but this practice is not systematic for natural hazards (Ayral, 2004).

The lessons learnt after an accident or a crisis take place in different step of time.

- Immediately after the end of the event, generally one week, a first study is conduced in order to collect the first impressions, positives or negatives, of the actors but also to list damages or indirect consequences (Ayral, 2004). This step can be named the immediate lessons learnt or lessons learnt on the spot.

- The second step of learning takes place several months later. These studies are more complete and have for objectives to analyse the roots causes of the accidents, to describe all the consequences, to try to find the aggravating factors and the warning signals, to highlight the failures, in the aim to improve, in the future, the anticipation and the detection of a crisis, but also to put the organizational failures, in an obvious, without trying to seek responsible.

Beyond the operational aspects that are generated by a crisis, the lessons leant is essential in order to put forward the factors which led to this situation. Indeed, lessons learnt allows to highlight the positive and negative aspects in order to capitalize the knowledge acquired during the crisis, thus to prevent the occurrence of a forthcoming crisis, to improve the vigilance by detecting warning signals (Wybo, 2004) and trigger event of a crisis but also the aggravating factors.

The learning can be made also through exercises or simulations of accidental scenarios allowing to improve the coordination between the varied actors via an increase of knowledge of "With which I must work? How must I work?", to test the operational techniques, the emergency plans and to prevent *in fine* individual error (Crichton, 2001).

So that the learning about crisis was efficiently, the exercises and the lessons learnt must integrated the various characteristics of the crisis that is a description of the accident and the consequences but also the weak signals and aggravating factors in the aim of not starting again the last errors and to capitalize the knowledge as in the following example.

ILLUSTRATIVE CASES STUDIES

The 21st September, at 10h17, a terrible explosion occurred in Toulouse generating the greater catastrophe in France of the last years.

ACCIDENT DESCRIPTION

The explosion took place in a warehouse used for a temporary storage of "off-specifications" ammonium nitrate. The mass of the substance was estimated by INERIS (Dechy, 2004, a) in a range of 20–40 t of TNT that is the equivalence of 20–120 t of Ammonium nitrate involved as reactant. The roots causes of the explosion haven't found an agreement among investigators and a controversy about the ignition source of the ammonium nitrate stored.

CONSEQUENCES OF THE ACCIDENTS

The extent of the damages following this terrible explosion is impressive principally on the population of Toulouse and on the buildings.

Human effects

According to the different report (INVS, 2006; Dechy, 2004,a; INESC, 2002), the first conclusions have identified as 30 fatalities which 21 on the site and 9 off-site, about 9 000 peoples injured with hospitalization (about 860) or medical care The sanitary consequences, in long term, on the population were principally due to three effects: toxicological – *transient eyes effects and respiratory effects for the people leaving nearby-*, traumatic – *blast effects due to the overpressure causing three types of lesion as body wounds (418 persons), eyes injuries and ear traumatism (522 persons)* – and physiologic – *post-traumatic stress (5 600 persons), psychotropic treatment, depression* – (INVS, 2006).

Material effects

The extent of the materials damages in the city of Toulouse was very important and was estimated of 1 500 million Euros by (Dechy, 2004, b) with 75 000 notifications of disaster including about 30 000 housings and 12 000 families have to be rehoused, several schools and universities were damaged and required to be built again and about 1 300 companies were damaged causing about 7000 persons unemployment.

THE CRISIS MANAGEMENT: EXAMPLES OF AGGRAVATING FACTORS FOR THE ACTORS

During the first days of the crisis, about 1500 persons were mobilized to manage this extreme situation.

Several problems have emerged and have contributed to lead to a complex situation. In the aim to understand recurring problems in crisis management, some examples of difficulties encountered by firemen, Mobile Emergency Medical Service, policemen, are exposed (INESC, 2002).

- Problem for the location of the accident area due to a large scale of shock wave impacts and the several calls for terrorist attacks in the centre of the city. Indeed, the explosion has occurred one week after the World Trate Center generating a climate of worries.
- Collapse of the entire communication network during 10 minutes for the emergency call and during 8 hours for the rest of the city cutting of Toulouse from the France.
- No adequate protection for the first firemen and no gaz detector for toxic cloud
- Overloading of the radio networks leading to difficulties for emergencies services to communicate, to transfer information's. This is created a slowdown and a no-coordination of the organization on site. The overloading of the communications ways has also aggravated the management of the accident.
- Imbalance between the means and the needs requiring emergencies reinforcements that are arrived 12 hours after.
- Definition in emergency of a new strategy of injuries management to deal with the extent of the accident.

What lessons can be learnt about this dramatic accident? This extent of this event has demonstrated a limited

response capacity of the first aids (or rescuers) and has highlighted several gaps as a lack of preparation for crisis management when the risk is unknown, a lack of information about the nature of the explosion, difficulties to identify an unknown risk, difficulties to manage the flows of circulation, problem of transmission of information, the lack of emergency-plan for the policeman and some difficulties in hospital for managing a massive surge of victims.

Several lessons and news regulatory plans were created after this greater catastrophe as:

- Reinforcement of emergency response and planning
- Reinforcement of risk assessment
- News regulation in European Union and in France

This case allows defining several aggravating factors can be proposed as for the communications: the default in alert, the collapse or rupture of networks, the lack of communication being able to create a lack of coordination between actors. This dramatic event allows to define and to target the essentials information's useful for the anticipation of various problems that an organization could face during a crisis.

The lessons learnt after an accident are essential in order to highlight the negatives and positives causes and consequences of the crises but also to seek the warning signals and the aggravating factors in the aim to improve the management thought a decision-making aid process.

A SOLUTION TO ANTICIPATE AND MITIGATE A CRISIS: THE DEFINITION OF A DECISION-MAKING AID PROCESS

OBJECTIVES

The aim of this study is to propose a framework allowing to the crisis manager, within the case of industrial, natural or intentional crisis, to collect and analyse the information's that coming from their environment, in a continuous way, 24 h/24 h. This methodology will allow an anticipation of changes caused by an event that potentially can produce a crisis while reducing their vulnerability and the uncertainty of the situation.

The general objective of this study is double:

- To anticipate, in vigilance, a trigger event that can induce a crisis of great scale.
- To mitigate an important crisis during the emergency phase by detecting the aggravating factors that can amplify the initial situation.

To be done, several indicators will be defined in the aim to establish a level of crisis allowing informing in a clear way, the manager.

This methodology allowing establishing a potential of crisis, is composed of two stages (Figure 2):

Stage 1: The characterization of the crisis system.
Stage 2: The definition of indicators and the definition of the potential of crisis. This stage corresponds to the organization of the information, to the definition of the indicators used to assess the potential of crisis.

THE CHARACTERIZATION OF THE CRISIS SYSTEM

The first step of the methodology corresponds to the targeting of the information's characterizing a crisis. For this, a systemic approach is used to structure the problem. A crisis can be defined **as a trigger event** that impacts **the stakes** (the humans and their activities, the natural and built environment), **the actors** who set up various actions, the whole in a political and international **context** favourable for a crisis. Several resources (cases study, lessons learnt) are used to create different typologies (trigger events, stakes and the potential consequences, actors, weak signals and aggravating factors) that constituting the input data. These different

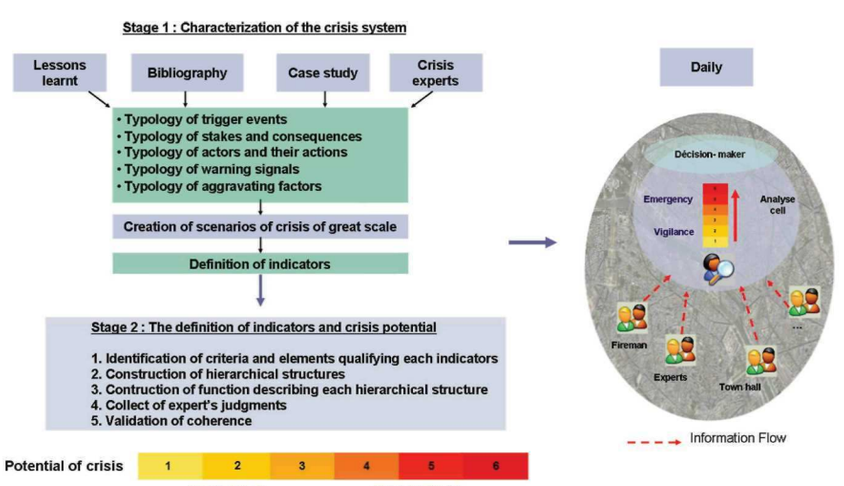

Figure 2. The definition of the decision making process

typologies allowed defining each indicator and finally the potential of crisis.

THE DEFINITION OF INDICATORS AND CRISIS POTENTIAL

The objective of the methodology is thus of to create a potential of crisis based on the aggregation of indicators. For these, the use of a multi-criteria decision method proves to be adequate.

Indeed, the decision making process in crisis management is qualified as complex because several elements of description and analyses of the process of crisis intervene in an interactive and interdependent way. So, to take the right decision in the right time, it's necessary to organize the information's. For this, a multi-criteria hierarchical method (Saaty, 1984) is used because it brings an organization of information and appreciations which intervene in the process of decision-making (Tixier, 2006). Five main steps are defined:

Step 1: Identification of criteria and elements qualifying each indicator based on the characterisation of system defined previously.

As underline previously, a crisis can be understood through a systemic approach allowing defining several sub system as the context, the trigger event, the crisis actors and their actions, the consequences on the various stakes, the weak signals and the aggravating factors. Each sub system corresponds to a general indicator. Thus for each indicator is defined according to several criterions and elements. The objective being of to anticipate a crisis through vigilance, the indicator weak signal could be characterised, for example, by criterion that put in exergue an increase of activities in different emergency services by the use the criterion "call" and "activities" for a specific event compared to a normal. The normal will be defined regardless to the activity of the precedents months or years.

After the collect of information allowing the qualification of each indicator, the following step corresponds to the organization of this information.

Step 2: Construction of hierarchical structures

In order to answer to the potential of crisis problematic, the indicators, the criterions and the elements must be organized. Therefore the step two consists to establish several hierarchical structures.

The construction of a hierarchical structure requires the creation or the identification of links between the various levels of this structure (Tixier, 2006). Four levels are defined. The upper level corresponds to the global objective i.e the assessment of the crisis potential (Figure 3). Therefore, the quantification of each indicator (Level 2) is assessed by a set of criterions (level 3) and elements (level 4). But other hierarchical structures take place at all the levels. These structures allow then to compare the importance of each criterion with another one is evaluated by the way of binary comparison.

Step 3: Construction of function describing each hierarchical structures

From each hierarchical structure, the functions are deduced. For example, the function for the crisis potential could be defined in the following way (Eq. 1):

$$\textbf{Potential of Crisis} = \alpha \cdot \mathbf{I_{Contexte}} + \beta \cdot \mathbf{I_{TE}} + \gamma \cdot \mathbf{I_{Actors}} + \delta \cdot \mathbf{I_{Cq}} + \epsilon \mathbf{I_{WS}} + \zeta \mathbf{I_{AF}} \quad (1)$$

With TE, trigger event; CQ, consequences; WS, weak signals; AF, aggravating factors. The weight of each indicator will be assessing by expert judgement.

The indicator "weak signal" being composed of two criterions "Call" and "Activities", the function could be defined (Eq. 2 and Eq. 3) as:

$$\textbf{I Call} = \alpha \text{ I call (F)} + \beta \text{ I call (MEMS)} + \gamma \text{ I call (Hl)} + \delta \text{ I call (...)} \quad (2)$$

$$\textbf{I Activities} = \alpha \text{ I action (Firemen)} + \beta \text{ I act (MEMS)} + \gamma \text{ I act (H)} + \delta \text{ I act (...)} \quad (3)$$

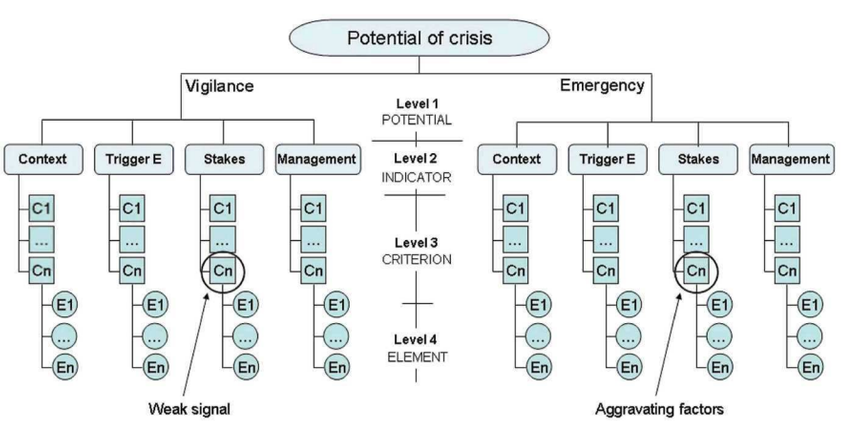

Figure 3. The global hierarchical structure of the potential of crisis

With F, Firemen; MEMS, Mobile Emergency Medical Service; H, Hospital,

Step 4: The collect of expert's judgments

This step corresponds to the assessment of the priority between each criterion based on pairwise comparisons of elements. The experts assess the relative importance of an element compared to other of the same hierarchical structure through a numerical scale (Saaty, 1987). The expert judgement is collected through the use of questionnaires. At the end of this step, each indicator, criterion and element will be modified by a weigh (corresponding, in this example, to α, β, γ, δ, ϵ, and ζ).

Step 5: Validation of coherence

To validate the coherence of expert judgement, a ratio of coherence for each hierarchical structure will be calculated.

But several limits emerge and will take into account. By definition, a crisis is an only situation. The lack of information but also the abundance of information can be also a revealing indicator of crisis. Some elements present during a crisis can have any effect whereas in other situation, they can have an aggravating effect and amplify the initial situation.

CONCLUSION

The crisis management is one of the political issues of the European and French governments. Indeed, each year, a crisis of great scale impacts societies causing more and more dramatics damages on the population but also on the economy of a country. The crises correspond to dynamics phenomenon's which can be defined by an event approach (trigger event is the starting point of the crisis in the case of abrupt crises) or by a process approach (the crisis has started before and under the impact of a trigger event, increases in intensity). The improvement of the crisis management can be process by several ways as:

- An increase of the knowledge about these extremes situations through the formalisation of lessons learnt from the past and by the use of simulation in the aim to improve the coordination between actors
- The definition of an expertise usable in a continuous way, to anticipate a trigger event while detecting the warning signals but also to avoid a crisis of great scale by taking account the aggravating factors via the creation of a crisis potential index. A crisis represents an opportunity to learn.

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