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CRISIS SCORECARD: How to reduce impacts increasing resilience and awareness

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ABSTRACT:
Crisis management is oriented towards the reduction of impact caused by crises. However, this impact reduction cannot happen immediately. Crisis managers have to increase resilience, which will subsequently lead to the decrease of the magnitude of impact. Analogously, to enhance resilience the existence of a high awareness level is essential. Consequently, impact, resilience and awareness cannot be observed as independent variables, but as interrelated ones. This paper presents the Crisis Scorecard tool, based on the successful Balanced Scorecard tool, which provides a systemic perspective on crisis management based on the integration of the following three perspectives: impact, resilience and awareness. It also explains how to implement the Crisis Scorecard in four different scenarios: the case of an unintended accident, the case of a terrorist attack, the occurrence of a natural disaster, and finally a crisis which evolves without any triggering event, for instance the evolution of road accidents in a specific country.

KEYWORDS:
Crisis management, Crisis Scorecard, Impact, Resilience, Awareness

1. INTRODUCTION

The final goal of crisis management is the efficient reduction of impact caused by crises. This means that crisis managers have to allocate the available resources in the most efficient way to prevent, respond and recover from crises. In fact, the most effective crisis management would be the one that impeded crisis occurrence, that is, the one that would achieve zero impact. But it is unanimously accepted that this is not a realistic objective (Wildavsky, 1988). Hence, crisis management could be considered as a process analogous to business management, where available resources have to be allocated in order to maximize benefits in a sustainable manner (Mishra, 1996).

One of the main difficulties in crisis management is that crisis managers have to wait until the crisis has really unfolded to have real information about the impact it has generated (Boin, 2007). Hence, there is a significant time delay until they can evaluate the effect of the decisions they have made. Therefore, there is a need to anticipate and infer the current state of the system (a critical infrastructure, a city, a country…) that has to be protected against crises even before any crisis strikes (Egan, 2007). This is also analogous to what happens to business managers, who have to be permanently making decisions in a proactive way.

Another relevant difficulty is that measuring rigorously some of the key variables in the crisis management context is not easy. We should accept that there is still not any precise method to assess the resilience level and the awareness level, although there is promising ongoing attempts (Pfefferbaum et al., 2012). As an example, there is no unanimity about which should be the most suitable tool or methodology to be used to measure the impact caused by a natural disaster (Laugé, 2012).

Business managers accepted long time ago that they had to deal with some level of uncertainty. They admitted that even if they were not able to precisely measure a key variable, such as customer satisfaction, they have to make some estimation on it to make their decisions. The worst mistake they could do is not to take into account the variables that are hard or impossible to measure, if they are relevant for their business. So, they use indicators that although do not accurately measure a variable, they can estimate it. Satisfaction surveys, the amount of received complaints or the percentage of loyal customers do not accurately measure the customer satisfaction level, but they are considered valuable approximations to improve the decision making process.

Adapting the tools that are widely used in the business management to estimate relevant variables and to increase proactivity appears as a promising approach towards a more effective crisis management. Several tools, such as the Balanced Scorecard (Kaplan & Norton, 1996) have been developed to increase anticipation and the estimation capacity of key variables in the business management area. Inspired in Balanced Scorecard, this paper presents a Crisis Scorecard, a managerial tool oriented towards supporting crisis managers to deal with crises in a proactive way. Crisis Scorecard comprises three perspectives: impact, resilience and awareness.

2. THE CRISIS SCORECARD: AN EFFECTIVE TOOL FOR CRISIS MANAGEMENT

In the following section the three perspectives of the Crisis Scorecard are going to be presented.

2.1 Impact

The impact that may result as a consequence of a crisis can be different and can stay for short or long term periods, depending on the triggering event that caused the crisis (Eusgeld et al., 2011); but also depending on the way these crises have been managed.

Crisis impacts can be classified based on two different classification types. The first type classifies impacts according to their nature differentiating between tangible versus intangible and direct versus indirect impact (Laugé et al., 2012). The second classification distinguishes impacts based on the affected sector: Critical Infrastructures (CI) sector, economic sector, social sector and environmental sector (Middelmann, 2007; Hallegatte & Przyluski, 2010).

Figure 1 represents the evolution of direct and indirect impacts produced by a particular crisis over time. Direct impacts represent the partial or complete physical destruction caused by the triggering event to human beings, buildings, infrastructures, vehicles, capital and on stock while indirect impacts are consequence of direct impact caused by the hazard. Indirect impacts are more difficult to quantify as months or years are needed to properly evaluate them (Lequeux and Ciavola, 2011, Pfurtscheller, et al. 2011).

The impact caused by a crisis can evolve differently depending on the previously deployed prevention and preparation policies. Moreover, consequences of a crisis can be aggravated and prolonged if resilience policies, including response and recovery activities, are not effective.

A comprehensive assessment of the crisis impact has to be conducted so that crisis managers are aware of the consequences and can improve their preparation and response capabilities to better respond to future crises. A suitable impact assessment helps improving the way these impact should be avoided or managed and makes possible the learning from the consequences of a crisis.

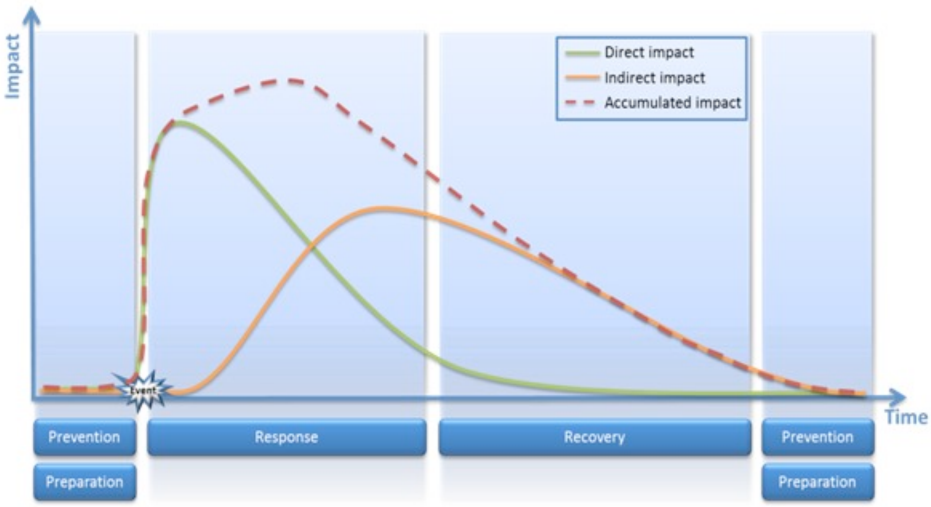

Figure 1: Evolution of direct and indirect impacts over time

2.2 Resilience

Resilience has been defined in several different ways in the scientific literature depending on the context. Originally, it was a concept used in material science. In that context resilience refers to the ability of a material to return to its original state (Stewart et al., 2009). It has also been used in behavioural sciences described as ‘the

dynamic process indicating the adaptive functioning of individuals at risk' by Sapountzaki (2007, p. 277).
In the context of this paper we will define resilience as the capacity of a system to avoid crisis occurrence, to mitigate the impact of a crisis in case a triggering event occurs and to come back to normal situation in an effective way time and resources wise (Chen et al., 2013; Norris, 2008; Sheffi, 2005).
As it can be directly derived from the resilience definition, there is a tight connection between resilience and impact. If a crisis occurs in a resilient system the magnitude of the impact will be significantly less (Figure 2) than in case of no resilient system (Figure 3).

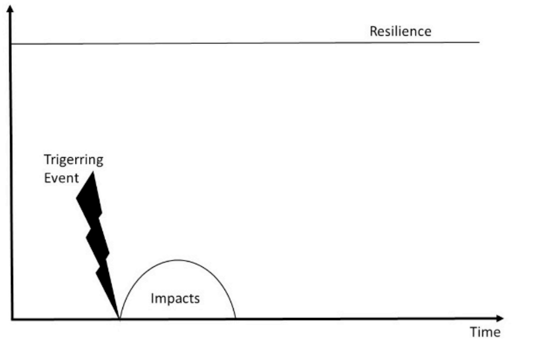

Figure 2: A crisis affecting a resilient system

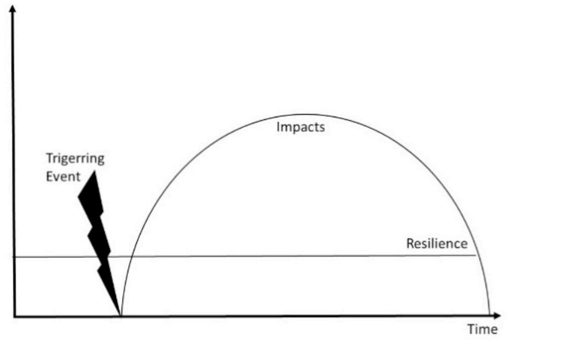

Figure 3: A crisis affecting a no resilient system

Thus, we can conclude that if we are able to estimate the resilience level of a system we can obtain valuable information about the impact that a crisis could have on it. Of course, the magnitude of the impact will also depend on the type and strength of the triggering event, but this is often unpredictable. However, a relevant consequence we can extract is that, if we are able to know the resilience level of a system we will be able to estimate the impact that a crisis affecting this system would generate. Resilience presents a transversal approach that helps to deal with both, expected and unexpected crises. Knowing the impact of a crisis in advance helps making better decisions. Therefore measuring the resilience level helps dealing with crises.
It is important to choose a set of indicators that would allow assessing both types, internal and external, and the four dimensions of resilience. Internal resilience involves stakeholders from inside the system, while external resilience involves stakeholders from outside the system. For instance, resilience can be increased through the deployment of technical equipment that can be used for avoiding future crises or for facilitating a more efficient response. Moreover, it can also be increased by the development of organizational skills that can improve the capacity to early detect or to cooperate more effectively during the crisis response.

2.3 Awareness

The awareness level and commitment of society towards avoiding a crisis occurrence reduces the probability of crisis occurrence and the magnitude of the impact in addition to enhancing the ability to respond (Shaw et al., 2009; Parsons, 2007). Resilience evolves over time, thus the implementation of the activities and policies that contribute to an increase of a system's resilience level is dependent on the awareness level of involved stakeholders such as decision makers, top management, crisis managers, workers and even society. For example, volunteers might assist first responders in dealing with the affected people, thus reducing possible adverse effects. In addition, the collaboration and information that society can provide may be crucial to enhance crisis management. Therefore, if we can estimate the awareness level and its evolution, we will be able to anticipate the evolution of resilience.
As it can be seen in Figure 4 and Figure 5, in the case of a system where stakeholders are highly aware concerning resilience, the evolution of resilience will be more positive than in the case of a system where there is a low awareness level.

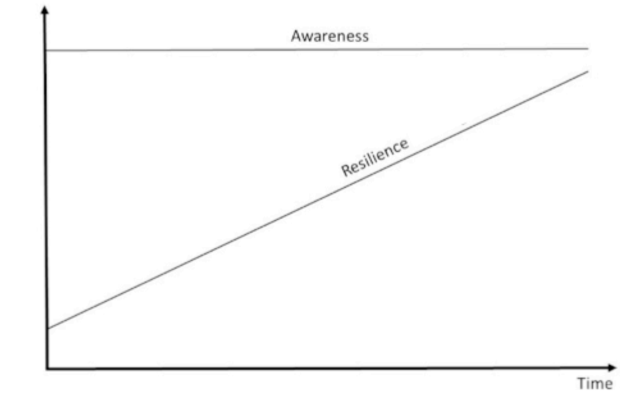

Figure 4: Resilience evolution when awareness is high

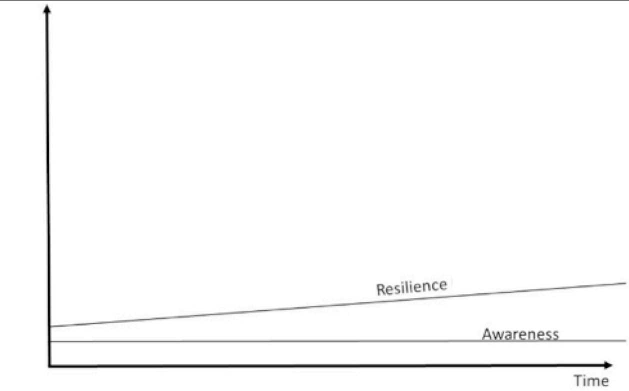

Figure 5: Resilience evolution when awareness is low

3. CRISIS SCORECARD IMPLEMENTATION

The implementation of the crisis scorecard consists basically in the identification and the assessment of a set of selected indicators that can be used for the continuous monitoring of the three main perspectives that defined the crisis scorecard: impact, resilience and awareness. The scorecard should be adapted to the particular characteristics of the system where it is implemented: a critical infrastructure, a city, a region, etc.
Table 1 shows indicators that could potentially be used for the assessment of the three main perspectives in four different scenarios: the case of an unintended accident, the case of a terrorist attack, the occurrence of a natural disaster, and finally, a crisis which evolves without any triggering event, for instance the evolution of road accidents in a specific country.

Table 1: Indicators for different crisis types

	Accident	Attack	Natural Disaster	Evolutionary Crisis
Impacts	Deaths	Deaths	Deaths	Deaths
	Critical Infrastructure Downtime	Security expenses	Homeless people	Traffic accidents
Resilience	Mobile hospitals' capacity	Mobile hospitals' capacity	Mobile hospitals' capacity	Mobile hospitals' capacity
	Preventive maintenance budget	Time until attackers are arrested	Safe buildings percentage	Low accident roads
Awareness	Press Releases	Press Releases	Press Releases	Press Releases
	Number of Inspections (audits)	Number of Cooperating citizens	Number of Twitter messages	Social Alarm

As it can be seen in Table 1, there are some indicators that could be used for the assessment of the four scenarios while there are some others, which are specific for each scenario. For example any of the four types of crises could cause deaths, and this one would be one of the most relevant indicators to estimate the impact of a crisis. The efficient response to any of these critical events will need the deployment of some extra capacity of hospitals. This means that one indicator that monitors "Mobile hospitals' capacity", which refers to the amount of people that could be attended by this type of hospitals, could be used to assess the resilience of a system. The implicit assumption is that having mobile hospitals can reduce the number of deaths. Thus, the evolution of the capacity of mobile hospitals is dependent on the awareness level of decision makers that can be measured, for

example, considering the amount of news published concerning crisis management in general and regarding mobile hospitals in particular. If this amount is high we could conclude that the awareness level will be high; but if it is not, then, we cannot expect a positive evolution of the capacity of mobile hospitals in the close future.
There are some other indicators that are more suitable for just one of the cases. If we think of an accident affecting one critical infrastructure, such as energy or water, the downtime caused by the accident could be a valuable indicator for evaluating the magnitude of the impact. Assuming that a well-maintained infrastructure would be recovered in a more efficient way, the resources allocated to the infrastructure maintenance can be an indicator for assessing the resilience level of the infrastructure. The number of audits, which could early warn about the maintenance level of the infrastructure, could be used as an indicator to evaluate the awareness level in this case.

4. SIMULATION MODEL

In this section a more detailed example of the practical use of the crisis scorecard in a particular crisis type is explained. The selected case is referred to an evolutionary crisis such as road accidents. A simulation model based on System Dynamics (SD) has been developed to better illustrate this example (Figure 6). The aim of the model is to explain the influence of decisions made by crisis managers on the number of traffic accidents. SD is a modelling methodology that is used to model complex systems. It focuses on analysing the underlying structure that generates the behaviour of the complex system (Forrester 1961; Sterman 2000). This way, the structure of the model can be directly compared to descriptive knowledge of the real system structure.
The model includes stocks, flows and auxiliary variables. The stocks are accumulations and are represented by rectangles. They are altered by inflows and outflows, increasing or decreasing the stock, respectively. Arrows with a valve represent the flows. As an example of these terms, it could be said that "the inventory of a manufacturing firm is the stock of product in its warehouses and it is increased by the flow of production and decreased by the flow of shipments" (Sterman 2000).
The auxiliary variables provide useful information to create a model that reproduces reality as precise as possible. The most important variables are chosen and then the cause-effect relationships between them, which are represented by arrows, are defined. Each of the variables is defined by an equation that depends on the variables for which is getting affected. In the same way, their value will be used to determine the value of the variables on which they are causing an effect.

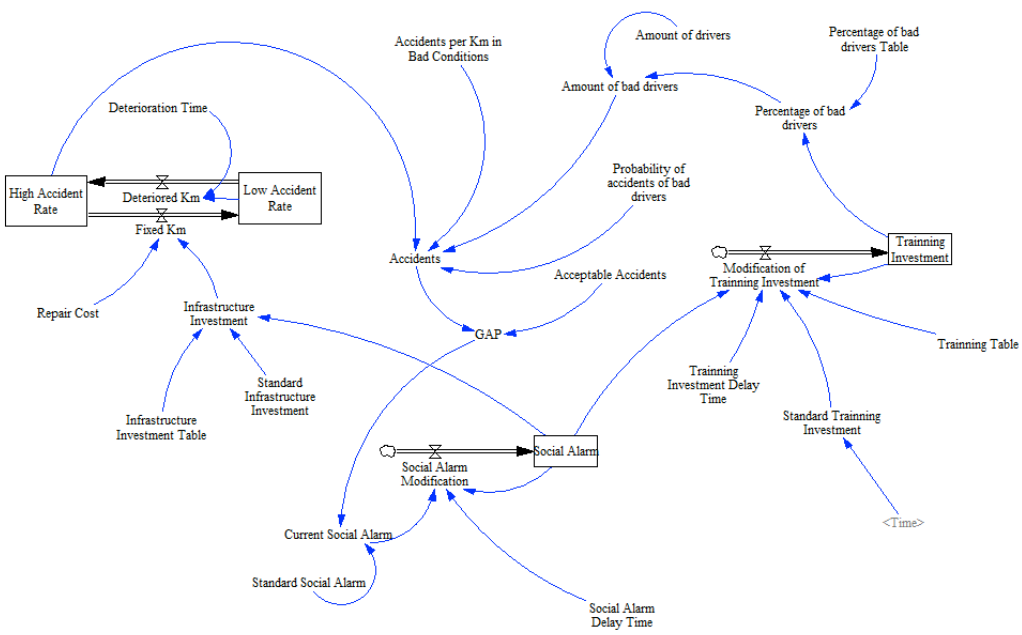

Figure 6: Simulation model

It is important to bear in mind that this model has been developed to prove how an improvement in awareness helps enhancing resilience and consequently reduce the impact of the crisis. The simulation model allows to

observe the evolution of the three perspectives, impact, resilience and awareness over time. Moreover, it also provides the possibility to see how different policies affect the overall behaviour of the system. This is particularly useful for public authorities because it may help to make better decisions.
The most relevant variables that represent the problem of traffic accidents are presented below:

- GAP: it represents the difference between the acceptable amount of accidents and the real amount of accidents.
- Social Alarm: it estimates the awareness level of society regarding traffic accidents. It directly depends on the GAP between the acceptable amount of accidents and the real amount of accidents. However, society is not able to immediately perceive this difference therefore, a time delay exists between the GAP and the Social Alarm variables.
- Infrastructure Investment: it measures the amount of funds to repair traffic infrastructure. Its value directly depends on the social alarm.
- Percentage of bad drivers: the percentage of irresponsible drivers that exist in the analysed country.
- Low Accident Rate: the amount kilometres of road of low accident rate that exists in the analysed country.
- Accidents: the amount of accidents that occur. It directly depends on the High Accident Rate Kilometres and on the amount of cautious drivers.

In Table 2 the previous variables are classified depending on the different perspectives of the Crisis Balanced Scorecard that they are related to.

Table 2: Relationship between the variables and the perspectives

VARIABLE	PERSPECTIVE
Accidents	Impacts
Low Accident Rate Km	Resilience
Percentage of bad drivers	Resilience
Social Alarm	Awareness

With the aim to analyse the behaviour of the model, these six significant variables will be graphed. The graphs will help to visually represent how an increase in awareness leads to reduce accidents. Or in this particular case, how when the social alarm variable increases, the amount of accidents variable reduces. Table 3 represents the value of the main variables of the model in the equilibrium state when all the variables are balanced.

Table 3: Value of the main variables in the equilibrium state

VARIABLE	VALUE
GAP	1
Accidents	27000
Low accident rate kilometres	170000
Percentage of bad drivers	0.2
Infrastructure investment	127.5M
Social Alarm	1

Crisis managers can apply different policies to solve the same problem. This simulation model helps to analyse the consequences of these decisions on the overall system. Some variables of the model will be changed in an attempt to represent the consequences of the decisions made by public authorities in different scenarios. Thus, six of the most important variables of the model will be graphed and compared with the base run to understand the behaviour of the model when applying a policy.
The first scenario represents the scenario where the public authority decides to reduce the target of acceptable amount of accidents from 27000 accidents to 20000 accidents in month five because they decided to be more exigent. Figure 7 shows the behaviour of the six main variables of the model over time.

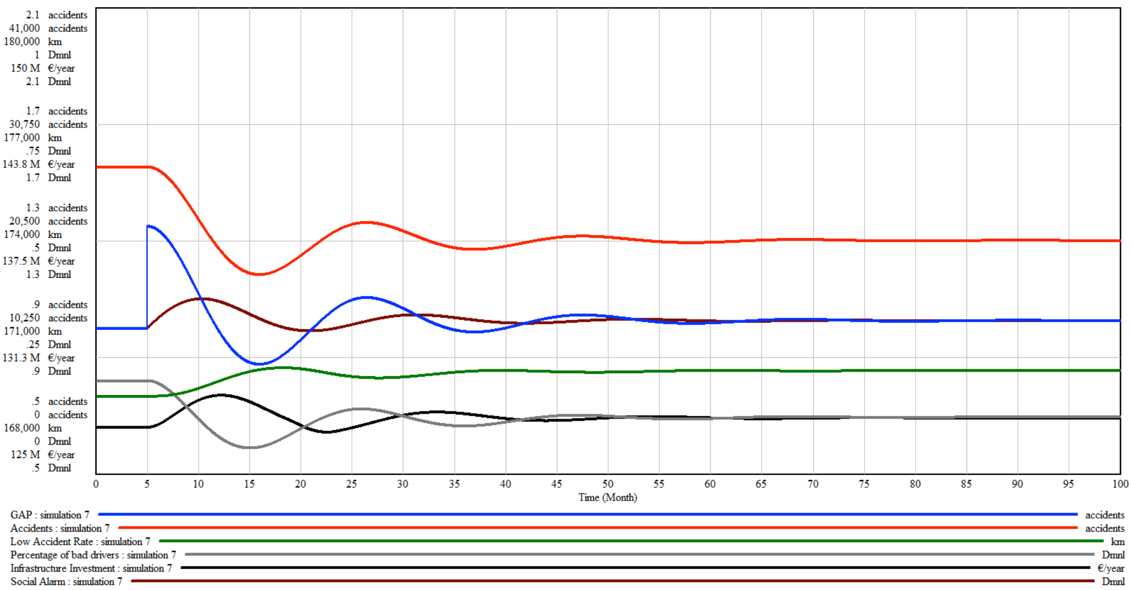

Figure 7: Behaviour of the variables when the amount of acceptable accidents is reduced to 20000

The main aim of this simulation is to prove how an increase in the awareness level of a system enhances resilience and consequently reduces impact. Therefore, the first variable we should pay attention to is social alarm. Social alarm is defined by GAP and a division between accidents and acceptable accidents defines GAP. When the amount of accidents is bigger than acceptable accidents GAP will be bigger than one. When the amount of accidents is smaller than acceptable accidents GAP will be smaller than one. In this first simulation, in month five the acceptable amount of accidents is reduced from 27000 to 20000 which means that GAP will increase and will be bigger than 1. An increase on GAP leads to increase the social alarm or the awareness level of the system. Awareness enhances resilience; therefore an increase on social alarm increases firstly the investment on traffic infrastructure and on training programs and secondly, after a time delay, it enhances the two indicators of the resilience perspective “Low accident rate kilometres” and “Percentage of bad drivers”. Consequently, the impact of the crisis gets reduced as the total amount of accidents reduces.
However, when accidents are equal to the acceptable amount of accidents and while accidents continue reducing GAP become smaller than one. Consequently social alarm decreases and less investment is done in infrastructure and training what decreases the overall resilience level of the system and increases the amount of accidents.
These oscillations continue over months however, when the variables reach their new equilibrium it could be seen that the amount of accidents is smaller than what it was in month one. This proves the veracity of this simulation model.
In the second scenario, the variable “Acceptable accidents” is also reduced from 27000 accidents to 20000 accidents as in the first scenario, however in this case starting from month twenty five there is no investment in road safety training programs. Figure 8 shows how a reduction in the resilience level of the system has a negative effect on impacts.

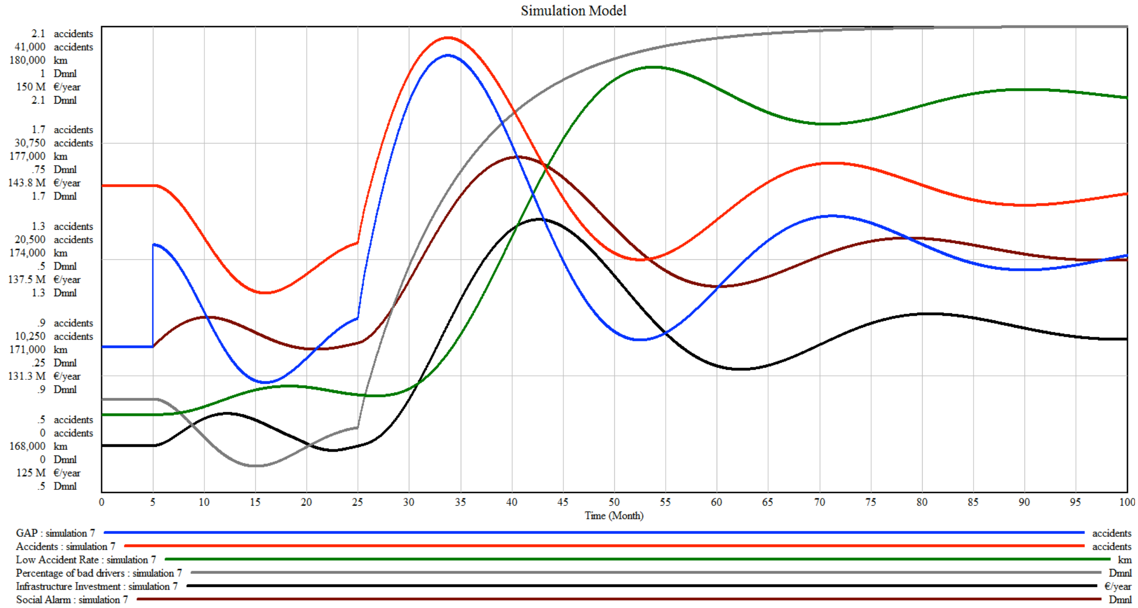

Figure 8: Behaviour of the variables when there is no investment in training programs

As it can be observed in the graph, social alarm increases. Consequently and after a time delay infrastructure investment increases and low accident rate kilometres increases as well. However, as no investment is dedicated to training programs, the percentage of bad drivers increases over time. In this model the resilience perspective includes two indicators; “Low accident rate kilometres” and “Percentage of bad drivers”. Therefore, although traffic infrastructure is being efficiently maintained, not investing on training and road safety programs decreases the overall resilience level of the system. Consequently, when variables reach their new equilibrium the amount of accidents will not be reduced unlike in the previous simulation.

The third scenario represents a more "compliant" society. Important cultural differences exist between different countries and some countries take more into consideration what public authorities suggest. Therefore, in these cases the policies applied by the public authorities need less time to have an effect in the system. In order to simulate this behaviour, the value of “Social Alarm delay time” and “Training investment delay time” variables have been reduced from 10 to 5 months.

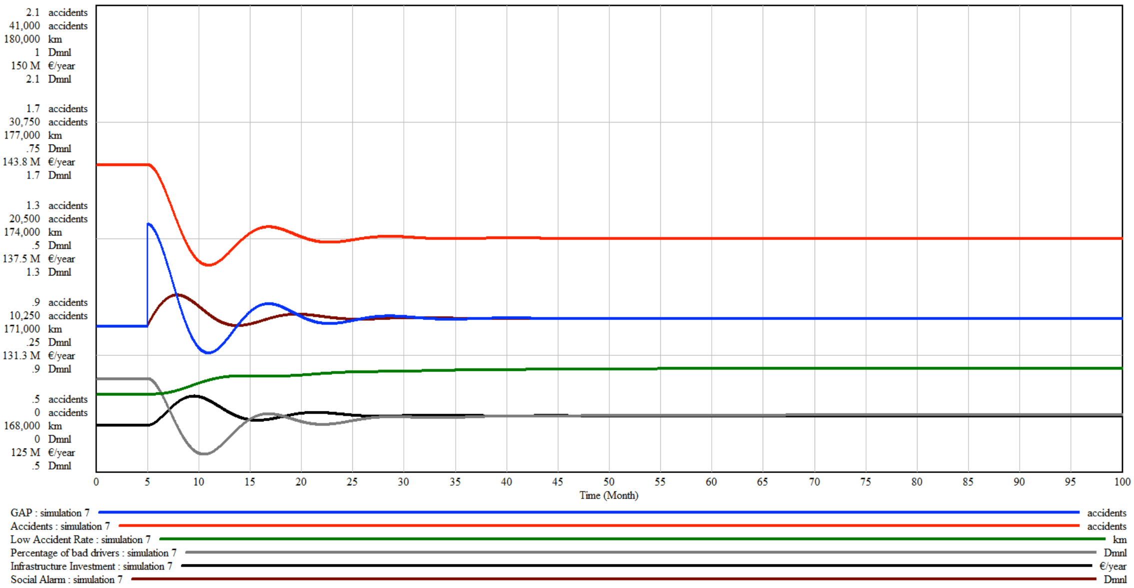

Figure 9: Behaviour of the variables when society is more obedient

Figure 9 represents the evolution over time of the variables when society is more compliant. The overall behaviour of the system is very similar to the one observed in Figure 7 however, in this particular case the oscillations of the variables cease earlier than before. Consequently, when society is more compliant, less time is needed to obtain the aimed results.

5. DISCUSSION AND CONCLUSIONS

The main objective of this paper is to present the Crisis Scorecard, a tool based on the successful Business Balanced Scorecard, whose aim is to provide useful information to crisis managers in order to anticipate and reduce crisis impacts. This tool is based on three main perspectives, impact, resilience and awareness and the cause-effect linkages that relate these perspectives to one another. Perspectives are theoretically explained and different indicators for different types of crises are presented.

Then a simulation model for a particular type of crisis is presented. The aim of the model is to prove that decisions that affect awareness have a consequence in the resilience level of the system and eventually in the overall amount of impacts. This means that the impact produced by a crisis could be anticipated, providing crisis managers useful information to deal with crises more efficiently. After that, three different scenarios are presented and the behaviour of the main variables of the models is graphed. These scenarios reproduce the consequences of the decisions made by public managers. The graphs obtained from each scenario provide useful information to understand how crisis will evolve over time and the consequences of the applied policies to reduce impact.

Thus, this paper is a preliminary step in the development of a crisis management model taking as a basis the effective Business Balanced Scorecard. The model presented is useful for a particular type of crisis so it could be interesting to investigate how the simulation model could be adapted to be useful for other type of crisis. Moreover, little information is given about how this tool could be used in practice. Therefore, future research should be done to assess how useful is this tool in mitigating the impact of a future crisis.

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