Crisis Management and Simulation

SEMINARIO DE TITULO.

PROFESOR: JUAN PABLO TORRES

INVESTIGADORES: FRANCISCO SURIC
RAÚL NOGUERA

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Abstract

The purpose of this research is to show the opportunities that Business Simulations produce when combining them with Crisis Management in a non-controlled environment. Although, there are some other studies about each topic, but this non studied synergy created shows a much more important and efficient effect when talking about managing a crisis. We used a systematic data collection of relevant articles that talked about each stage of a crisis management, making a vast literature background for each one. A combination and collision of conclusions and studies of each topic, ended up in the main topic of this article, where the authors got to capture the importance and efficiency of the combination strategy between Crisis Management and Crisis Simulation. We found that crisis management literature divides a crisis in three stages: Prevention, Handling and Recovering. These stages allude to the timing of the action to control the crisis, where a pre-crisis action stands for Prevention, in-crisis actions go for Handling and after-crisis actions relate to Recovery. In each stage, a crisis simulation would help firms by improving their reaction time and capacity, their adaptability and reduce costs of a bad decision. Our results are important because other articles talk about these topics separately and the synergy and efficiency that comes with the use of both topics in parallel is not noticed, so the importance of this research would be to note and explain this synergy and efficiency, and make emphasis in how simple can this be implemented.
Keywords: Business Simulation, Crisis Management.

1. Introduction

Crisis Management (CM) has always been present in organizational management, but since the last three decades this studies have got much deeper and have had some big advances. A crisis is defined as "a concept of transition to something better or worse" and "an ongoing experience of uncertainty" (Mascareño, 2015), which describes a lot of daily life situations, this is where the importance of CM has arisen, because every member of the actual society has to deal with it, going from a family to a country, but this article refers specifically to the CM in a company and how can or should the managers react, based on a whole amount of investigations and Crisis Simulations (CS), made among these last 30 years. Mitroff et al. (1988) suggest that CM starts with the detection of "Crisis clusters" and defining standard reactions to each cluster, coming among the time with the idea of the personalized CM due to some important variations on each company and its crisis, as the study "A holistic framework for building critical infrastructure resilience" (Labaka et al., 2015) arises by using a CS. This explains the importance of this article, where a lot of these topics are put together and explains how they build up "synergy" when managing a crisis and preventing possible scenarios in this topic.

As said before, when a company is dealing with a crisis, there are a lot of possible scenarios and outcomes depending on which decision a company takes, how do the company implements it and how the company's members adapt to this decision, among some other macro factors, so most of the time a CM planning may be very variable or erratic, without complete certainty of their effectiveness. This is where this article focuses, when CM and CS are used together. In other words, a CS gives the decision maker an advance of the future scenario and shows him the most possible outcomes of his decisions or actions of the company, making the CM less erratic and, with this, lowering the company's probability of failure when dealing with a crisis. Another point of view of the importance of simulation when managing a crisis is the objective view that it gives to the manager about the company, because sometimes top managers have a blinded view and don't manage to see some very important flaws in the company's function, but sometimes a simulation can open a manager's eyes and show these imperfections or some possible crises that weren't considered before, making the company prepared for a more wide spectrum of possibilities and improving their success possibilities.

Until now, there is a lot of literature that talks about Crisis Management and Business Simulation (Labaka, Mittoff, Gröbler, Hernantes, etc.), deepening in a lot of topics about it and making a big help for all the companies. This literature mostly talks about how to prevent a crisis, how to handle an actual crisis and simulations of this crises in business, but there are two topics that are very important and does not have been studied yet, how to recover from a crisis and why this crisis occur, which can help to do something when everything else fails or to even prevent the prevention actions, respectively.

This article has three contributions to the study of Crisis Management and Business Simulation: first, it synthesizes and puts together a lot of authors and literature, shaping an actual idea of Crisis Management and showing the advance of this theory among it began being studied in 1980's. Second, shows the importance of simulations when managing a crisis, leaning on how other articles just use them, basically, explains why they are used and where their importance lies. Finally, this study overlaps the other two contributions, explaining how Crisis Management and Business Simulation create synergy and can save a company by helping them to prevent critical events.

The structure of this article is as follows. First we present and explain the actual literature about Business Simulation and analyze the importance of this topic for Crisis Management. After that, we focus on the principal factors that trigger a crisis, following by the three possible stages of the Crisis Management (Prevention, Handling and Recovery) and finally, the investigation opportunities that we found.

2. Crisis Management and Business Simulation

Our research is focused in getting to understand a main topic, Crisis Management (CM), using Business Simulation (BS) in parallel. This has been investigated around the world focusing in different isolated topics that belong to CM or BS, but not together, and this is where this research focuses.

A BS is the type of CS that only makes the business in study as a variable to investigate, while the economic environment and the competence is static, making the manager's behavior relating to the business the topic of the simulation. While using a BS, the pros that can be seen are: (1) it's less complicated than an environment simulation, (2) is more accurate than just a study and helps to evaluate how effective will future actions be. On the other hand, the problem would be the high cost of time and money, which is much higher than a simple study. This is how a new investigation tool has arisen, the Amazon Mechanical Turk (Manson & Suri, 2011), which use questionnaires that are answered online by people who gets paid for them, so it seeks to be the cheap option to CS and aims to the lowest paid working class in society, so it can be a very useful tool for some situations, but not every time, because of the low capacity of future prediction.

BS should be transparent, have clear instructions and a good feedback tool, making it easier and clearer for the individuals in study, getting with this more accurate results (Gröbler et al., 2000). This can be seen by Kopainsky and Alessi (2015), where studying simulation of stock management until year 2060, with more transparent procedures and clearer instructions, best results were obtained and the individuals learned more too (Kopainsky & Alessi, 2015).

With a well implemented BS, a firm can anticipate their future scenarios, so they can be prepared for them. Every change of scenario, future could be good or bad, so for possible bad scenario a crisis will emerge in the firm or environment. Organizations has to be prepared and have a plan of avoidance for implement.

Furthermore, it is important, for organization and studies, identify how crisis start and have been separated in two groups of causes; endogenous and exogenous. Crisis start by a mix of causes and factors, how have been studied by Probst and Raisch (2005) and are studied and incorporated to business simulations, becoming important factor to add. Finally, as the authors Labaka, Hernantes and Sarriegi (2015) define, there are three stages for crisis that are part of the CM methodology and simulation that firms experiment, there are: Prevention, Handling and Recovery, in all of them organizations are affected in different ways. As well, the case of Food Safety Crisis occurred in Hong Kong in 2007 by Chan and Chan (2008) test prevention, handling and recovery in the same crisis. Principal stages that have been investigated have been the Crisis Prevention and the Crisis Handling stages.

2.1.   Causes of Organizational Crisis and Simulation

Crisis Management has identified three stages for an organizational crisis mentioned before, it is common and easy to see some times that this phases are related and affect one to another in their natural order explained by Chan and Chan (2008). But the independent factors that can cause a crisis, could be different in each lap (exogenous causes or endogenous causes) and have been studied by Probst & Raisch (2005) and Mascareño, Ruz & Goles (2015). This analysis situates before of three crisis stages that conform our crisis cycle model, giving a better understanding of the process and factors that cause a crisis.

An organizational crisis is always a threat, reducing the stability in organizations and industries, making a fast way to firm's failure, sometimes as part of a natural process and life cycle, or others in an accelerated process occurring on their high level of success (Probst & Raisch, 2005). A crisis could be avoided if managers identified their problems and were able to change them before it is too late (Probst & Raisch, 2005). Other point of view would be that it contributes to "causes of organizational crisis" with a social system view mentioned by Mascareño, Goles & Ruz (2015) in their text about "Crisis in complex social systems" where they have been studying compulsive growth of system communication and drivers of social crisis that are triggering collisions of systems and making a restructuration for the social situation, are factors that contribute to crisis depth.

Probst & Raisch (2005) define four endogenous factors that trigger a crisis for organizations that are in their highest level of success: (1) Growth is important – unless it becomes excessive. (2) Change is positive – if you preserve your company's identity, (3) Visionary leaders are beneficial – as long as they share their power, (4) Internal competition spurs performance – if incorporated into a culture of trust. These four reasons of failure will be explained next.

The first one is "growth of companies", if it's higher than 7,5% annually, these firms are likely to more managerial problems and loss of effectiveness in their business, because difficulties of coordination and complexity in their operations increase inside (Probst & Raisch, 2005). Other problem related to this, is when they reach the organic growth limit, where it will be impossible to keep this level, solving these with firms acquisitions, rising to the desired growth. . In the other side, low growth or stagnated growth affect negatively to companies because they lose market share and increases costs position (Probst & Raisch, 2005). The second cause is "uncontrolled change", related with high diversification of companies, exploring new markets. Probst & Raisch (2005) say that in extreme situations this could generate coordination problems and loss of control, finally organization can suffer a loss of identity and lose their focus from the core business to the new acquisitions. Probst & Raisch (2005) suggest that change is not bad, but loss of organizational identity produce some problems that are mentioned before, but also the idea of not changing could give other problems like what happened with Kodak, ignoring digital photography as new trend.

Autocratic leaders are the third reason for an organizational crisis, lack of control and a top executive with too much power, trying to reach personals objectives and not the organizational targets. In the other hand, weak organizational leaders finish in a loss of control and in a lower position of CEO related with managers and also employees (Probst & Raisch, 2005).

Finally, Probst & Raisch (2005) found that "excessive success culture" with high competitive standards and rivalry between employees affects trust between them and between their bosses, causing a big lack of open communication and information sharing. Relating to the other extreme of "lacking success culture" this would reduce employees' security and set up a bureaucratic culture. In fact, recent researches determined that these factors are related with lack of innovation and low performance (Probst & Raisch, 2005).

2.2.   Crisis Prevention and Simulation

First phase of CM that have been identified by Labaka, Hernantes & Sarriegi (2015) how was mentioned before, on this stage will be study and analyze how organization develop ideas and plans to avoid all possible crisis inside their organization, reducing internal and external threats.

The main idea of making BSs to improve the Crisis Prevention among the organization is to generate a good and proper crisis management culture, where everyone who is part of the firm tries to avoid a crisis before it starts, keeping it from causing bigger trouble or problems. As "Structure of man-made organizational crises" says, to improve a company's results it has to look over the past, see what has happened to it and make some "crisis clusters" and a pre-made solution for each cluster in the case this crisis occurs again (Mitroff et al. 1988), but the firm has to be prepared for every possible scenario and if a new crisis that doesn't have occurred in the past comes up, it has to be prepared, so that's where the BS comes in and helps to be prepared for this crisis, making a full covered Crisis Management Culture (CMC). As "Preparation for Crisis Management" stands, the Egyptian cotton industry started being a normal and basic product from a third world country, but with the time some economic and social crises started coming and by natural selection only the firms who anticipated and were prepared for this crises survived, getting to the highest level of quality that the Egyptian cotton actually has, getting Egypt to be a developed country too, by spreading this CMC to the whole society (Elsubbaugh et al., 2004). Now, this explains the importance of using BS for Crisis Prevention, because if the Egyptian cotton companies had anticipated this crises, the road to high quality cotton wouldn't have had so much "casualties" (closed firms because of "natural selection") and the adaptation time would have been lesser. Another example of the effectiveness of the CMC and Crisis Prevention is shown in the food safety crisis of Hong Kong in 2007 that was mentioned before, where a huge crisis was avoided by solving little and isolated safety problems in certain kinds of food, because with the control of this little crises, the government achieved to generate a CMC and prevented the worst part of the crisis (Chan & Chan, 2008). Another example is the study "Attitudes and perceptions of crisis planning among accommodation managers: Results from an Australian study", where the results say that Australian managers need as the most important abilities, the short term problem or crisis management and solution, being able to react to these crises or problems and being transparent with the problems and the rest of the organization. These abilities showed in the study that help to prevent and control

the crisis, because they involve an objective and more wide view of a crisis, including the whole company opinion and involving a common CMC (Wang & Ritchie, 2012).

Another topic of Crisis Prevention are the studies "Misperceptions of Global Climate change: Information Policies" (Moxnes & Saysel, 2006) and "A holistic framework for building critical infrastructure resilience" (Labaka et al., 2015), a common type of crisis can be detected, the "low probability, high impact events" that in these studies, where the air contamination and the energy plants are the subjects, respectively, this crisis would be people intoxication or a whole zone of the country without energy, so the consequences are very serious. This implies that a government (acting like a firm avoiding a contamination crisis) and a nuclear plant need to prevent this crisis as a priority, that's why in these studies, BSs were made to analyze which signs were indicators of a potential crisis, how to react to them and prevent this "low probability, high risk crises". To achieve these goals is completely necessary to work as a team and a have a strong CMC, as the study "The role of Positive affectivity in team effectiveness during crises" (Kaplan, Laport & Waller, 2013) concludes, a work team always gets better results when the whole team has the same affectivity, in other words, when the whole work team thinks the same way and leads to the same objectives, the results are much better and can react the same way to an unexpected crisis, making synergy and getting the best results. This shows the effectivity and the importance of a common attitude and a well implemented CMC.

2.3.   Crisis Handling and Simulation

The second stage of the crisis management is the Crisis Handling (CH) stage. This is the one that follows Crisis Prevention and it occurs when crisis is already happening in the company, and helps a manager to handle it, because their mental model and decision making model can change the firm's future. Crisis Handling is very important because it's the final contingency plan, the one that a manager has to use when the other plans have failed (i.e. Crisis Prevention plans), and the way it's handled can lead the direction of the business's crisis, making it disappear or persist and have critical consequences. There is a lot of literature that talks about CH and how it should be treated, but in this section the focus will be on how the BS helps a manager to improve the firm's CH.

At the moment when a crisis starts, knowledge about statics situations is useful for the new situation (Moxnes, 2004), everyone is wondering where and how will this end, without deep understanding of the current situation. Moxnes (2004), defines that people's mental model are used at static situations, trying to apply feedback rules on making decisions, but for a crisis, this will be different because everything is in constant change. Furthermore, concludes that a repeated feedback is not enough for rapid learning, affecting performance and organizational development in crisis. Sometimes even highly qualified people in power don't know what to do and how to manage a new situation (Sterman & Sweeney, 2007), explaining some of the economic crisis of countries and companies that we have seen among history. Sterman and Sweeney (2007) study how highly educated people can help to develop new strategies and ideas that could help to handle current crisis like climate change or others problems.

As we mentioned before, business simulation helps a company to anticipate possible crises, and the optimal solution is to prevent them, but the possibility of a prevention plan that doesn't success always exist, so there are going to be two types of BS for CH, the ones that are made before the crisis to discover how to react to a prevention failure and the ones that are made while the crisis is happening and to find out what will the outcome of a certain type of handling will be. The most important choice that a manager needs to take when handling a crisis is how to confront it and to transmit this to the rest of the company, so the mental models of the managers and the other employees are fundamental factors in this stage, needing a popular and common culture, with similar levels of effectiveness, being positive or negative. According to authors like Chan, Sterman, Sweeney, Moxnes and others, the best way to handle a crisis is to confront it, communicate it to the employees and the possible complications that this crisis can carry with it, giving a very clear and transparent view of the company to everyone, making the problem more objective than before and getting better possible solutions. We can see these results in studies like "Food Safety Management Crisis Plan in Hong Kong" (Chan & Chan, 2008) or "Understanding Public Complacency about Climate Change" (Sterman & Sweeney, 2007) where the communication to the population, the team work and the team affective configuration were fundamental to avoid these crises, making every member of the organization to attack the crisis from his personal point of view. This is why it's so important to include the mental models in this study, because a BS cannot be common for different firms, every episode will be very different depending on the mental models of the people inside the organization, moreover the manager. So, to improve competitive success or achieve higher performance outcomes it is necessary for the managers or decision makers to have more accurate mental models

of the causal relationships in the business environment and apply it (Shayne Gary & Wood, 2011). According with this, it's very important for a company to react as soon as possible to this crises, avoiding any bigger consequences, an example of this problem are the "low probability, high impact events" like the crises that can affect a water distribution company or a nuclear power plant, where a crisis can be lethal to a lot of people and is very uncommon, so companies in these industries use the resilience in Critical Infrastructure (CI) model, where each part of the infrastructure that can have a crisis, handles it by itself, making a big and common CMC for the company and a very own BS and CH management for each CI, but gives the fastest and more effective response to any crisis. (Labaka, Hernantes & Sarriegi, 2015)

Simulations and studies about crisis handling, talk about quick learning using feedback and mental models that will improve decision making in crisis situation, also could be improved performance considering science investigation and high educated people developing new and more strategies for prevent or handle crisis. Finishing with how are composed environments and their relation between organization and their targets, affecting negatively if they are not aligned.

2.4.   Crisis Recovery and Simulation

On the last phase of a crisis, Crisis Recovery is the CM stage that follows the Crisis Handling stage in time. When a crisis avoids the prevention stage, occurs and avoids the handling stage, the only possibility left is the recovery stage, where the company accepts the damage and moves on, so in very little words, this stage is moving on and letting a crisis behind. An example is how the economic crisis of 2008 affected the European Union community and how the crisis stopped the misrepresentation of financial information to get past off this crisis, because in spite of all the prevention law and the first ones that got caught in bad financial behaviors, this crisis occurred and had enormous economic and social consequences (Cimmini, 2014). This stage is not very popular, because to study it, the researcher has to assume that the other stages have failed, which is not well seen and most of the time this attitude is labeled as negative, so there is not so much literature about it and it's a good research opportunity, given the amount of times that this situation occurs day to day and the critical consequences that a bad Crisis Recovery has.

Crisis Recovery is the possibility to help companies that are being aided right when a crisis struck them, this is, as a first action instead of the least action, so getting in deep with this topic could help the industry of consultants, as most of the time other companies come to them when facing a crisis. Said that, this new point of view is a push to include Crisis Recovery in I&D and include simulations on it, as simulations will improve the recovery strategies effectiveness as seen in the other topics of this lecture.

3. Theoretical Framework for analyzing Crisis with Simulation

Figure 1: Crisis Management and Simulation and its areas of research
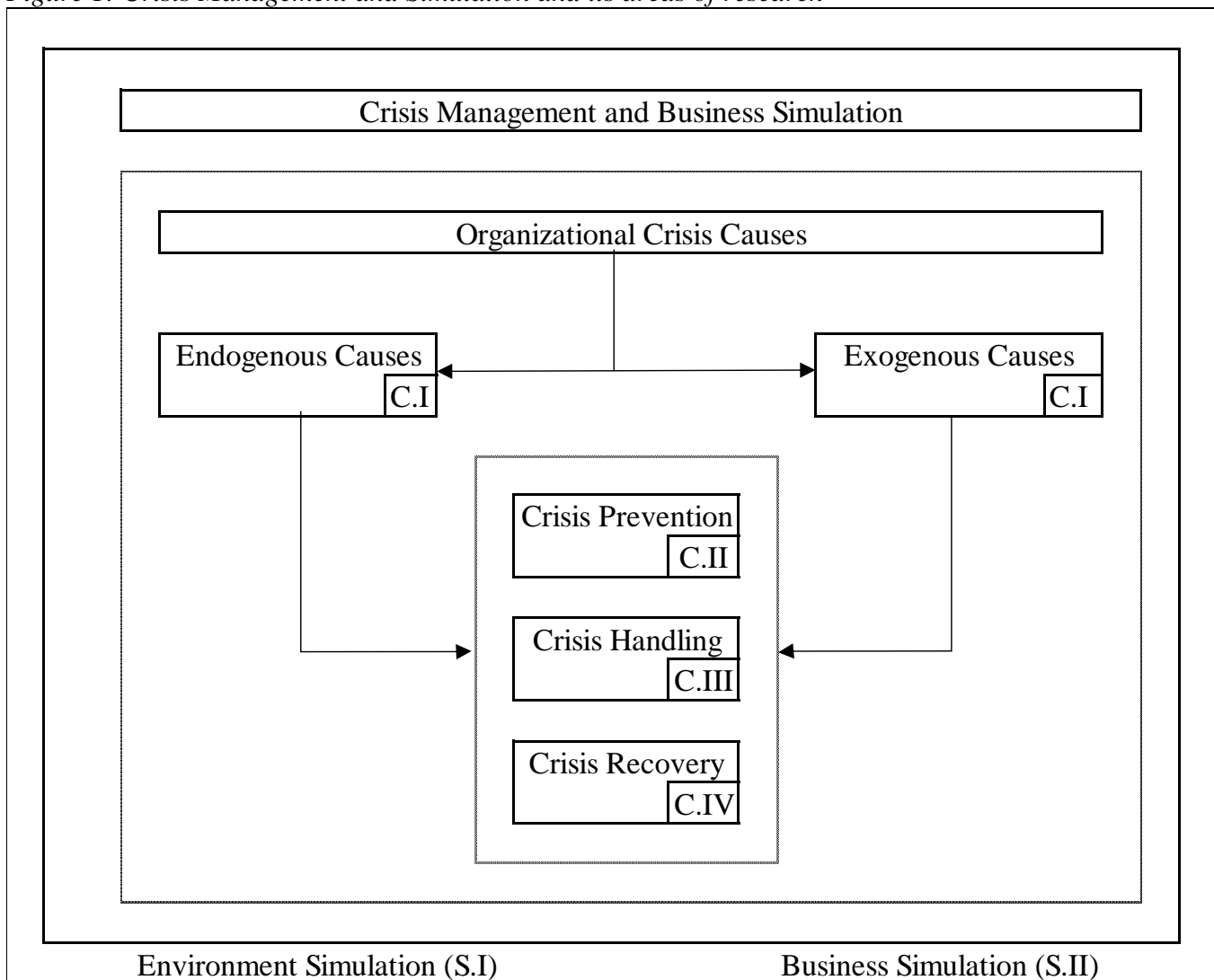
Table 1 Linkage-Exploring Review Matrix

	C I	C II	C III	C IV	S1	S2
C I	1					
C II	3	4 - 9				
C III		2 - 6 - 30				
C IV			31			
S1			8 - 15 - 32		5-26	
S2		18	17			7 - 10 -11 - 13 -19 - 20 - 21 - 24 - 25 - 29
Support	12	14	16	22	23	28

4. Research Opportunities

As this article shows, there has been a lot of studies among the last three decades about Crisis Management and Crisis Simulation, giving extensive amounts of literature about it to the society, talking about almost every topic of the ones raised among this article, but there is a lack in some topics that can be seen as research opportunities for future investigations, presented in Table 2.

The Organizational Crisis Causes that are defined in this article are four specific endogenous causes and very common critical scenarios that can relate to any firm of any industry. But, there is not much investigation and detail on each one of this causes or in the different manifestations of this scenarios in each industry, so a big research opportunity is raised here that will help both, developing or growing companies, on each industry and reduce the number of companies that fail in their first 10 years, which is (globally) near to the 73% of the non-franchised companies according to the US Commerce Department, so it's a very important topic to investigate and too deep in.

Among these three decades, there have been lots of studies mentioning the three stages of Crisis Management, the Prevention, the Handling and the Recovery. In the vast literature available, there are some very good investigations and conclusions about CP and CH, but there is almost non literature about Crisis Recovery, which is a very important stage that helps a company when everything else fails. It's not a popular topic because it's assuming that the other two stages didn't work out, so it has a negative stigma, but in reality there are a lot of cases where a crisis cannot be controlled on the first two stages, and the lack of literature in this topic shows a big opportunity to investigate and avoid a high number of crises that can get a company to bankruptcy, because of their inability to recover. Finally, our biggest opportunity that have been founded it is, that crisis phases haven't been studied relating, Prevention, Handling or Recovery, with endogenous and exogenous causes. Exogenous causes have the biggest opportunity research, our study haven't found a connection between endogenous causes and crisis stages in Crisis Management simulation.

Table 2: Research opportunities among theoretical streams

Research Stream	Perspective	Key Opportunities
Crisis (C): Organizational Crisis Causes	New Ventures Growing Companies	Develop a better growing strategy for new and young companies
Crisis Recovery	New Ventures Growing Companies Old Companies	Improve reaction quality for every company to recover and heal from a crisis

5. Conclusion

The first idea that this article raises is how Crisis Management and Business Simulation have been studied in different universities and countries. Analyzing these isolated results, the main conclusion that we got is that Crisis Handling has been the most studied topic in the last years, relating to Crisis Management, because it helps managers to react in the best way against changes, like an economic downturn or upturn. Besides that, the studies showed that Crisis Handling and Business Simulation were better together than by themselves, developing synergy. On the other hand, authors leave aside the Crisis Recovery stage and its organizational implication, with a very low amount of literature available, so, here we found that there are good research opportunities in this topic, relating to this stage in Crisis Management by itself and linking it with Business Simulation.

Finally, this article provides three important advances to the Crisis Management and Simulation topic, firstly, a big summary of the literature that has been written among the past, emphasizing the interrelation between authors and topics. After that, this article explains the importance of Business Simulations on an uncertain decision making process, and the last advance that this article provides is the link between the summary of Crisis Management to Business Simulation, emphasizing the synergy generated when complementing this topics.

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Table 3: Linkage exploring studies

PAPER	LINKAGE	TITLE	AUTHOR(S)	YEAR	SOURCE	FINDINGS	UNIVERSITY	COUNTRY
1	CI	CRISIS IN COMPLEX SOCIAL SYSTEMS: A SOCIAL THEORY VIEW ILLUSTRATED WITH THE CHILEAN CASE	Aldo Mascareño, Eric Goles and Gonzalo Ruz	2015		This paper's research about compulsive growth of systemic communication. Acceleration of modern life seems to be a factor strongly related to events of communicative compulsive growth. Since in modern society social time is system-dependent (each system creates its own treatment of time in form of orthogonal rhythms of acceleration and deceleration), systems of higher acceleration rates such as economy, finance or even politics, are prone to produce episodes of compulsive growth and engage in "multiple overlapping timescales", thereby triggering temporality collisions among systems. The question is how inflationary tendencies in some social systems, particularly in politics (politicization), economy (monetization), and religion (increasing dogmatization) affect other systems, and how they concomitantly produce deflation in terms of decreasing trust in other fields	Universidad Adolfo Ibañez	CHILE
2	CII - CIII	PREPARATION FOR CRISIS MANAGEMENT: A PROPOSED MODEL AND EMPIRICAL EVIDENCE	S. Elsubbaugh, R. Fildes and Mary B. Rose	2004	Journal of Contingencies and Crisis Management, 2004, Vol. 12, No. 3, pp. 112 - 127	Various activities were identified as efficiency of day-to-day activities, delegation and coordination among people and departments. Also, the results provided an empirically based framework for understanding the Egyptian textile firm's crisis preparation, which might, if adopted, speed up existing attempts to create a crisis management culture in the Egyptian context. The studies showed that neither government nor boards of directors can hope to cope with crises through legislation, they must create a dramatic shift in the culture of organizations such as those studied, which involve transforming a firm from one that hides bad news to one that seeks out and values different viewpoints, opinions, and contradictory information.	Oxford University and Lancaster University	UK

PAPER	LINKAGE	TITLE	AUTHOR(S)	YEAR	SOURCE	FINDINGS	UNIVERSITY	COUNTRY
3	CI - CII	ORGANIZATIONAL CRISIS: THE LOGIC OF FAILURE	Gilbert Probst and Sebastian Raisch	2005	Academy of Management Executive, 2005, Vol. 19, No. 1, pp 90 - 105	This study has shown that in the majority of cases, the failure of successful firms largely follows the same logic. Affected organizations in this investigation reveals that this is a real threat faced by all organizations. The good news is that organizations do not face this danger defenselessly, if the danger is recognized in time, and if the organization corrects the course effectively, the crisis itself can be avoided. Final conclusion leads to four key lessons learned: (1.) Growth is important – unless it becomes excessive. (2.) Change is positive – if you preserve your company's identity. (3.) Visionary leaders are beneficial – as long as they share their power. (4.) Internal competition spurs performance – if incorporated into a culture of trust.	University of St Gallen	SWITZERLAND
4	CII	THE STRUCTURE OF MAN-MADE ORGANIZATIONAL CRISES: CONCEPTUAL AND EMPIRICAL ISSUES IN THE DEVELOPMENT OF A GENERAL THEORY OF CRISIS MANAGEMENT	Ian I. Mitroff, Terry C. Pauchant and Paul Shrivastava	1988	Technological Forecasting and Social Change 33, pp. 83 - 107	The present study has been successful in shedding important light on the essential phases of crisis management and the structure (i.e., organization) of crises and preventative actions. The relationship between the empirical results, analyses, and the process models of CM is highly important. If different types of crises leave different kinds of early-warning signals; calls for different kinds of preparatory and prevention mechanisms make different "crises clusters", should organizations form a crisis portfolio based on the probable occurrence and possible "blocking actions" for this portfolio?	University of Southern California, Laval University and New York University	USA AND CANADA

PAPER	LINKAGE	TITLE	AUTHOR(S)	YEAR	SOURCE	FINDINGS	UNIVERSITY	COUNTRY
5	SI	PATH DEPENDENCE, COMPETITION, AND SUCCESSION IN THE DYNAMICS OF SCIENTIFIC REVOLUTION	John D. Sterman and Jason Wittenberg	1999	Organization Science, Vol. 10, No. 3, Special Issue: Application of Complexity Theory to Organization Science (1999), pp. 322-341	Authors find that the fate of a particular new theory or paradigm is strongly conditioned by the circumstances surrounding its creation and only weakly influenced by its explanatory power or logical force. In particular, simulations show that new theories with great explanatory power frequently fail to attract a critical mass of adherents, while weaker ones often triumph.	Massachusetts Institute of Technology	USA
6	CII - CIII	FOOD SAFETY CRISIS MANAGEMENT PLAN IN HONG KONG	S.F. Chan and Zenobia C.Y. Chan	2008	Journal of Food Safety 29 (2009) 394–413.	A recent series of food safety problems in Hong Kong may already give us an alarm prior to a real food safety crisis. The proposed food safety crisis management plan can facilitate the handling of a crisis when it comes or even avoid it to turn into real crisis. Finally, three phases of the crisis management are obtained: Prevention, Emergency and Reconstruction.	The Hong Kong Polytechnic University	CHINA
7	SII	THE EFFECTS OF FEEDBACK FORMAT ON DYNAMIC DECISION MAKING	Paul Atkins, Robert Wood and Philip Rutgers	2002	Organizational Behavior and Human Decision Processes, 88(2), 587-604	This study makes a simulation consisting in a program that represented reality of a company sales with a linear part and a random one. The final objective of the study is to analyze the effect of 2 different types of feedback on the groups. The 2 types differ in the way the information is shown, in a table with numbers or in graphics with numbers and a table. The study had 3 hypotheses, that the second type of feedback would do better in: Performance in lower costs, less response time and more analytical thinking, but the simulation brought as a result that just the first hypothesis was true, and that the different feedback doesn't have any effect in the other 2 hypotheses.	University of New South Wales	AUSTRALIA

PAPER	LINKAGE	TITLE	AUTHOR(S)	YEAR	SOURCE	FINDINGS	UNIVERSITY	COUNTRY
8	CIII - SI	UNDERSTANDING PUBLIC COMPLACENCY ABOUT CLIMATE CHANGE: ADULTS' MENTAL MODELS OF CLIMATE CHANGE VIOLATE CONSERVATION OF MATTER	John D. Sterman and Linda Booth Sweeney	2007	Climatic Change, 80(3-4), 213-238	A simulation with MIT students was made and were asked some questions to see how much "highly educated people" could help to make efficient policies and stop climate change. This hypothesis was confirmed and the conclusion is that people of good faith can debate the costs and benefits of policies to mitigate climate change, but policy should not be based on mental models that violate the most fundamental physical principles. The results suggest the scientific community should devote greater resources to developing public understanding of these principles to provide a sound basis for assessment of climate policy proposals.	Massachusetts Institute of Technology and Harvard Graduate School of Education	USA
9	CII	ATTITUDES AND PERCEPTIONS OF CRISIS PLANNING AMONG ACCOMMODATION MANAGERS: RESULTS FROM AN AUSTRALIAN STUDY	Jie Wang and Brent W. Ritchie	2012	Safety Science 52 (2013) 81–91	This study has investigated managers' attitudes and perceptions that determine their intentions to undertake crisis planning. Results indicated that attitude and subjective norm made significant contributions to the prediction, while perceived behavioral control did not affect intention. Intention to implement crisis planning activities was associated with anticipated short and long term consequences. Among the short term consequences, the ability to respond to and deal with crises was highly valued, as the long term consequences focused on organization competitiveness in terms of improving long term viability and reputation. The present study demonstrates the applicability of the theory of planned behavior to the problem of the low level of crisis planning implementation in the accommodation sector in Australia.	The University of Queensland, Brisbane	AUSTRALIA

PAPER	LINKAGE	TITLE	AUTHOR(S)	YEAR	SOURCE	FINDINGS	UNIVERSITY	COUNTRY
10	SII	ANALYSIS OF STOCK MANAGEMENT GAMING EXPERIMENTS AND ALTERNATIVE ORDERING FORMULATIONS	Yaman Barlas and Mehmet Günhan Özevin	2004	Systems Research and Behavioral Science, 21(4), 439-470	This paper has two different research objectives. The first is to analyze the effects of selected experimental factors on the performances of subjects in a stock management simulation game, revealing the most significant factors that determine the manager's behavior, like "discrete delays have significant destabilizing effects on inventory oscillations compared with continuous delays. On the other hand, the step–up–and–down demand pattern has no obvious effect on inventory dynamics, when compared with step up only demand pattern. The length of order interval has strong destabilizing effects on all performance measures". The second research objective was to evaluate the adequacy of standard decision rules typically used in dynamic stock management models and to seek improvement formulations. The first result is 3 patterns of order: smooth damping orders, alternating large-and-zero orders and long periods of constant orders punctuated by a few sudden large ones.	Bogazici University	TURKEY

PAPER	LINKAGE	TITLE	AUTHOR(S)	YEAR	SOURCE	FINDINGS	UNIVERSITY	COUNTRY
11	SII	ENHANCING LEARNING CAPABILITIES BY PROVIDING TRANSPARENCY IN BUSINESS SIMULATORS	Andreas Grobler, Frank H. Maier and Peter M. Milling	2000	Simulation & Gaming, 31(2), 257-278	This article deals with two aspects: (a) an appropriate and general experimental design for investigations about the effectiveness of gaming-oriented simulation tools and (b) the application of this research framework to analyze the benefits of adding transparency about model structure in business simulators. Finally, this research indicates, a presentation about system structure can be an important step from black-box business simulators to effective learning environments. In this way, transparency can combine with other aspects, such as constructive feedback from the tutor or facilitator, guides to improve performance, links to things already known (Gagné, 1985), or source material (Davidsen, 1996), to form a comprehensive framework for learning in and about complex systems.	Mannheim University	GERMANY
12	SUP	MENTAL MODELS CONCEPTS FOR SYSTEM DYNAMICS RESEARCH	James K. Doyle and David N. Ford	1997	System dynamics review, 14(1), 3-29	This article presents a review of existing descriptions and definitions of "mental models" in a variety of literatures. There has to be a clearly specified, comprehensive, and agreed upon definition of mental models. Finally suggest the next definition; a mental model of a dynamic system is a relatively enduring and accessible but limited internal conceptual representation of an external system whose structure maintains the perceived structure of that system.	Worcester Polytechnic Institute and University of Bergen	USA AND NORWAY

PAPER	LINKAGE	TITLE	AUTHOR(S)	YEAR	SOURCE	FINDINGS	UNIVERSITY	COUNTRY
13	SII	EFFECTS OF STRUCTURAL TRANSPARENCY IN SYSTEM DYNAMICS SIMULATORS ON PERFORMANCE AND UNDERSTANDING	Birgit Kopainsky and Stephen Alessi	2015	Systems, 3(4), 152-176	First research question was the following: will learners who receive the prior exploration strategy embedded within a more transparent interface show better understanding than learners receiving the prior exploration strategy embedded in an opaque interface? The new hypothesis is that model structure transparency benefits higher levels of learning (applying and analyzing) more than lower levels of learning. Second research question was the following: will learners who receive the prior exploration strategy embedded within a more transparent interface demonstrate better performance in the final simulation-game than learners receiving the prior exploration strategy embedded in an opaque interface, where performance is measured by the final per capita income adjusted for interest on debt in the simulated nation. This two conditions did not differ significantly, being consistent with previous studies.	University of Bergen and University of Iowa	NORWAY AND USA
14	SUP	RATIONALITY IN SYSTEM DYNAMICS: MODELLING HUMAN AND ORGANIZATIONAL DECISION MAKING	ßler and Peter M. Milling	2004	Systems Research and Behavioral Science, Vol. 21, Issue 4, pp. 313–317, July/August 2004	A simulation where each one of the inviteds exposed his paper and had a discussion about decision making models and rationality.	Universität Mannheim and London School of Economics	GERMANY AND UK

PAPER	LINKAGE	TITLE	AUTHOR(S)	YEAR	SOURCE	FINDINGS	UNIVERSITY	COUNTRY
15	CIII - SI	MISPERCEPTIONS OF BASIC DYNAMICS: THE CASE OF RENEWABLE RESOURCE MANAGEMENT	Erling Moxnes	2004	System Dynamics Review Vol. 20, No. 2, (Summer 2004): 139–162	This papers study by simulation where experiments show that even minimal representations of a renewable resource are sufficient to cause severe mismanagement of the type observed in the real world, besides that repeated outcome feedback is not sufficient to achieve rapid learning over time and over repeated trials. Finally, the results show that people's mental models seem biased towards static, correlational representations and they tend to apply feedback rules when making decisions. On the other hand, once a simple, dynamic model is available, a quite simple heuristic would in our case lead to appropriate management. In this lies a considerable hope for improved management of renewable resources.	University of Bergen	NORWAY
16	SUP	IMPACT OF POS DATA SHARING ON SUPPLY CHAIN MANAGEMENT: AN EXPERIMENTAL STUDY	Rachel Croson and Karen Donohue	2003	Production and Operations Management 12(1): 1–11	The experiments reported in this paper investigate the behavioral impact of adding POS data-sharing to supply chains. Results indicate that the addition of this data significantly improves performance by reducing order oscillation, particularly at higher levels in the chain (distributor and manufacturer). This reduction of oscillation at higher levels of the supply chain leads to reduced amplification between the two middle levels (wholesaler and distributor) but not between the other levels.	University of Pennsylvania and University of Minnesota	USA

PAPER	LINKAGE	TITLE	AUTHOR(S)	YEAR	SOURCE	FINDINGS	UNIVERSITY	COUNTRY
17	CIII - SII	MENTAL MODELS, DECISION RULES, AND PERFORMANCE HETEROGENEITY	Michael Shayne Gary and Robert E. Wood	2011	Strategic Management Journal, 32(6), 569-594	This study provides empirical evidence for the links between mental models and performance outcomes and help explain why some managers and not others adopt strategies that are ultimately associated with competitive success. Results show that decision makers with more accurate mental models of the causal relationships in the business environment achieve higher performance outcomes. Furthermore, help address an important challenge facing the strategy field about whether more accurate mental models enable manager's ex ante to identify and interpret signals from their business environment that lead to superior strategic choices and performance out-comes.	University of New South Wales and Melbourne Business School	AUSTRALIA
18	CII - SII	MISPERCEPTIONS OF GLOBAL CLIMATE CHANGE: INFORMATION POLICIES	Erling Moxnes and Ali K. Saysel	2006	Climatic Change, 93(1-2), 15-37	A simulation where 5 different models were used to investigate the capability of people to control the contamination that causes climate changing. Each model improved the subject's problem understanding and the only group that had a positive effect with the information adding was the group with the strongest mathematical background. However, this should be sufficient to apply it in government policies. Finally, less attention should be put on discussing the causes of ongoing variations in the climate, more attention should be put on the basic underlying mechanisms and the delays, as well as on quantitative measures of how large emission reductions are needed just to stabilize the CO_2-concentration.	University of Bergen	NORWAY

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PAPER	LINKAGE	TITLE	AUTHOR(S)	YEAR	SOURCE	FINDINGS	UNIVERSITY	COUNTRY
19	SII	DOES FORMAL SYSTEM DYNAMICS TRAINING IMPROVE PEOPLE'S UNDERSTANDING OF ACCUMULATION?	John D. Sterman	2010	System Dynamics Review, 26(4), 316-334	A simulation where different students were exposed to a Department Store experiment and analyze the simplest relation between inflows and outflows. The pre-test showed the poor performance typically found in prior work. Performance on the post-test improved substantially and statistically significantly.	Massachusetts Institute of Technology	USA
20	SII	ORDER STABILITY IN SUPPLY CHAINS: COORDINATION RISK AND THE ROLE OF COORDINATION STOCK	Rachel Croson, Karen Donohue, Elena Katok and John Sterman	2014	Production and Operation Management Vol. 23, No. 2, February 2014, pp. 176–196	A simulation where the problem of inventory stock is compared to the beer distribution game, using 10 teams and 4 different experiments with different amount of information available. Three principal findings: -The "bullwhip effect" (small change at the beginning of the supply chain makes a massive change at the end) is a behavioral phenomenon and will always be present, even without uncertainty on demand. -The study identifies coordination risk as a possible new source of uncertainty that may both trigger and further amplify bullwhip behavior. - Performance is similarly improved by adding coordination stock, which buffers against strategic uncertainty.	University of Texas at Dallas, University of Minnesota and Massachusetts Institute of Technology	USA

PAPER	LINKAGE	TITLE	AUTHOR(S)	YEAR	SOURCE	FINDINGS	UNIVERSITY	COUNTRY
21	SII	LEARNING, COMMUNICATION, AND THE BULLWHIP EFFECT	Diana Yan Wu, Elena Katok	2005	Journal of Operations Management, 24(6), 839-850	This study examines the effect of training and communication on decision-making process in a dynamic supply chain simulation. This result indicates that the observed supply chain instability is, at least in part, due to insufficient coordination between supply chain partners. It also reveals that training may serve to build up individuals' knowledge and thereby enhance their decision quality, while communication may serve to successfully transfer individual learning into coordinated organizational actions that eventually lead to better system performance.	Penn State University	USA
22	SUP	WHY DON'T WELL-EDUCATED ADULTS UNDERSTAND ACCUMULATION? A CHALLENGE TO RESEARCHERS, EDUCATORS, AND CITIZENS	Matthew A. Cronin, Cleotilde Gonzalez, John D. Sterman	2008	Organizational Behavior and Human Decision Processes, 108(1), 116-130	Prior work has demonstrated that even highly educated people do poorly on a range of simple stock–flow problems. This research demonstrates that Stock-Flow failure is not an artifact of the task, nor is it easily corrected. Rather, the error reflects serious misunderstanding of the basic principles of accumulation. They tested whether people in fact understand the concepts of accumulation, but perform poorly due to information displays, unfamiliar contexts, inadequate motivation, inability to read or construct graphs, or limited cognitive capacity.	George Mason University, Carnegie Mellon University and MIT Sloan School of Management	USA
23	SUPP	CONDUCTING BEHAVIORAL RESEARCH ON AMAZON'S. MECHANICAL TURK	Winter Manson and Siddharth Suri	2011	Behavioral Research Methods 44(1): 1–23	This article describes a tool for behavioral researchers to conduct online studies: Amazon's Mechanical Turk. It's a crowdsourcing platform that provides researchers with access to a massive subject pool available 365 days a year, with a completer and deeper population to study.	www.springer.com	ONLINE STUDY

PAPER	LINKAGE	TITLE	AUTHOR(S)	YEAR	SOURCE	FINDINGS	UNIVERSITY	COUNTRY
24	SII	HUMAN-COMPUTER INTERFACE DESIGN CAN REDUCE MISPERCEPTIONS OF FEEDBACK	Edward Howie, Sharleen Sy, Louisa Ford and Kim J. Vicente	2000	System Dynamics Review; Autumn 2000; 16, 3; ProQuest Psychology Journals pg. 151	In this study the topic is the MOF (Misperception of Feedback) in decision making for managers. A simulation shows that, without much explanation and training, is better to have less information and simpler programs to achieve more efficient results. In the other hand, it's shown that with more training before the experiment, the results are much better and near to the optimal.	University of Toronto	CANADA
25	SII	DO MARKETS MITIGATE MISPERCEPTIONS OF FEEDBACK?	Christian Erik Kampmann and John D. Sterman	2014	System Dynamics Review, 30(3), 123-160	The experimental results demonstrate that bounded rationality and, in particular, misperceptions of feedback, can have large effects on market behavior, including conditions with well-functioning and common pricing institutions. Thus markets seem to moderate, but do not eliminate, the effects of decision makers' misperceptions of feedback structure. The mere existence of markets does not imply that individual misperceptions of feedback are ameliorated. Misperceptions continue to occur, but their consequences are a function of the dynamic structure of the market setting.	Copenhagen Business School and MIT Sloan School of Management	DENMARK AND USA
26	SI	MANAGERIAL DECISION MAKING AND FIRM PERFORMANCE UNDER A RESOURCE-BASED PARADIGM	Martin H. Kunc and John D. W. Morecroft	2010	Strategic Management Journal,31(11), 1164-1182	This paper presents a view of managerial decision-making processes under a resource-based paradigm. In this paper, they focus on one situation: managerial decision making of homogeneous resources that can lead to heterogeneous performance. Therefore, this paper extends the resource-based view of the firm literature by showing that decision-making processes for managing resources can lead to a heterogeneous distribution of resources and subsequent performance differences, even though the initial resources are homogeneous and easily available.	Warwick Business School and London Business School	U. K

PAPER	LINKAGE	TITLE	AUTHOR(S)	YEAR	SOURCE	FINDINGS	UNIVERSITY	COUNTRY
27	SUP	DOES ANALYTICAL THINKING IMPROVE UNDERSTANDING OF ACCUMULATION?	Arash Baghaei Lakeh and Navid Ghaffarzadegan	2015	System Dynamics Review vol 31, No 1-2 (January-June 2015): 46–65	The idea of this study is to prove that there exists more efficient and cheaper way to improve management behaviors, referring to Stock - Flow problems. Principal findings were (1.) The overall performance in the department store task was very poor. (2.) Asking people to think about an analytical question before answering the SF task improved their performance in the SF task. (3.) So, finally, there are simple, low-cost interventions that can improve people's response in SF tasks.	Virginia Tech	USA
28	SUP	BATHTUB DYNAMICS: INITIAL RESULTS OF A SYSTEMS THINKING INVENTORY	John D. Sterman and Linda Booth Sweeney	2000	System Dynamics Review, 16(4), 249-286	This study concludes that highly educated subjects with extensive training in mathematics and science have poor understanding of some of the most basic concepts of system dynamics, specifically stocks and flows, time delays, and feedback. The errors are highly systematic and indicate violations of basic principles, not merely calculation errors. Subjects tend to violate fundamental relationships between stocks and flows, including conservation.	MIT and Harvard	USA
29	SII	EXPLORING RETAILERS' ORDERING DECISIONS UNDER DELAYS	Sebastián Villa, Paulo Gonçalvesa and Santiago Arango	2015	System Dynamics Review, Volume 31, Issue 1-2, pages 1–27	In this paper, was developed a laboratory experiment to explore how subjects playing the role of a retailer place orders in response to a surge in final customer demand. Subjects must minimize total cumulative costs, given by the sum of two cost components: a supply gap cost and an ordering cost. In the experiment, subjects face two types of delays: retailer ordering delays and supplier's capacity acquisition delays. This experimental results show that subjects underperform when compared to the optimum, even when demand is known and constant and the system begins in equilibrium.	Università della Svizzera Italiana (USI)	ITALY

PAPER	LINKAGE	TITLE	AUTHOR(S)	YEAR	SOURCE	FINDINGS	UNIVERSITY	COUNTRY
30	CII - CIII	A HOLISTIC FRAMEWORK FOR BUILDING CRITICAL INFRASTRUCTURE RESILIENCE	Leire Labaka, Josune Hernantes and Jose M. Sarriegi	2015	Technological Forecasting & Social Change 103 (2016) 21–33	This research is a comprehensive advance in the implementation of resilience in critical infrastructures (CI). This study with a nuclear plant and a water distribution company, shows that critical infrastructures need to complement their approach and be aware that a transversal preparation is required in order to be capable of dealing with any kind of event, whether expected or unexpected, to detect improvement opportunities and to project future actions or policies to enhance the CI's resilience level. Furthermore, the influence of the resilience policies on the three resilience lifecycle stages (prevention, absorption and recovery) can differ from one CI to another.	University of Navarra	SPAIN
31	CIII - CIV	HOW HAS THE FINANCIAL CRISIS AFFECTED EARNINGS MANAGEMENT? A EUROPEAN STUDY	Riccardo Cimini	2014	Applied Economics, 47:3, 302-317 (2015)	This paper talks about the earnings manipulation in companies and the difference in this misrepresentation when there is a regular economic time (2006 - 2007) or an economic crisis bursts (2008), specifically in the European Union. The hypothesis is that when an economic crisis bursts, this misrepresentation of financial information decreases, which means that the audited ones became more skeptics and the auditors became more scrutiny.	University of 'Tor Vergata'	ITALY

PAPER	LINKAGE	TITLE	AUTHOR(S)	YEAR	SOURCE	FINDINGS	UNIVERSITY	COUNTRY
2	CIII - SI	THE ROLE OF POSITIVE AFFECTIVITY IN TEAM EFFECTIVNESS DURING CRISES	Seth Kaplan, Kate Laport and Mary J. Waller	2013	Journal of Organizational Behavior, J. Organiz. Behav. 34, 473–491 (2013)	The topic of this paper is the role of team affective configuration in team effectiveness under crisis conditions. Conclusions: (i) mean-level PA was not associated with effectiveness, (ii) heterogeneity in PA was negatively related to team effectiveness, (iii) there was an interaction between these two characteristics in predicting effectiveness, in that heterogeneity seemed to have a more pronounced effect in differentiating teams with lower, rather than higher, mean-level PA, and finally (iv) the influence of lower heterogeneity on team effectiveness appears to be transmitted, in part, through the experience of lower negative emotion during the crisis.	George Mason University and York University	USA AND CANADA