Avoid remaking the same mistakes again: a framework to analyse previous errors

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Abstract

Managing complex systems is not an easy task. In particular, crises management involves a huge variety of difficulties that challenge even the most skilled managers. The analysis of previous real crises and disasters shows up that managers face analogous problems and tend to make similar mistakes. The troubles of these decision making processes include, for example, the absence of explicit management plans and goals, or the focus on intended consequences, ignoring unintended or non-desired ones. These problems have already been analysed in the literature by authors such as Dörner, Sterman or Wolstenholme. This research paper compiles some very relevant ideas about the reasons and rules that lead crises managers to understand the evolution of crises and presents them in a structured framework.

1 Introduction

Modern society has created sophisticated systems that have significantly increased our welfare. However humans still are fragile when accidents, natural disasters or intended attacks happen. In the case of a crisis, even the best managers could make wrong decisions, although they have the best intentions. There are several causes behind these errors. Some of these causes are more related to the characteristics and the boundaries of the system, some others are more related to the perspective adopted over the system. This paper compiles these difficulties of managing crises and presents them in a coherent and structured framework. This framework has been built because we have not found an analogous taxonomy in the analysed bibliography.

The framework presents three main dimensions: the first is related to the characteristics of the problem being managed. The second concerns with the management style. The last is related to the boundaries of the crisis and the "permeability" of these boundaries. The framework presented in this paper can be used to classify different types of crises. This classification could be helpful to better understand the causes that create problems during crisis management.

2 First Dimension: Characteristics of the crisis

There are no longer simple crises. Any crisis involves the management of many interrelated variables. In addition, there may be variables hard to measure, which will generate new problems to crisis managers. There is a last problem; some crises are significantly affected by time delays. Consequently, we can define three types of crises: Complex crises, complex opaque crises and complex opaque dynamic crises.

2.1 Complex crises

Crises typically include social, economic, environmental, technical, legal and might involve other types of variables. Accordingly, decisions may affect the system in many different ways. Agents involved in crisis management may have a partial perspective over the problem. In this case, they will concentrate their attention on some particular aspects of the problem and ignore the "whole picture".

Additionally, humans tend to focus on desired consequences, while they tend to ignore the non-desired ones. If agents believe that an action can improve a situation they will only focus in events that verify their thinking, so a superstition turns into a theory (Sterman 1998).

Example: The amount of young people consuming drugs has increased within a community. This problem can not be solved only capturing drug dealers. We will also need to implement educative and social activities that suppose a real and sustainable solution. However, managers can decide that the more efficient and productive policy consists on arresting dealers. This solution can have a positive effect for some days. The recognition of this positive effect can lead to identify the arrest of dealers as a "best practice" of this kind of problem. A deeper approach to the problem would determine that this is not a sustainable long term solution.

2.2 Complex opaque crises

Managers might not have access to the entire information about the current status of the problem they have to deal with. This situation takes place because some of the variables involved in the problem are hard to measure. Due to the heterogeneity of the variables implicated in a crisis, managers only have partial information. Consequently, they have to make decisions about a system they do not observe entirely.

Managers may be aware about this lack of information or not. Therefore, it may happen that there is a situation where managers "do not know that they do not know".

Some examples of this type of behaviour can be explained using systems archetypes (Wolstenholme, 2003). Archetypes are "a formal and free-standing way of classifying structures responsible for generic patterns of behaviour over time, particularly counter-intuitive behaviour" (Wolstenholme, 2003). These archetypes include a mechanism that is usual in the management of complex systems: the system reacts to the implemented policy in an unattended and unexpected way.

Example: The fraction of smokers has increased in a society for several years. This has caused that the expenses for attending the derived medical costs have also increased to unacceptable levels. Therefore, the local Government decides to highly increase the taxes to tobacco. The intended consequences are two: the first one is reducing the smokers' rate due to high prices; the second one is to increment the government incomes to have more money for medical care. But managers do not take into consideration all variables because some of them are hard to measure. For instance, the capacity of tobacco industry to create a new substitutive product: the low quality cheap tobacco. This means that the health problems derived from this low quality tobacco get

worse, while the money taken by the government through taxes is reduced due to the low prices.

2.3 Complex opaque dynamic crises

Real systems usually need some time to react after one decision has been made. Once crisis managers have decided to implement countermeasures, some time is needed to communicate this decision to the ones responsible for its implementation. Usually more time is needed for producing results. As a consequence, it is not easy to connect the obtained results to their cause (t1+t2+t3) (See Figure 1). This can be even more difficult if more decisions have been made in the meantime.

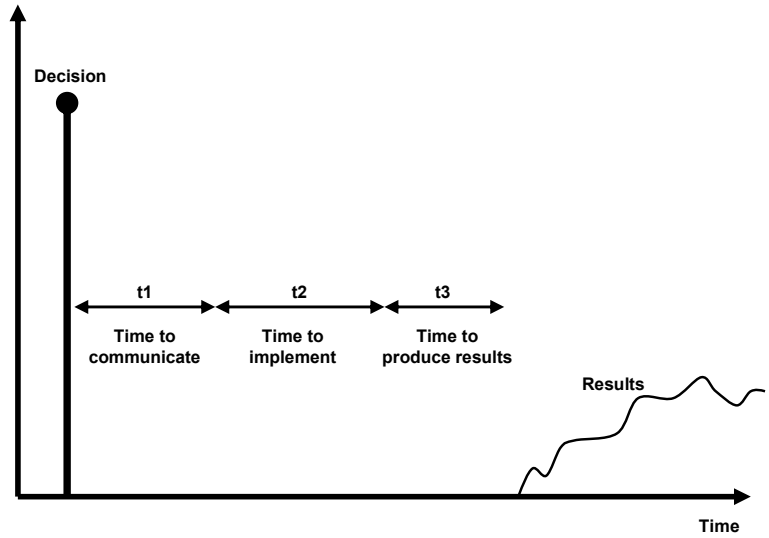

Figure 1: Delay between the decision and its results

There is another fact that affects this "dynamic complexity" very significantly. Humans tend to focus much more on events than in behaviour patterns. This means that slow evolutions may stay unnoticed until a sudden mayor event happens (Sterman 2000). We can think about overweight: Would a person react in the same way if he gained suddenly twelve kilos or if he gained them one per month during twelve months?
Managers have difficulties linking decisions and their delayed consequences. This way they can accept an implemented policy, just observing its immediate consequences, but ignoring the delayed ones.
Example: Climate change constitutes a perfect example for this kind of crisis. The problem evolves "slowly", used policies need long incubation times to have results and in the meantime managers have to use forecasts. These long delays make very difficult the calibration of the impacts of already implemented policies, i.e. it is hard to measure the impact of CO_2 reductions on climate behaviour change. Likewise, proper solutions such as scientific research and knowledge creation take long time before they provide useful insights.

3 Second dimension: Managerial style

This second dimension is used to describe the managerial style of crisis managers. Depending on the maturity and formalization, we can distinguish three different management maturity levels: the worst case corresponds to the situation where crisis managers have no explicit and measurable goals, the next one is the case when these objectives exist but there is no one explicit planning to achieve them, the third level corresponds to a case where there are explicit goals and some planning to accomplish

them, but there is no formalised control system about this achievement. There is an optimal level when also a control and monitoring system is implemented.

3.1 Uncontrolled management

This management style assumes that there are some specific goals during the crisis management and also some explicit and communicated planning to achieve them.
Is it possible to permanently monitorize the behaviour of a crisis in a reliable and feasible way? Answering positively to this question needs a previous strong preparation. It is not possible to put in place a trustworthy network of measures during a crisis if it has not been carefully designed, tested and deployed previously.
Monitoring the evolution of a crisis may need a heterogeneous variety of resources. Some of these resources will not be immediately achievable. Sometimes managers do not analyse detailed information about the current situation and evolution of the crisis, even having access to it.
Example: Fire-fighters usually have routines in place that guide them when dealing with a fire. However, in a massive fire (particularly in open fields such as forests), these routines could not be enough if the evolution of variables such as wind speed, water reservoirs and landscape's season changes are ignored. Modifications in these variables accelerate the speed of events, overwhelming emergency managers. The absence of reliable information about the behaviour of this variables can exacerbate the consequences of a fire.

3.2 Unplanned management

Unplanned management implies that there are some explicit goals defined for a suitable crisis management. We have to take into account that many different agents have to collaborate during a crisis situation. This collaboration might start well in advance to the crisis occurrence. Agents have to define some protocols about how to act and communicate during a crisis situation. In the absence of these guidelines, even the best intended agents will act in a chaotic way. This would mean that they will try to reach the defined goals in different ways and probably may not be held concurrently.
Example: In crises such as a heavy snow storm evolving into an ice storm or in a significant city flood several agents are forced to work together. If there is not a defined communication protocol between emergency departments, for instance fire stations, power stations, gas stations and hospitals the coordination could become highly ineffective. i.e. emergency managers during pressure were unable to figure out how to contact other departments after a power cut-off (walky-talkies, cell phones, IP phones, etc).

3.3 "No goals" management

The worst management style appears when there are no explicit goals for a crisis situation. As Dörner points out, having a goal entails at least, one decisive factor for success, but without goals this can not be assured (Dörner 1997).
In this case any event could change the current objectives and the management tends to act in a reactive way. In this case, managers prone to answer to what they consider the most urgent aspect of the problem. Consequently they tend to focus on the symptoms of the problem, instead of analysing the root causes of what is happening.
Different involved agents will allocate their efforts to deal with local problems. These local problems are the ones they know better. Additionally they are also able to observe

the consequences of their decisions; but they can not adopt a more holistic perspective over the problem.
Example: If an oil ship is damaged and the oil is spreading into the ocean the time to make a decision is fairly short. Taking the crashed oil ship far away from the coast, instead of closer to it, to avoid destroying that zone, maximizes the affected area by the spilled oil in the ocean. Consequently, actions carried out can aggravate the situation when the goal is not clear.

4 Third dimension: the boundaries of the problem

The third dimension of this framework corresponds to the type of limits of the analysed problem. Managers need a clear definition of these limits to know what they can decide about. They also should have a clear understanding about the relationship of the crisis they are managing and the variables from outside.

4.1 Interconnected crisis

The behaviour of a crisis may be affected by variables from the outside. Thus, external variables can influence somehow the duration of the crisis or the gravity of its consequences.
However, in this kind of crises, the external variables can not determine if the crisis happens or not, neither its end.
Example: Countries geographically close, in some cases adopt different policies in regards to illegal immigration. If a given country assists illegal immigrants who come at its coast and their neighbours do not, then this geographic interconnectivity could magnify the consequences of the crisis exacerbating the ability of this country to help people. Actions carried out by a neighbour are not a problem's trigger but they can aggravate it.

4.2 Interdependent crisis

In this case the behaviour, even the occurrence, of a crisis depends on external variables. This means that external variables can very significantly determine when the crisis stars, how it propagates and affects and how it can be stopped.
Managers are aware of these dependencies and could establish some alerting mechanisms; although they do not have direct methods to act over the external variables.
Example: The dependency that some countries have on others who own natural resources (gas, oil, water, power) could originate severe crises that significantly impact society. If country "A" provides power to countries C, D, E, through a channel that travels across country "B" and furthermore, it is widely known that the tension between countries "A" and "B" has increased due to legal, economic and political issues. Then, it can be expected that a possible power supply crisis may emerge at some point in time. In this case managers can be prepared for the crisis as they know that the power supply could be affected due to the tension between countries.

4.3 Unaware interdependent crisis

Some crisis can be dependent on external variables, while the managers who have to manage them are not aware of this circumstance. If the crisis occurs they will suddenly realize that they would need to act on some external variables; but they have not access to them.

This scenario is the worst one, as the managers could not have thought previously about it. Therefore, they face a problematic situation that they can not manage and they have to improvise as they were not aware about this possibility.
Example: A given city is located in a place where a natural fault has not been identified and suddenly breaks causing a tsunami. Local emergency managers (unaware of such fault) are not prepared for managing the cascading effects that this natural disaster can originate.

5 The crisis classification framework

If we combine the three dimensions previously presented we obtain a framework that can be used as a diagnosis tool in several different circumstances (Fig.2):

- It can be used to analyse previous crisis, to gain a better understanding about their behaviour.
- It can be used as a diagnosis tool to determine the current situation of a crisis management team

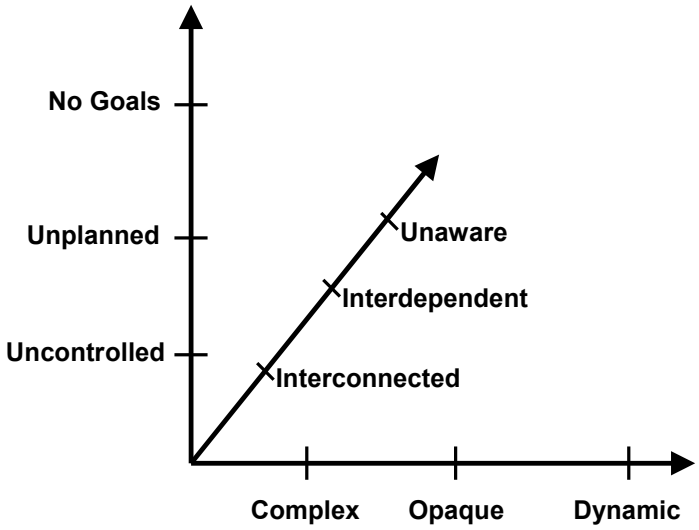

Figure 2: Three dimensions

6 Framework validation

To validate the usefulness of the presented framework we have used it to analyse three well-known and well documented crises.

6.1 Bhopal gas tragedy

The Bhopal gas tragedy occurred in India in 1984 (Fig.3) (Manion and Evan 2002 and Bisarya and Swaraj 2005). A dangerous chemical reaction happened in the Union Carbide factory when a large amount of water got into the Methyl isocynate (MIC) storage tank. The excessive pressure forced the emergency venting from the tank to release a large volume of toxic gases which caused about 14.000 deaths and 200.000 injuries.

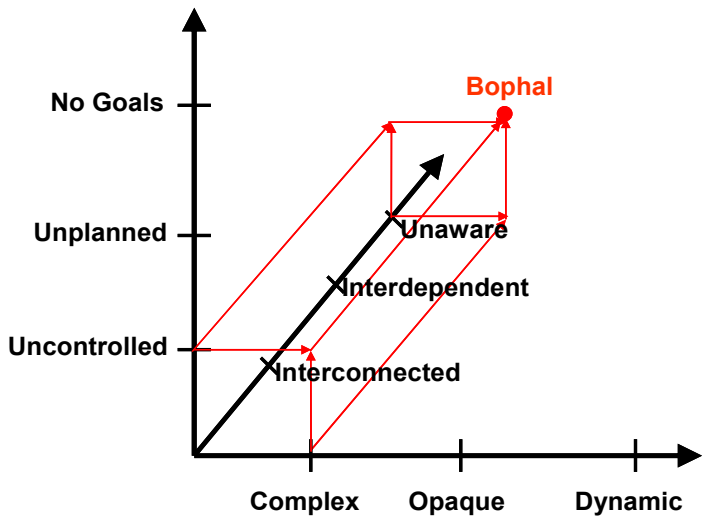

Figure 3: Bhopal gas tragedy

Characteristics of the crisis:

This crisis can be considered a complex one. Managers have access to what was happening, but they were not able to anticipate to the risk originated by the water income to the tank.

Managerial style:

Bhopal is a suitable example of deficient control. Workers did not appreciate the water entrance in the tank until they realized about the gas escape. Furthermore, at the moment the manager was informed about the gas escape he acted as if nothing had happened so more water entered.

The boundaries of the problem:

The Bhopal gas tragedy had unknown interdependencies, such as the possibility of water coming into the tank. Nobody in the plant thought previously about this possibility and its consequences, so they were not prepared to manage it efficiently.

6.2 Canadian ice storm

The 1998 Ice Storm is often considered the worst ice storm in living memory (Fig.4) (Milton and Bourque 1999, Klaassen et al. 2003, Chang et al. 2007 and Henson et al. 2007) because of the quantity of ice accumulated and its persistence. The power outage showed that the loss of energy infrastructure led to oil supply problems because most gas stations were unable to pump fuel. The ice storm was one week long and it caused about 28 deaths in Canada and 19 in the United States.

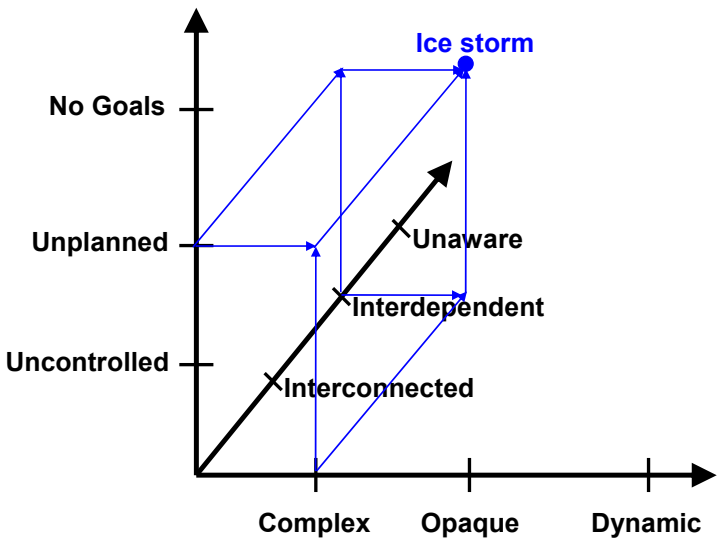

Figure 4: Canadian ice storm

Characteristics of the crisis:
The ice storm is a good example of a complex crisis. This ice storm shows how electric power outages affect other critical infrastructures, causing disruptions to society. Railways and airports were shut down, hospitals were full and water reservoirs stop water supply due to the power cut.

Managerial style:
In this case the ice storm was unplanned. There were several managers from different sectors that should manage the crisis. The lack of an updated emergency plan provoked a slow and poor management as for example, one month was necessary to restore the power in the Quebec area.

The boundaries of the problem:
The Canadian ice storm's example shows how an external factor such as the weather can be interconnected and interdependent with critical infrastructures. In this case managers knew that the storm was going to happen but they could not do anything to minimize its strength.

6.3 Chernobyl's catastrophe

Chernobyl's catastrophe took place on April 26, 1986 (Fig.5) (Dörner, 1997) when the Ukrainian atomic energy plant exploded. Chernobyl's engineers wanted to conduct an experiment to improve a safety system so they began to slow the reactor down. Due to an error, reactor's capacity decreased until 1% so it was working unstably (20% safety level). However, they continued with the testing when it was at 7% of capacity (unstable) due to external pressure to finish the testing as soon as possible. They turned on all the cooling pumps, but they did not understand that it would activate the mechanism to withdraw the control rods (bars to control the fission in the reactor). Two minutes after they realized that there were few control rods the reactor exploded, causing about 6000 deaths and 30000 injuries.

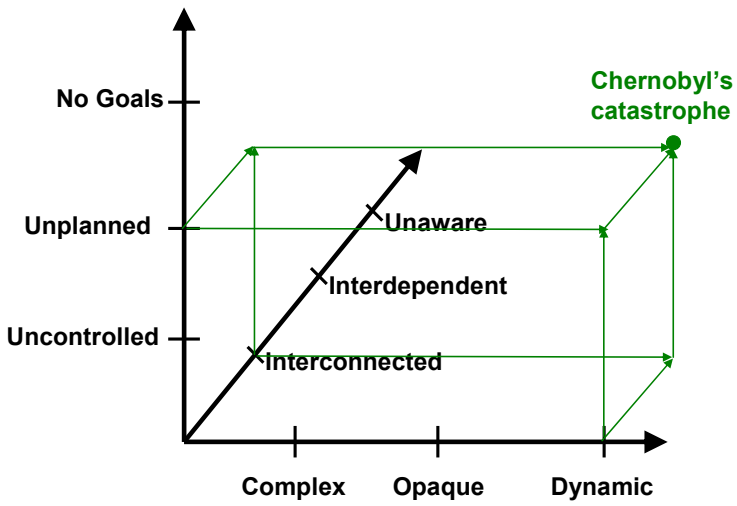

Figure 5: Chernobyl's catastrophe

Characteristics of the crisis:
Chernobyl's catastrophe was complex, opaque and dynamic. Opaque because managers did not realized that the mechanism to withdraw control rods was activated and dynamic because they had not enough time to introduce the control rods in the nucleus before the reactor exploded.

Managerial style:
It can be classified as unplanned. It was uncontrolled as they did not realize about the rapid decrease of reactor's capacity until it was at 1%. Furthermore, it was unplanned because although having an emergency plan they acted ignoring security measures.

The boundaries of the problem:
This example has interconnected boundaries such as external pressure. They need to finish the testing as soon as possible so they decided to continue with the testing when the reactor was working unstably.

7 Conclusion

This research paper presents a three dimensional crisis management framework that compiles the difficulties when managing crises. Our motivation for building such framework derives on the one hand, from the necessity to classify and better understand the evolution of crises and on the other hand, from the absence of an analogous taxonomy in the analysed bibliography.

This framework presents an excellent opportunity for emergency managers to see each dimension not as an isolated crisis issue but as a trinity of aspects that need to be engaged and understood in order to minimize the impact caused by internal and external factors.

The framework's dimensions explained here and validated through real documented crises examples reveal significant crises' characteristics such as delays in decision making, structure complexity, system's interdependencies, boundaries and managerial styles that if are considered prior crises, "avoid remaking the same mistakes again" could become an achievable goal.

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