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# Performance Evaluation of Organizational Crisis Cell: methodological proposal at communal level

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**ABSTRACT:** Crisis management has become an essential activity for all public and private organizations. Crisis management is most often based on a specific tool called "crisis cell". This paper aims to implement the precautions of anticipation, vigilance and intervention to meet the targets. Recent studies indicate that for over 50 years, catastrophic events have increased. In France, the crisis management plans are deployed to ensure an optimal state of readiness in case of a crisis. However, these plans do not guarantee optimal performance of crisis units. Crisis cells may become particularly vulnerable, and unable to fulfill their missions according to each event. This article proposes a method, primarily based on systems thinking to understand the vulnerability of the crisis cell and assess the performance of crisis management at the municipal level.

## 1 INTRODUCTION

The word crisis comes from the Greek word "krisis" means "decision". It was originally used in the field of medicine and then expanded in the field of psychology, politics and economics. According to Morin, the notion of crisis has spread to all areas (Morin 1977) but remains the sudden and intense appearance of certain rupture phenomena.

In 2004, the French state established a legislation to modernize the civil defence to organize and manage crises (Bill to modernize the civil security, Senate, N°277). This law allows a municipality to establish a crisis cell to protect people and safeguard the environment. However, these plans do not guarantee optimal performance of crisis units. Crisis cells may become particularly vulnerable, and unable to fulfill their missions according to the event. Questions concerning the management of crisis begin to emerge, for instance: What are the concerns of crisis management? How to manage a crisis? Which tools support the decision? Who are the main actors involved? Is the complexity of the territory a hindrance for decision-making in a risky situation?

The estimation of the decision's consequences in a risky situation will be delicate because of the complexity of urban land in question (physical structure, networks, etc.) and environment on which these decisions must be taken. This fact underlines the importance of the implementation of a comprehensive

approach for decision making, particularly on indicators ensuring an effective management of emergencies in terms of space and time.

This subject is a research project on the systems approach to formalize the decision in an emergency situation within a complex urban area. It is subsidized by a scholarship from the PACA (Provence-Alpes-Côte d'Azur) Region with the partnership of CRC (Centre for Research on Risk and Crisis) and security centre of a French city. The objective of this paper is to present a methodology for the analysis of the vulnerability of the crisis cell and assess the performance of crisis management at the municipal level.

This article is structured in four sections:

The first part aims to define the crisis management cell and its organization. The general principles and experiences of crisis cell will be described here through a bibliographic state of the art. The second part is devoted to describe the modeling as a methodological support for studying organizations. In this part the systemic approach and UML language will be presented as the modeling tools for this research.

The third part details the method to study the vulnerability of crisis cell. A crisis cell model will be presented by using UML approach. This illustration will analyze the system in order to understand the organization's performance.

The last section will present the expected results and the conclusion of the article.

## 2 THE CRISIS AND CRISIS MANAGEMENT

Before going into details of crisis cell, it is necessary to define the notion of crisis, the actors playing a role in the system and the tools used to be prepared for the crisis management. Then, a short presentation of the organization confronted with a crisis situation will be made. Finally, the sequence of the crisis will be presented. This last part will include the organization of the municipality and the actors involved in crisis management.

### 2.1 *Crisis management at municipality level*

Crisis is defined as a loss of controlling the situation. According to Marguin (Marguin 2002), crisis occurs in an environment which is composed of multiple actors who interact in the context of organized structures. It results from a combination of three phenomena:

- An event that may cause a disruption of the balance of the system,
- The desire of actors,
- A “spark” event (an unexpected event, a violence, an uncertainty or inadequacy of an action, etc.).

The French state, based on the definition above-cited, has established a set of disposal to avoid an event generating a crisis. As a result, crisis management is a set of tools and techniques that are in place to enable an organization to cope with a crisis and be able to manage better.

### 2.2 *Municipal Plan for Safeguard*

In France, the law of modernization of civil security (Bill to modernize the civil security, Senate, N°277, 2004) insures the protection of people by developing a culture of preparedness for risk and threat. It focuses primarily on addressing the risks by anticipating the reshaping of "protecting people" and the mobilization of all available means (Dautun 2007). Therefore decrees have been introduced, asking for the implementation of the plan of “Organization of Civil Security Response” (ORSEC stand for Organisation de la Réponse de Sécurité Civile), “Communal Information Document on Major Risks” (DICRIM stand for Documents d’information Communal sur les Risques Majeurs), and “the Municipal Plan for Safeguard” (PCS stand for Municipal Plan for Safeguard), etc.

The PCS is a document for managing a crisis in municipalities. This document will be discussed in

more detail because it describes the stages of communal crisis management as well as the organization of the crisis cell. It is addressed to the mayor and aims to establish an organization in the occurrence of serious events to protect the population and the environment. The mayor is responsible for the civil protection in the commune. He has the control of police power, the responsibility to develop the PCS and to be in charge of the crisis cell. This plan is used by the mayor or his designated representative and aims to establish the communal crisis cell in order to support the civil security in the critical phase of the crisis, to restart the city as soon as possible and to manage crises. The crisis cell defines the conduct of operations and controls all operational phases such as information, support, rehabilitation, logistics, communications, general services and the switchboard. The cell can be initiated by the Mayor or upon the request of the prefectural authority. These means will permit the organizations to establish a network of response structures supporting the coordination of actors (Dautun 2007).

To be more efficient, the number of members of the communal crisis cell must be limited to fifteen (Renaudin & Altemaire 2007), composing of at least:

- A crisis manager (Pilot/Co-pilot) who determines the strategy of the intervention, makes decisions and coordinates the crisis to manage it in the best conditions.
- A spokesperson who responds to the expectations of the media and the public in a structured and consistent way.
- A general secretary: who manages the human and material resources of the town, available places or make available the vehicles of the town hall and other materials that could be used in case of crisis.
- A Secretary responsible for the installation of the cell. His role is to edit and send the reports, maintain the schedules, classify and archive documents and ensure the smooth functioning of the logistics team of crisis management.
- A communications officer who links between different municipal actors, the administrations concerned with crisis management and the office of mayor
- A person who is in charge of the handrail. The handrail is a note book to note the various events during the crisis (phone calls, hours of output communication press, the stages of crisis management, etc.). It is used in case of litigation or for the lessons learned.

The figures 1 and 2 were designed from the PCS. Figure 1 shows the crisis cell of the studied city. It is organized in 14 sub cells. These cells are grouped according to the collaborations between each cell.

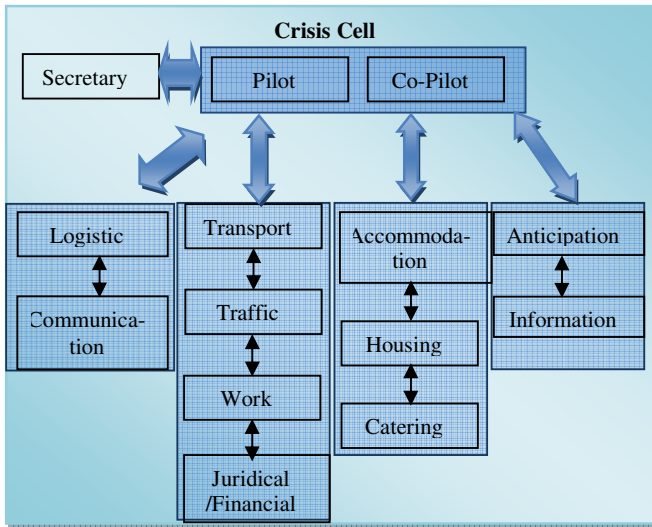


Figure 1. Crisis cell model for municipality

In a crisis situation many partners (fire men, police, etc.) should interact with the crisis cell in order to resolve the problem. Their coordination in this context is a major challenge for the resolution of the crisis and their interoperability is a critical component for a successful resolution. The diagram below (Fig. 2) shows the actors who are interrelated within the cell. Relevant actors of the crisis situation have been identified during visiting the city.

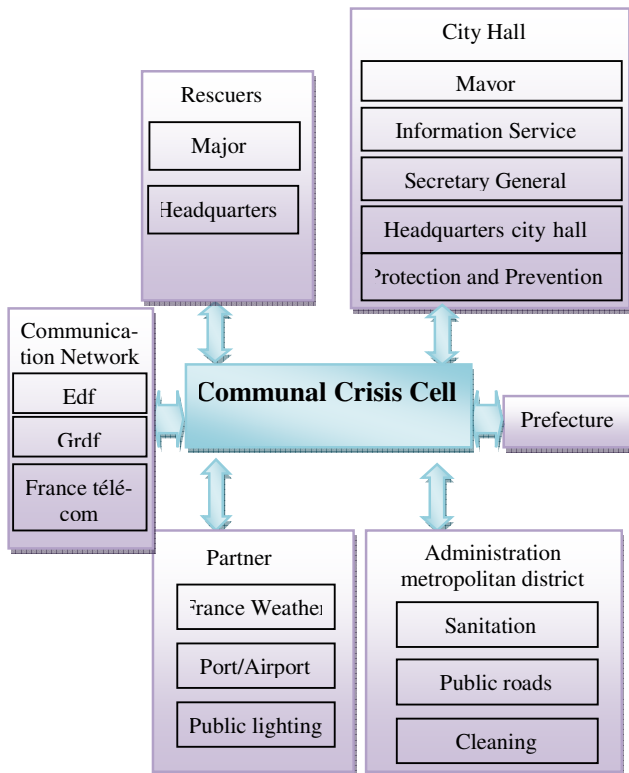


Figure 2. Partners interact within the municipality crisis cell

PCS is one of the few documents describing the organization at the municipal level. It implements an organization planned in advance in case of occur-

rence of serious events to safeguard the public and protect the environment.

This section presented the general framework of the crisis management focusing on the crisis cell.

From the perspective of modelling the crisis cell, this part underlines the necessity of crisis management process and the present actors during the occurrence of a major risk.

After defining the organization of the crisis cell and the actors involved, the following section focuses on the complexity of the city and introduces the concepts of systemic, UML and their contribution to the context of crisis cell.

### 3 MODELING AS THE METHODOLOGICAL SUPPORT FOR STUDYING THE ORGANIZATIONS

In parallel to considerations of public policy for prevention and management of emergency situations, there are some approaches to model complex dynamic systems and simulate their changes over time to build scenarios. The systemic approach represents an appropriate approach to understand the behavior of a complex system (Katsky 2004, Marguin 2002) develops a system of representation for understanding complex situations such as a complex urban territory.

A system is “a set, forming of a coherent and autonomous unit, of real or conceptual objects (hardware, people, actions, etc.) organized according to a goal (or set of goals, objectives, finalities, projects, etc.) by means of a set of relationships (mutual interrelations, dynamic interactions, etc.), all immersed in an environment” (Le Gallou 1993 in Aubert-Lotarski). But what is the system that will be modeled? What are the approaches that will be used? For what purpose? What are the outcomes?

In this section, the main principles of the systemic approach will be presented focusing on the main types of models and the systemic approach. Finally UML approach will be presented.

#### 3.1 The general systems theory and systemic approach

The territory is an evolutionary complex system that concerns a set of actors on the one hand and the geographic space on the other hand. The actors use, develop and manage geographic space (Moine 2006).

This research will focus on the games of the actors of a crisis cell and particularly on the relations of actors evolving within an organization. Are these games of actors complex? And are they considered as a complex system?

According to Moine (Moine 2007), the actor’s system is complex. The geographical area is also a

complex framework with which the complex system of actors combines. Mintzberg (Mintzberg 1982) defines the complex framework as being guided by uncertainty factors. Moine adds that the territories are in "tension", that is to say that the dynamic equilibrium is based on a set of interrelationships that constantly change and evolve over time. The territories have constraints that are not foreseeable, so they change the decision context of the actors.

The studied city can be considered as a complex system because of these interactions. Modelling of complex games of actors in the management of crisis cell will be conducted during this project. This modelling allows understanding the organisation of the cell in order to evaluate its performance. A model is a simplified representation of a system at a particular time or space to promote understanding the real system (Durand 1992). The general systems theory has been proposed by Von Bertalanffy in 1956. Its purpose is to analyze areas that are outside the current type of explanation in physical science (Rojot 2005). This theory allows analyzing complex phenomena in which the behaviours of interconnected components are oriented to a goal or a direction (Von Bertalanffy 1956). Several approaches were inspired by the general theory of systems such as the systemic approach.

The systemic approach aims to formalize a method to organize the production of knowledge about objects and direct action on these objects (Aubert-Lotarski). Donnadiu and Karsky (Aubert-Lotarski) define three stages for the systemic approach:

- Systemic exploration permits to define the system under study and to situate the system in its environment. The observation identifies the system, its environment and the various streams running through the system (Aubert-Lotarski).
- Qualitative modelling can make a representative map of the system, adding the interactions between the key components, flows and control actions to regulate it.
- Dynamic modelling introduces the concept of time to observe possible changes of the system through the simulations

The systemic approach is needed to understand the system and the organizational complexity (Aubert-Lotarski).

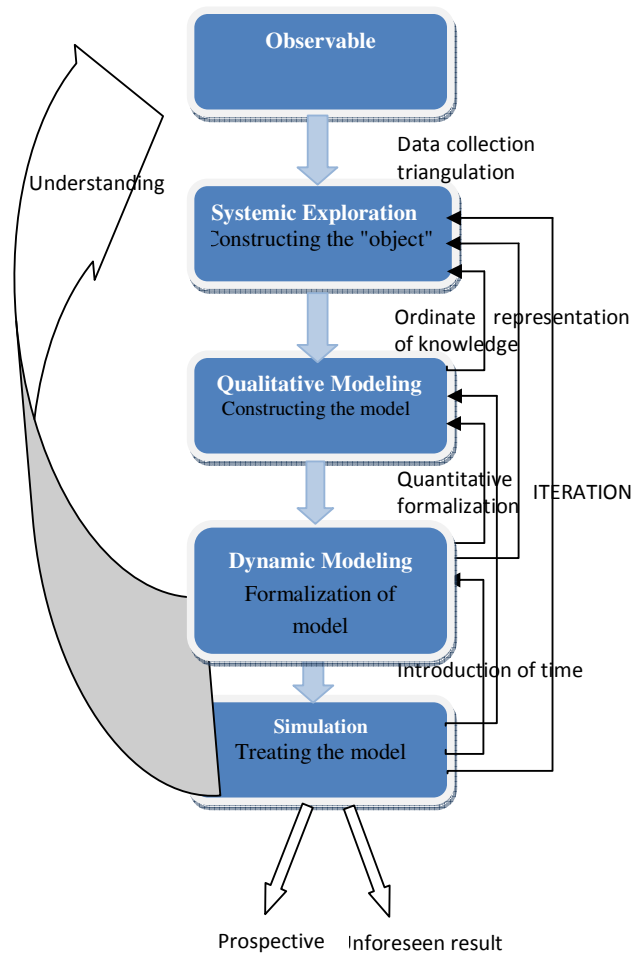


Figure 3. The steps of the systemic approach (Donnadiu & Karsky 2002)

To analyze the "dynamic interaction" between the actors of the crisis cell, our research project will use the systemic approach and will integrate the UML approach.

### 3.2 Formalizing UML

UML is a graphical modelling language and has become a standard for modelling objects defined by the Object Management Group (OMG). In this paper, UML will be used as an operational tool to formalize the interactions within the system of crisis cell in order to understand the performance of the crisis cell. This approach will give a definite form to the system in a standard way by using different diagrams. UML is a language for specifying, visualizing, implementing and documenting computer systems (Jacobson et al. 1999). It has thirteen kinds of diagram to represent different aspects of the system. These diagrams can be categorized into three types: static, dynamic and behavioural.

Some diagrams are used specifically for the IT sector that's why only three diagrams will be used for this work:

Table 1. Structural and dynamic diagrams in UML language

Diagram Types	Name	Objective
Static Diagrams	Class Diagram	Represents classes involved in the system
Dynamic Diagrams	Sequence Diagram	Sequential representation of the treatment and interactions between system components and / or actors
Behavioural Diagrams	Use Case	It models the interactions between system and actors

This language is commonly used in computer modelling for computer systems and software. Increasingly, it is used to model other types of systems such as the information system of natural hazards (Napoli 2001), Development of safety-critical systems of railways (Boulanger et al. 2009), Systemic modelling approach applied to support risk analysis of a storage unit of chemical products in Morocco (Bouloiz et al. 2010). The following section presents the method to study the vulnerability of crisis cell.

#### 4 STUDY OF CRISIS CELL'S ORGANIZATION VULNERABILITY

Most of the time, the crisis cannot be avoided. The purpose of this research is not to reduce the probability of the occurrence but to improve the management of the occurring event, focusing on the resilience of the organization (Bout 2005).

The organization plays an important role in managing risks and crises. In a crisis situation, the trigger may destabilize organizations that are unprepared and may react inappropriately because of their vulnerability. The lessons learned from Hurricane Katrina in 2005, emphasize the internal vulnerability of the U.S., vulnerabilities within its security system and its impotency. It was indicative of a lack of internal preparation. Indeed, during ten days, the event had not been categorized, the number of players needed to act was inadequate and did not allow actions to manage the crisis where the gravity and the destruction rate was high.

Mintzberg (Mintzberg 1994) defines the organization as "the total sum of the ways to divide the work in separate tasks and then provide the necessary coordination between these tasks."

An organization may have three meanings, according to Crozier and Friedberg (Crozier & Friedberg 2009):

- "A group of humans who are coordinating their activities to achieve common goals, the organization is considered here as a response to the problems of

collective action, coordination, stabilization and development

- The various ways in which the groups structure their means at their disposal to achieve their ends
- The organized action or process that leads groups or organizational structures. "

This section presents the methodology used for studying the performance of the Crisis Cell. Afterwards the qualitative modelling will be presented.

##### 4.1 Approach for study the vulnerability of organization

The proposed approach to develop the analysis of the vulnerability of PCS's organisation based on systemic approach (section 3.1). It is organized in the following divisions:

- The first phase of the systemic approach (observation) allows to know the organization of the crisis cell, the actors involved and the flows between them. Thus a visit in the studied city was necessary for the identification of crisis actors who have influence on other actors or the instability factors. Each actor is characterized by its own goals, means and constraints and by its links with other actors (Marguin 2002). This phase involves analyzing the PCS and visit the town under study.
- From these observations, two models will be offered: the crisis cell as prescribed and as observed. After validation of both models by stakeholders, a comparison will be made to "see" if there is a difference between the two. If a difference exists between these two models, would it be related to the organization of the crisis cell?  
After having modelled the crisis to understand the system, we study the quality of organization by Risk Analysis. Risk Analysis will be modelled with Primarily Risk, or fault tree and UML sequence diagram.
- Risk analysis allows building scenarios. Scenarios are developed to evaluate the system in different situations. Risk analysis is the study that determines the degree of risk and assesses the direct and indirect, tangible and intangible event on an organization (Garbolino et al. 2010).
- The fourth phase of the systemic approach is to integrate the concept of time in the qualitative model to observe changes in the system. In the dynamic simulation for common applications, two modeling methodologies exist: the System Dynamics (SD) and Multi-Agent System (MAS).  
MAS is a collection of autonomous agents that can interact freely with each other. It is



used in complex systems where artificial entities and/or natural interact to produce collective behavior (Muller 2005).

System Dynamics proposes to study, to model and simulate the phenomena that make a change through time. Models allow us to understand the dynamics of systems based on the concepts of interaction, feedback and complexity (Forrester 1956).

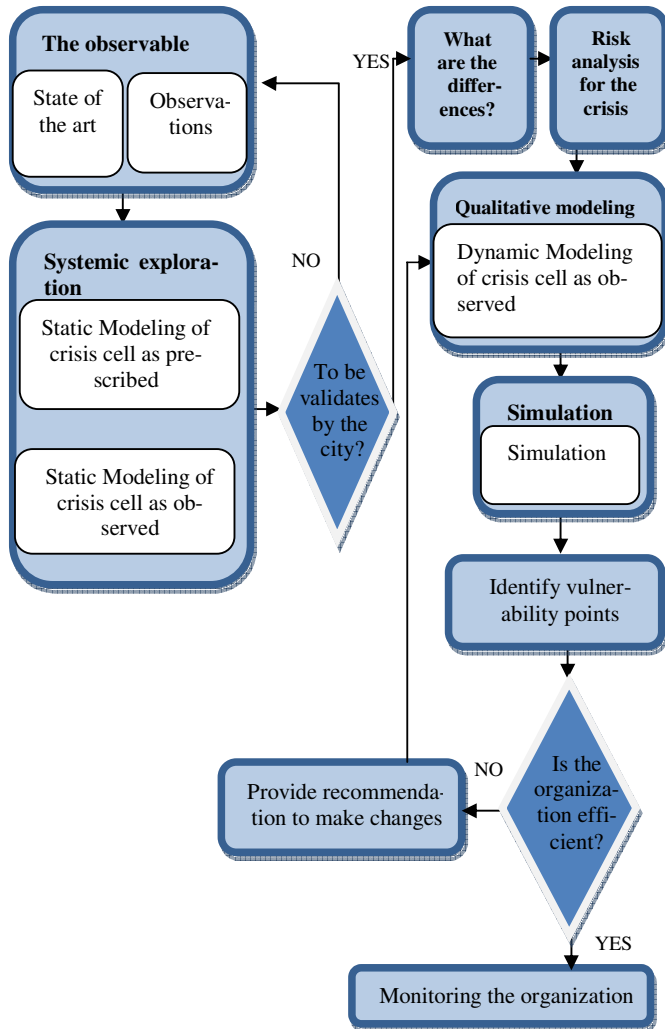


Figure 4. Proposal of a methodology for studying the performance of the Communal Crisis Cell

MAS is focusing on individuals unlike the SD which is used for strategic modeling. One of these methodologies with theory of organization will be chosen for dynamic modeling

- The above step allows to identify vulnerabilities of the organization.
- Finally a mode of organization will be proposed

In the following section, we present the first part of the study. This study focuses on the static modeling of Crisis Cell.

## 4.2 Applying UML for the modeling of the organization

The first two phases are analyzing and modeling the system. UML approach is used for modeling.

Figure 5 highlights the actors involved in crisis management and actions made during the occurrence of the event. Three actors are present in this diagram: Firemen, Mayor (and the city hall) and Prefect (and the prefecture). These actors have been identified from the PCS and meetings with department security. This representation is general and does not take into account all the actors involved in crisis management.



Figure 5. Case of the crisis sequence at the scale of a city

The sequence of the crisis is separated into two parts: the preparation phase for the crisis and the crisis management phase. Only the Mayor and the Prefect involved in the first phase, concerning the establishment of emergency plans. If the event exceeds the commune, the prefect is responsible for directing rescue operations. With the help of the directions of studied city, the Mayor has the duty to rescue people and preserve the environment. Emergency and safeguard backup phases include protection, evacuation of the population, informing the population, protection of natural environments, etc. The Mayor also manages the firemen who provide the information for the crisis cell, manage the infrastructure and carry out the rescue.

Crisis cell models have been made from the PCS book and the observation. The external links are not described. Here, the mission and resources are described for each sub cell. The first one (Fig. 6) is the prescript model and the second one (Fig. 7) is the observation model. For reasons of clarity, only part of the organization of the crisis will be presented. The two models are almost identical. The number of sub cells is the same but the links are different. In

these examples, we select the Pilot / Co-Pilot cell, anticipating-assessment cell and the information cell. The Pilot / Co-Pilot cell coordinates all the cells of crisis affecting the missions and is in contact with other cells. Anticipation - evaluation, as its name implies, assesses the extent of the crisis and trying to anticipate the evolution of the crisis. As for the information cell, the “central information” is the bridge input information.

From the PCS book we obtain the following diagram (Fig. 6). The PCS is divided into five parts. The third part of PCS book details each sub cell. The PCS details all the activities of the crisis cell, the communications between the sub cells are difficult to distinguish.

In PCS, evaluation anticipation cell is present and is even the central cell for decision support. It receives information from other services and the pilot and copilot (the other sub cells receive the information as well). So with all of its information, the cell assessment advises the driver and co-pilot.

Seven meetings were held to make figure 7. The information and anticipation sub cells were met at the first meeting. At this meeting the problem that was raised was the lack of valorization of the evaluation sub cell. This cell feels excluded because other cells do its works. The second meeting was with the decision group. Pilot copilot, the communication sub cell, the secretary and the logistic were present. This meeting underlined the proper functioning of the communication cell. Others meetings were held with each sub cells. All cells were invited in the meeting synthesis. Several problems were highlighted technical problems. However, three problems were the central points of the meeting. The first one is the staff shortage. The role of the anticipation cell is not very well defined. Finally, the last problem is that cells do not know each other. For that, exercises should be done.

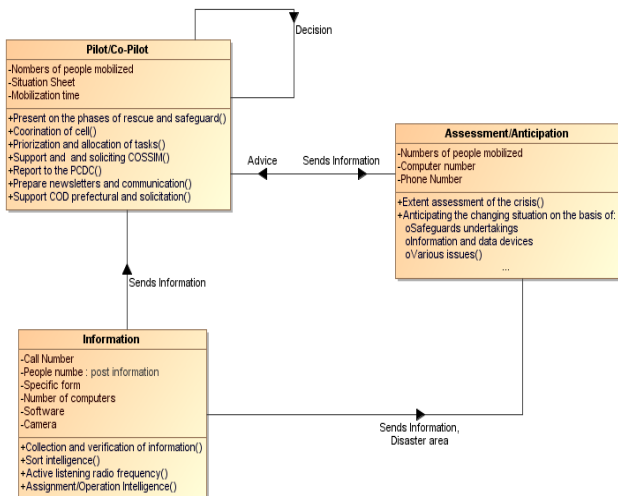


Figure 6. Class diagram describing the various relations and interactions between crisis sub cells as prescribed in PCS book

Figure 6 allowed having the composition of the crisis cell. Meetings concentrate more on the exchange between each sub cell.

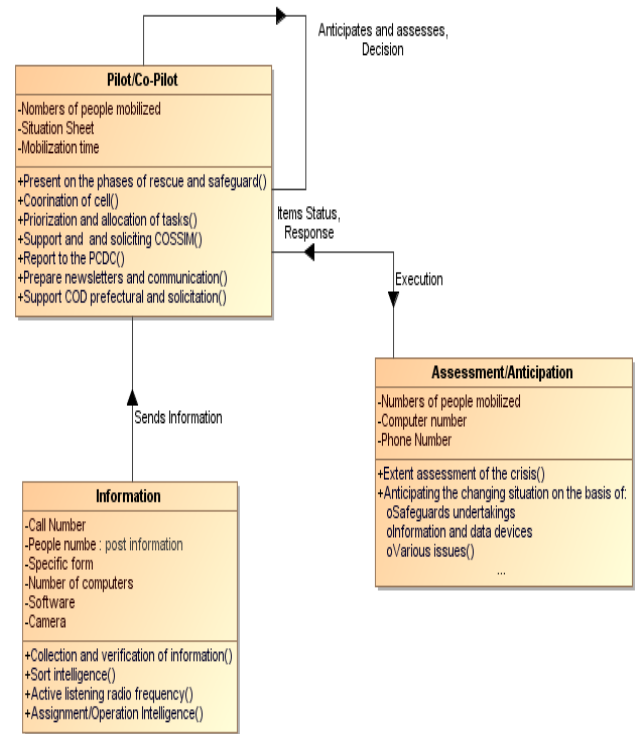


Figure 7. Class diagram describing the various relations and interactions between crisis sub cells as observed

And finally the Figure 8 is a sequence diagram that describes the conduct of the operational phase. This diagram shows the chronological sequence of operations performed by actors of crisis management (Audibert 2009). It evokes the conduct of the operational phase during a flooding. This sample is not random: The flood is a known risk in the studied city and this scenario may be used as an example for the simulation of the model. The weather service warns the prefect and the commune of flooding risk. If the alert is confirmed, the municipality requisitioned the companies so that they can provide equipment, housing and other required facilities.

The city informs the population, activates the PCS and manages rescuers. Firemen rescue the people. If the event exceeds the municipality, the city requires the intervention of the state and the prefecture will take over the rescue. Once the event ended, the return to normal situation is announced. Then a process of return to normal situation is put in place.

This diagram can be used for the Fifth part to define scenarios.



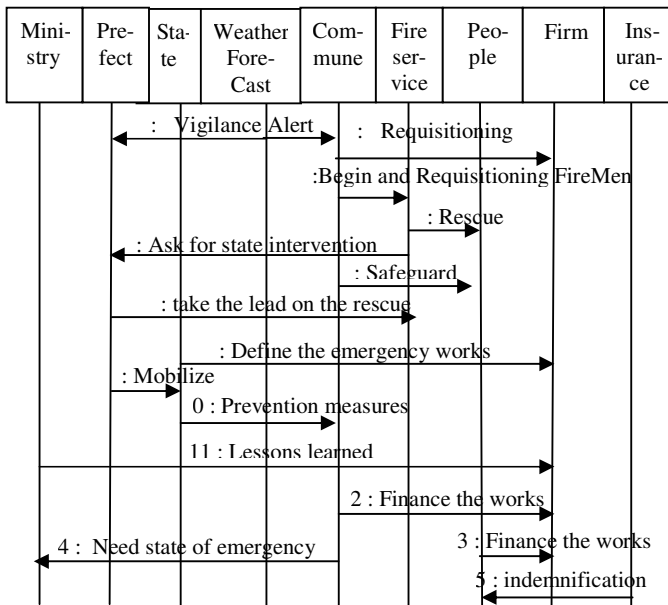


Figure 8. Crisis Sequence Diagram describing the conduct of the operational phase during a flooding

## 5 EXPECTED RESULTS AND CONCLUSION

The decision support is an activity of those who seek to apply a scientific approach (eg. systemic approach) to illuminate the managerial decisions and / or guide decision-making processes in organized systems. Since the crisis cell and relations between actors are complex systems (Morin 1977, Moine 2007), our research project underlines the importance of implementing an approach that can analyze and understand complex dynamic systems of a system.

The UML approach aims to understand and simulate the operation of the crisis, including the interactions between actors which are complex. It represents an approach particularly suited to understand the behaviour of a system. The UML approach was chosen for several reasons:

- The UML includes several diagrams including class and sequence diagram. The latter introduced the concept time. Class diagram describe the resources and functions of each sub cell.
- Finally, the UML was originally designed for analysis software. The aim of our research is to have MAS (or simulation tool like JAVA CSCW ...) to study behaviours of actors in crisis cell. UML is insufficient for dynamic models. Unlike objects, agents are active, have initiative and can choose how to treat an external request. The UML analysis will help to understand this system.

Studies have been done on decision support contingency plans. Georgios-Marios Kargiannis (Kargiannis 2010) has done some work on robustness analysis of industrial emergency plans. The methodology used is based on structural-functional model describing both functions and resources. In his study, he fo-

cuses on the rescue plan in itself and not crisis cell organization. Juan Jamon Jacob (Jacob 2010) also works on PCS but he focuses exclusively on the upstream and after crisis. Both studies use risk analysis to identify failures of plans. The time concept is not integrated in these studies.

The next stages of our study will incorporate the concept of time.

The usefulness of all above mentioned methods is to define failure scenarios of the organization and to identify the consequences of these failures.

From this model a form of crisis cell organization will be proposed to the studied city in order to make it approaching to a high performance organization.

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