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# ***Emotional states of the individual in a process of organizational change***

**Cristian Castillo Gutiérrez**

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# Emotional states of the individual in a process of organizational change

*Ph.D. Thesis*

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By

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Acabada la lectura y después de dar respuesta a las cuestiones formuladas por los miembros titulares del tribunal, éste otorga la calificación:

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## ABSTRACT

**Context:** Given the importance of knowing and anticipating employees' reactions before organizational changes when it is perceived as negative, this Ph.D. thesis defines the individuals' six emotional states during the organizational change so that future researchers and change leaders have the enough knowledge and tools to address it.

**Purpose:** The Ph.D. thesis is divided into two interrelated purposes: (1) the identification of the different emotional states through which the individual transits during a process of organizational change when it is perceived as negative and (2) the development of a simulation model that allows analyzing the emotional changes that occur in an organization.

**Method:** For the culmination of the first purpose, we have resorted a qualitative methodological approach and we chose individual interviews as the main method of qualitative data collection. In this case, the sample consists of fifteen individual participants that they have experienced an organizational change perceived as negative. As for the second purpose, we have followed the guidelines and recommendations of the literature: problem definition, data collection and configuration of model parameters, conceptual model, testing of the programmed model, and analysis of the results of the simulation.

**Results:** Through empirical qualitative research, we obtained the six emotional states of organizational change: denial and anger, bargaining, depression, revising, deserting and acceptance. Related to this, the results show that individuals can move freely between the first four states, but deserting and acceptance are always the final states. Furthermore, during denial and anger and bargaining, relationships with family, friends and co-workers improve, but during depression, relationships with family and friends deteriorate, but as co-workers become much more important, those relationships improve. Relationships with supervisors deteriorate during denial and anger and depression but remain stable during bargaining. As far as the simulation proposal is concerned, this allows the study of the evolution and propagation of states considering different interaction networks simultaneously. As an example, we use the results of the first qualitative research and we apply it to the study of states propagation against the organizational change.

**Conclusions / Implications:** Our results can guide managers in foreseeing and anticipating actions that would reduce the emotional impact of organizational change and mitigate the impact of individuals' negative emotions on the organization.

**Originality:** This Ph.D. thesis extends existing theory about the strategies of coping and organizational changes, as well as the definition of the heuristic necessary for the development of a model that it allows researchers in social sciences to carry out the analysis of propagation of states in a simple and efficient way.



## ACKNOWLEDGEMENTS

There is no greater pleasure than being able to write these lines of acknowledgements, a symptom that the memory of the Ph.D. thesis is about to end. Therefore, I can not leave without mentioning the people who in one way or another have contributed to the achievement of this document, which has accompanied me in these last three years with many joys and also with many headaches.

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I give you my heartfelt thanks.

Cristian Castillo Gutiérrez

A handwritten signature in dark ink, consisting of a series of fluid, connected strokes that form the name 'Cristian Castillo Gutiérrez'.



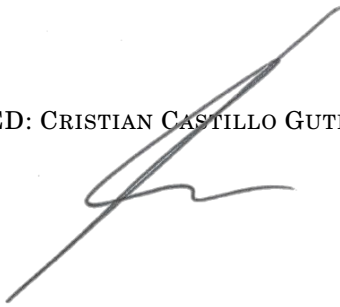


## AUTHOR'S DECLARATION

I declare that the work in this Ph.D. thesis was carried out in accordance to the regulations of the Universitat Politècnica de Catalunya - BarcelonaTech and the requirements of the Ph.D. program in Business Administration and Management in the Department of Management. Except where indicated by specific reference in the text, the work is the candidate's own work. Work done in collaboration with, or with the assistance of, others, is indicated as such. Any views expressed in the dissertation are those of the author.

SIGNED: CRISTIAN CASTILLO GUTIÉRREZ

DATE: 17/05/2017

A handwritten signature in dark ink, consisting of a series of loops and a long horizontal stroke, positioned over the 'SIGNED' text.



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## INTRODUCTION

Currently the world economy is going through a period of economic and financial crisis that affects, among others, organizations. This situation sometimes forces them to make changes in order to overcome the difficulties, for example by delocalizing companies (Daly and Geyer, 1994), the employee's wage freeze (Schaubroeck et al., 1994) and the destruction of employment (Burke and Cooper, 2004). Based on this last one, we can observe that in the year 2.012, when the crisis hit Spain the hardest, the employment regulation records (ERE, for its acronym in Spanish) increased by 56.3%, reaching 33.075 organizations (data base In the Bulletin of Labour Statistics of the Ministry of Employment and Social Security). While it is true that these data represent a problem, they are nothing compared to the long-term consequences.

### 1.1 The organizational change and its consequences in society

The organizational changes often entail a great effort for employees as well as increase the utilization of their resources (Hobfoll, 2002; Scheck and Kinicki, 2000). For this reason the organization before embarking on an organizational change has to evaluate correctly all its pros and cons (Kotter and Schlesinger, 2008). For example, a change in the lay-out of a manual packing line to reduce handling times is likely to change the distribution of the work tables and the raw material, but above all, it involves changing the working conditions of who is to carry out these. The latter point, that of the employee, may sometimes assume the failure of the change since based on the perception that these obtain from the actions carried out by the organization can be affected their morality (Cascio et al., 1997), productivity (Cascio et al., 1997) and satisfaction (Wah, 1999), all this sometimes leads to millionaire losses for the organization (Bennett and Robinson, 2000).

Based on the above, we find that one of the main elements that the organization must take into account for the correct planning of a change is the knowledge and anticipation of the emotional states of its employees (Robbins, 2004). If the organization does not consider the emotional states of its workers will be limiting in advance their understanding and their responses to the different circumstances that occur.

For this reason, it is a priority for the organization to know and identify the existing emotional currents in order to translate this information into specific benefits, such as avoiding counterproductive behaviour on the part of employees (Bennett and Robinson, 2000). The ability of the organization to perceive, assimilate, understand and manipulate the emotions of its employees is called emotional intelligence (EI; Mayer et al., 2001). Thus, the emotional intelligence takes on special importance in carrying out of the organizational changes by providing the necessary tools to mediate, for example, employee-supervisor conflicts and increase employee motivation and commitment (Goleman, 2012). This attention to the emotions and feelings of employees provokes a strong reaction to the events that are originated during the daily course of work, thus forming what is known as the organizational climate (Neubauer and Freudenthaler, 2005).

The organizational climate is defined as the perception that employees have about their organization based mainly on their experiences within it, which results in the employee's organizational behaviour (Robbins, 2004). For this reason, the study of the organizational climate provides the organization with information about how its employees perceive the measures taken, and can redress the situation if necessary and facilitates the planning of future changes (Robbins, 2004). One of the processes with the greatest impact on employees' perception of the organizational climate and their performance is the organizational change (*e.g.*, Fedor et al., 2006; Martel and Dupuis, 2006; Sirgy et al., 2001). The organizational changes are often perceived as the loss of the employee's status as well as the inability of the employees to achieve their goals, which increases their uncertainty about upcoming events (Lazarus, 2006; Rafferty and Griffin, 2006).

## 1.2 Structure of the Ph.D. thesis

Given the importance of emotional intelligence management, the organization must support the employee during the change process in order to facilitate their adaptation and avoid the consequences in which they can derive (Cullen et al., 2014). In order to increase the existing knowledge about the reactions of its employees to the organizational changes, we have presented two studies that provide a knowledge base on how the individual evolves emotionally during an organizational change. Therefore, both studies focus on:

1. The identification of the different emotional states through which the individual transits during a process of organizational change when it is perceived as negative.
2. The development of a simulation model that allows analyzing the emotional changes that occur in an organization.

Therefore, for the accomplishment of this Ph.D. thesis five chapters are presented below. Chapter 2 develops a review of the literature on organizational justice constructs, organizational change, organizational climate, and five states of grieving. It should be taken into account that we have used multidisciplinary bibliographical data through the search engine Scopus (from Elsevier provider), PsycINFO and Google Scholar for the search of this information. The most used keywords were: grief, organizational change, uncertainty, coping, organizational behaviour and complex networks. Chapters 3 and 4 develop the two main studies of the Ph.D. thesis and chapter 5 presents the main results and conclusions of the Ph.D. thesis. Finally, the reader can find the appendices and the references used throughout the document.

## 1.3 My motivations

For several years now, I have had the opportunity to become a production and quality manager facing one of the most difficult challenges of my life: people management. Each person is a reality, sometimes shared and others unique, that requires a personalized attention and of which I declare myself guilty for not having managed it many times in the most correct way. And if something I have learned in this time is that in most cases can not be treated equally and despite the day to day, a good leader and manager must be able to stop, listen and act on the basis to what each requires at a given time.

My interest in the knowledge of the organizational change arises from empirical experience itself. It has never ceased to amaze me how day-to-day actions such as the exceptional reassignment of a worker's tasks sometimes posed a problem. And what was surprising was not in itself the fact that the worker showed his denial of the situation, if not the motives that produced it. In the example used, reassignment was sometimes interpreted as a punishment for failing to perform properly their work, something that motivated the growth of uncertainty: Will I be doing it well?, Will they be happy with me?, Will they bid me farewell?; Although at first I associated it with the personality trait of each one, I can verify quickly that it was not a stand-alone event: the changes, however small, have an effect on individuals. This is how in my day to day interest in organizational changes grew, more specifically on how they influence individuals.

For this reason, taking advantage of my Ph.D. thesis, I decided to explore this field in more detail and try to contribute both to science and to my own experience with the knowledge that allows to be closer to understanding human behaviour. At this point, I can only feel great satisfaction to know that my contributions are a further stone on the way to the foundations of human knowledge.



## LITERATURE REVIEW

The concept of continuous improvement is known and used since the mid-twentieth century and becomes an important need in any organization (Galloway, 2002). Its objective is to introduce improvements in the organization products, services and / or processes and thus derive positive results over a medium - to long - term period. Being more competitive through innovation (*e.g.*, Husain et al., 2016), improving customer satisfaction (*e.g.*, Lun et al., 2016) or carrying out internal restructuring (*e.g.*, Girod and Whittington, 2016) are elements that force the organization to take measures that help to establish those objectives, considering the actions that are necessary for that effect. It is thus that the organizational changes become the necessary tool to reach the goal of improvement, the changes that can be driven and led from any position in the organization chart (Moran and Brightman, 2000). And it is that in today's dynamic, unstable society, the change becomes a necessary reality that forces the organization to be flexible and adapted to events (Burke, 2013). However, and based on some of the contributions of Fullan (2011), the changes have to be considered as an established project and therefore be carefully planned. In no case can these be managed individually, and their collective and equitable view of the actions carried out is important (Fullan, 2011).

For the organization, it is important to consider the group when it carries out the changes because the organizational climate depends on their global perception of the organization, so which affects the motivations and behaviours of the workers (Álvarez, 2006). In this case, the literature shows as there is a correlation between the individuals' satisfaction and the organizational climate, finding that the individuals are more satisfied when the work climate is better (*e.g.*, Griffith, 2006; Patterson et al., 2004; Schulte et al., 2006). In most processes of organizational change the job satisfaction of individuals disappears and generates a malaise that results in a negative organizational climate (*e.g.*, Fedor et al., 2006; Martel and Dupuis, 2006; Sirgy et al., 2001), leading to a redefinition of the relationship between the individual and the organization (*e.g.*, Kickul et al., 2002). Mainly during the organizational changes the work climate is defined by the presence of uncertainty among the individuals of the organization (Bordia et al., 2014). Its consequences lie mainly in the lack of control that the individuals experienced the new situations that they live (DiFonzo and Bordia, 2002). One way to reduce uncertainty during organizational changes is to maintain equity throughout the process, thus generating confidence in the individual and



generating an idea of where the organization is headed (Colquitt et al., 2006; Kernan and Hanges, 2002). For this reason, the organization must give the importance that the changes deserve since the individuals will base their opinion through the actions carried out by it (Colquitt et al., 2006). One of the consequences probably most detrimental to an organization in the process of change is when it is perceived as negative, resulting in a sense of threat that can be reduced when the individual perceives the change equitably (Van den Bos, 2001). It is at this point that the perception of organizational justice becomes more forceful because it will depend on the individual's evaluation judgment about the organizational changes (Lines, 2005).

## 2.1 Organizational justice

The organizational justice is defined as the individual's belief about how will be a state or future event based, largely, on past beliefs or experiences that affect their attitudes, judgments, and behaviours (Bell et al., 2004, 2006). The organizational justice is best conceptualized and defined through its three dimensions (*e.g.*, Colquitt et al., 2001; Konovsky, 2000).

The procedural justice is mainly based on the equity implemented by the organization where the means to achieve the goals are as important as the exchange of functions within it (Folger and Konovsky, 1989; Leventhal, 1980; Thibaut and Walker, 1975). Therefore, the individuals evaluate the level of justice applied in the decisions and actions of the organization, they take as a starting point the arbitrariness of those responsible throughout the process of change (Cropanzano and Schminke, 2001; Konovsky, 2000). Leventhal (1980) proposes the aspects that organizational procedures should have so that they can be considered by individuals to be fair. These aspects can be summarized in six main points as: (1) carry out procedures in the same way for all individuals and at any time, (2) the information used during the process must be reliable and valid, (3) the procedures must be performed objectively, (4) it has tools to detect and correct subjective actions, (5) take into account the opinion of those groups that may be affected by their decisions and (6) maintain the standards of morality and ethics that exist in the group. Thus, if the organization is able to meet the six points described above and, therefore, maintain the perception of procedural justice in individuals, they will show their trust (Colquitt et al., 2012).

The second dimension of organizational justice, the distributive justice, is based on the individual comparisons between what they consider to have contributed to the organization and what it has given in return to them (Adams, 1965). Thus, individuals perceive a negative distributive justice when they consider that they are perceiving, for example, less pay than a co-worker with the same working conditions and responsibilities. And it is to be noted that one of the elements most used for the elaboration of the perception of the distributive justice is money, the universal resource per excellence (Adams, 1965; Foa and Foa, 1980; Homans, 1958). However, there are a multitude of cases in which the emotional consequences of the perception of distributive justice go beyond monetary distribution, passing it into the background (Cropanzano et al., 2001). One of the main disadvantages of distributive justice is that it requires of a social system, because at present it is used the idea of justice since the point of view of the procedural justice, and it is necessary this distribution to be kept fair before any situation (Rawls, 2012). The contributions of Clay-Warner et al. (2005) suggest that organizational changes such as staff reductions affect and influence into the distributive justice, so it is the most important predictor.

Finally, the interactional justice is divided into two sub-dimensions: the informational and personal justice. In the case of informational justice, the employees make a value judgment to determine if the

information provided by the organization is necessary and enough to know the state of the processes and / or actions related to them. As for personal justice, it appears when the organization has treated with dignified and respectful to their employees, and they have had the opportunity to express their feelings at the same time (Platow et al., 2013). In the literature we find how individuals perceive the interactional justice as fair when they are treated with respect because, for example, they receive the necessary explanations by the organization about the results obtained during the decision-making process. And, moreover, it is honest, straightforward and upfront in its communications and it avoids prejudices, declarations or inappropriate questions (*e.g.*, Colquitt et al., 2013; Pinder, 2014; Richter et al., 2016). Thus, the comparison that employees make between perceived organizational changes and the responses they receive will lead to a feeling of dignity, respect and courtesy towards the organization (Greenberg and Colquitt, 2013).

Consequently, we observe that there is a close relationship between the perception of justice and organizational changes (Imberman, 2009). From the contributions of the author we obtain that when organizational change is perceived as unfair (it affects to the individual), the individual reduces the levels of affective commitment to the organization and its sincerity into the possible future changes. Whereas, when change is perceived as fair (it has benefits over the individual) the individual increases the levels of affective commitment to the organization and sincerity into the possible future changes.

## **2.2 Emotions in organizations**

At present, we are still not able to understand exactly how organizational change affects the individual and its perceptions, but we can affirm that these are part of the daily life of individuals and that are determinant for any organization to survive the passage of time (Leana and Barry, 2000; Rubiano et al., 2013). The organizational changes involve an additional effort on the part of the individual to adapt to the new situation which generates concern, uncertainty and fear (Lazarus, 2006; Rafferty and Griffin, 2006; Rubiano et al., 2013). This situation causes that the individuals feel the need to resist the organizational changes and consequently they fight against them. Based on this, Dent and Goldberg (1999) indicate that resistance to organizational change on the part of individuals has to be conceptualized from the point of view of loss. It is important that change leaders take into account that the potential consequences of change will not only focus on the object of action, but it will also affect their social environment (Davis and Newstrom, 2000). That is, however small the changes should be taken into account their possible indirect affectation. So with the result of the cognitive evaluation that the individuals perform they will base their perception on the organizational change and through which they will develop their strategy to coping with them (Beehr and Newman, 1998). For this reason, the study of the emotion threat on the changes that the individuals can be experienced facilitates and gives to the researchers the tools to predict their possible reactions (Fugate and Kinicki, 2008b). This threat arises from the uncertainty caused by the changes and derives from the injustice perceived by the individuals. Thus, the organizational justice becomes an important antecedent in assessing the threat individuals feel about organizational changes (Colquitt et al., 2006).

In the literature we find studies in which research models are proposed on organizational behaviour in which the actions carried out by employees are not only explained by cognitive means but rather through the affective ones: emotions and affective states (*e.g.*, Judge and Ilies, 2004; Weiss, 2002). The most recent studies in this area attach particular importance to the emotions of individuals when they resist to the

organizational change. For example, Jones and Van de Ven (2016) indicate that employees' feelings of commitment to the organization and the perceived effectiveness of the organization are negatively related to resistance to change. On the other hand, Aslam et al. (2016) argue that resistance to organizational change is based on cynicism and they conclude that confidence in leaders of change could increase the job satisfaction. Researchers are looking for the causes that produce the resistance to change and they are studying their emotional consequences. However, the emotional states have not been extensively addressed yet, although they have been analyzed from several points of view (*see* Mathews and Linski, 2016). For this reason, additional studies of the emotional evolutions of the individuals during the organizational changes are needed especially when these are perceived in a negative way. The few models that address the emotional consequences of individuals within the organization (*e.g.*, Huy, 1999; Liu and Perrewé, 2005) focus on the interaction between individual and organizational attributes during change processes and in the individuals' behaviour beyond the emotions that drive them. In addition, the models proposed do not contemplate the influence of the social environment on the individual, thus assuming linearity between the different states which contradicts the contributions of Luce (1995), who states that organizational changes should be considered as non-linear and dynamic.

Therefore, we come to the conclusion that the emotional states of individuals play a fundamental role in addressing the individual's reactions and behaviours within an organization. Emotions that can not only be affected by the organizational changes but also by any situation that is carried out within the organization. It is for this reason that we propose for this Ph.D. thesis two closely related research lines that share the same objective: we expand knowledge and we generate tools that allow future researchers to work more easily with the emotional states of individuals.

## **2.3 Final considerations**

Thus, in the first study we propose to analyze the adaptability of the model of the five states of grief by Kübler-Ross (1969) to the processes of organizational change when they are perceived by the individual as negative. Although this model has already been used in other research in contexts of organizational change (*e.g.*, Blau, 2008; Davey et al., 2013; Marks and Mirvis, 2001; Zell, 2003), it has not been analyzed their five emotional states to verify that they can really adapt to organizational changes. On the other hand, without neglecting the emotions of the individuals within the organization, the second study of the Ph.D. thesis proposes to develop a simulation model that allows to approach the study of the emotional states of the individual within the organization without having into account the main limitations that are derived as the size of the sample, the time of study and the typology of organization. This proposal arises from the difficulties observed during the development of our first study when analyzing and managing all the possible variables that can be derived from the different emotional states of the individual during an organizational change.

## THE SIX EMOTIONAL STATES OF ORGANIZATIONAL CHANGE

In the next study, our purpose is to define a model of the evolution of individual's emotional states during a process of organizational change perceived as negative. So, we apply the model of Kübler-Ross (1969) during a process of organizational change perceived as negative for the individual and check their adaptability, their behavioural pattern and their relation with individual' social environment as family, friends, co-workers, supervisor and organization. As we will see below, this study has embraced a qualitative methodological approach and we chose the individual interviews as the main method of qualitative data collection. The sample consists of fifteen individual participants that they have experienced an organizational change perceived as negative.

### 3.1 Introduction

The target of organizational change is to improve the current state of the organization to achieve a better adaptation to its environment or to adjust to changes of mission and objectives. Although organizational change is supposed to foster resource optimization and organizational adaptation, literature shows a lot of examples where organizational change has produced the opposite effect reducing productivity and shareholders value, and increasing its direct and indirect costs (Bowman and Singh, 1993; Bowman et al., 1999). Organizational managers may not consider the impact that organizational changes may have on the morale (Cascio et al., 1997), productivity (Cascio et al., 1997) and satisfaction (Wah, 1999) of employees because their future predictions are based solely on beliefs or past experiences (Kotter and Schlesinger, 2008). The attitude of the workers to a change is determined mainly by the evaluative judgment (positive or negative) they perform in response to the new situation in the organization (Lines, 2005). Organizational changes can increase levels of uncertainty due to the chaos generated on the normal tasks of employees (Tombaugh and White, 1990), leading to a significant change in work environment. In addition, uncertainty also generates a high level of job insecurity among employees (Greenhalgh and Rosenblatt, 1984), which is generally translated into job stress (Lazarus and Folkman, 1984). In this situation of uncertainty, employees tend to offer resistance to change (Cameron et al., 1988) through coping

strategies (Lazarus and Folkman, 1984). These strategies are defined as a set of behavioural and cognitive changes that employees adopt to meet domestic demands (emotional state) and external (stress) imposed by the organization and which go beyond the employees' own resources (Folkman et al., 1986).

The coping strategies of employees result occasionally in unwanted behaviour as counterproductive work behaviours (CWB; Bowling and Eschleman, 2010; Fox et al., 2001). It is therefore important that organizations and their leaders are able to understand how individuals evolve during the organizational change, anticipating to the reactions of the employees with more elaborated models than mere guesswork (Fugate and Kinicki, 2008a). Consequently, managers could avoid the CWB as well as some negative effects on organizational performance such as reducing competitiveness (Fugate and Kinicki, 2008b). Despite an extensive scientific literature on the process of adapting to change (*e.g.*, Ashford and Taylor, 1990; Chan, 2000; Skinner et al., 2003) and the development of coping in a process of change through mergers (*e.g.*, Fugate et al., 2002), a model of the temporal evolution of the coping process is lacking in extant literature. We try to cover this gap with a research with two main targets: identifying and defining the different states an individual can go through when experiencing organizational change negatively, and identify the transitions that an individual could perform between different states depending on their cognitive perceptions or emotional states. Additionally, we study the impact on the relationship of the organizational member with its social environment (family, friends, co-workers, supervisors and organization). The results provide a theoretical basis to catalogue and encompass the different coping strategies in a process of adaptation to organizational change.

## 3.2 Literature Review

Organizational change is a natural process in the working lives of employees (Leana and Barry, 2000) that is present in everyday situations such as the relocation of businesses (Daly and Geyer, 1994), the merger of companies (Schweiger and Denisi, 1991) or the frozen salaries of employees (Schaubroeck et al., 1994). Organizational change is often perceived as negative by the employees because they see the changes as a threat or injury (Scheck and Kinicki, 2000). However, some research addresses organizational change from a different approach (*e.g.*, Fay and Frese, 2001; Fugate et al., 2012; Luthans et al., 2007) so it is stating that the perception of change, positive or negative, it is an individual characteristic which varies depending on the context. Kotter and Schlesinger (2008) found that employees could react in three different ways in a situation of organizational change: passively, aggressively and honestly. The decision to use one or other of these coping strategies to deal with the new situation depends on their cognitive perception (Lazarus and Folkman, 1984). More specifically, the fundamental theory of coping is defined as a transaction process between the individual and its social environment. This starts through the individual's cognitive assessment to a stressful situation that is sometimes caused for an organizational change (*e.g.*, Beehr and Newman, 1998; Cooper et al., 2001; Lazarus, 1991, 2001). Despite the absence of a classification of coping strategies, Skinner et al. (2003) presented three processes of adaptation to cope with stressful situations that are then broken down into twelve classes of higher-order strategies.

The first process of adaptation includes coping strategies with the target to put the individual in harmony with change: troubleshooting (*e.g.*, effort, determination and strategy), searching for information (*e.g.*, reading, observation and experimentation), impotence (*e.g.*, relinquishes control, pessimism and passivity) and escape (*e.g.*, denial and avoidance). The second process of adaptation includes strategies where the individual uses social resources to cope with change: self-sufficiency (*e.g.*, regulating emotions

and behaviours), support of the search (*e.g.*, contact localization), delegation (*e.g.*, protest, complaint and recrimination) and isolation (*e.g.*, loss of contact with co-workers, friends and family). The last adaptation process consists of strategies where efforts are focused on coordination of desires or preferences toward change: accommodation (*e.g.*, acceptance of the situation and distraction), bargaining (*e.g.*, prioritization and seeking commitments), presentation (*e.g.*, anxiety and negative approach) and opposition (*e.g.*, aggression and resistance). As stated, Skinner et al. (2003) presented a model three states through which the individual passes during a process of change; however, several researches (*e.g.*, Ashford and Taylor, 1990; Scheck and Kinicki, 2000) suggest that this process is continuous and nonlinear, so it is exposed the need for a new model that allows for advance, recoils and jumps between the different states where the individual transits.

The initial propositions of the theory of the five states of grief for patients (Kübler-Ross, 1969) are significantly closer to represent the model of individual transactions between the different states of an organizational change. More specifically, the theory of the five states of grief states that the terminally ill and bereaved go through some reactions that allow them to protect themselves from the threat of imminent loss (Kübler-Ross, 1969). While it is true that the context for an individual with a terminal illness is completely different from that individual who faces an organizational change, we can establish an analogy between both if we take out the context of the states and we focus solely on its definition, because the organizational changes are also seen as a threat or loss (Greenhalgh and Rosenblatt, 1984; Scheck and Kinicki, 2000). In this sense, Luke et al. (1973) presented the possibility of using this model in situations where the individual perceived a loss and Newman et al. (1983) and Worden et al. (1997) stated that the model of the five states of grief could be used in any other situation where the individual has significant losses. Kübler-Ross (1969) defined and identified five states through which an individual passes emotionally during a situation of loss, normally near death: denial, anger, bargaining, depression and acceptance. The transition between states may be linear (the individual is a certain time in each state), nonlinear and sometimes parallel (several overlapping states simultaneously).

In the denial state, the individual feels unable to accept and recognize something that is happening and therefore is real, attributing the results perceived to errors or failures caused by external elements (Kübler-Ross, 1969). At this state the individual also avoids and feels repression for the situation with the hope that it will change by itself (Wheeler and Lord, 1999). According to Rabinowitz and Peirson (2006), the individual defends by himself of thoughts, feelings or information that may be painful or threatening during this state. In certain situations, the people that are near of the sick can experience the same denial about the change (*e.g.*, family and friends). In the state of anger, the individuals react with fury, envy, resentment and hostility, directing these feelings towards the social environment that surrounds them and which they consider to be guilty for what is happening. They can also direct these reactions towards themselves, including self-destructive actions (Kübler-Ross, 1969). In the state of bargaining, the individual accepts the blame of their actions and shows to the people to whom they have directed their anger. The individual often makes promises in order to achieve its goals: survival, recovering what was lost, etc. The main desire of the individuals at this state is their recovery and to continue forward, so they start to cope with changes (Kübler-Ross, 1969). In the depression state, the individuals experience a feeling of emptiness and sorrow for the situation experienced. The situation surpasses them and they just surrender to it. Even they lose the desire to recover and continue forward (Kübler-Ross, 1969). Finally, in the acceptance state, the individual recognizes the situation without search of guilty or enemies, and assumes that they must adjust to the new situation and live with it without feeling defeat (Kübler-Ross,

1969). This state is not the result of resignation or happiness, it is the stoicism of the individual (Peres and dos Santos, 2007).

### 3.3 Methodology and Analysis

The study of emotional states through which an organizational member evolves during an organizational change includes a set of complex personal and social phenomena. To capture this complexity, we designed a research with an inductive approach through primarily qualitative data. The method of data collection was the individuals' interviews. The sample selection followed a strategy of quotas, where all its members met the following criteria: they have minimum one year seniority in the company where they experimented the negative changes, they have not spent more than three years since the start of the negative changes and the organization is located in Spain. The final sample consists of fifteen individuals from different professional backgrounds, who acknowledged to have gone through an organizational change perceived as negative. More specifically, the final sample is formed by five individuals working in a company that served the public sector (cases A, B, C, D and E), five individuals working in a company (cases F, G, H, I and J) and five other individuals working in the public sector (cases K, L, M, N and O). The cases N and O working at a public university.

Due to the complexity of the analysed social processes, we developed a protocol as a conceptual guide and practical on data collection during interviews. The protocol is based primarily on the instrument developed by Ávila and de la Rubia (2013) to evaluate the five states of grief in terminally ill patients and it consists of five sections with a total of 66 Likert items. The protocol proposes a semi-structured interview designed with open questions and unlimited time in order to capture possible unexpected results and redirect the interview according to the responses of the interviewee. The interviews lasted an average of 60 minutes and all were conducted in places suggested by the interviewees to maintain their comfort and privacy. Besides, the interviews were recorded by a mobile phone for further analysis with a total of 900 minutes. The protocol also suggests the annotation of interviewees' reactions (*e.g.*, behaviours or nonverbal communication) when they are responding to questions. The transcript of the interviews was conducted through the Transcriber software following a process of double review. The next step was the codification of the interviews through the methodological proposals of Rodríguez et al. (1996) with the qualitative data analysis software called Atlas.ti.

The first phase of interviews coding is to identify the blocks or paragraphs where the interviewees have spoken about events before or after the organizational changes. This first coding allowed defining the starting point from which we analysed the consequences of organizational change. Although coding was only formed by two codes (BF: Before and AF: After), several paragraphs contained events of before and after the organizational change so they were coded several times. The second phase of coding consisted in assigning to paragraphs a list of preconceived codes from the theoretical framework of the research. More specifically, this phase aimed to identify blocks or paragraphs previously coded as AF with the five states of grief: denial, anger, bargaining, depression and acceptance. At the end of this coding, we obtained an overview of the five (sometimes less) states of grief for each individual of the sample.

The third and final phase consisted in coding the paragraphs with a more inductive approach (encoding in-vivo), recoding some of the interviews as new codes emerged. The final code book contains a total of 65 codes that it is classified into the following blocks: time frame (*e.g.*, before, during and after), states of change (*e.g.*, denial, depression and acceptance), relationship with the social environment (*e.g.*, co-

workers, friends and family), external aid elements (*e.g.*, psychologist, sport and massage), perception of organizational justice (*e.g.*, procedural, distributive and interactional) and consequences (*e.g.*, stress, uncertainty and hope). Table 3.1 shows the full list of codes. These codes have been translated from Spanish to English trying to keep the same meaning.

Table 3.1: Code book of this first study

CODE BOOK
<p><b>1. Codes related to external aid appeal (outside of organization and not environment):</b> external aid, sewing, training, homeopathy, massage, pilates, psychologist.</p> <p><b>2. Codes related to environment of individual:</b> friends, family, couple, organization (workplace), supervisor, co-workers, oneself.</p> <p><b>3. Codes related to consequences of change:</b> consequences, aspiration, commitment, conviction, disappointment, hope, stress, frustration, illusion, uncertainty, insurrection, fear, collaboration, refusal, resignation, wanted during change.</p> <p><b>4. Codes related to emotional states:</b> states, acceptance, depression, revising, anger, denial, bargaining, deserting.</p> <p><b>5. Codes related to dimensions of organizational justice:</b> justice, distributive, informational, personal, procedural.</p> <p><b>6. Codes related to the time frame of the event:</b> before change, after change, during change, it is present, it is not present, anticipation of change, desire for change.</p> <p><b>7. Codes related to job performance:</b> motivation, performance.</p> <p><b>8. Codes to indicate trend of relations:</b> relations, increases, decreases, positive, negative, same.</p> <p><b>9. Codes related to salary:</b> salary, feeling well paid, feeling underpaid.</p> <p><b>10. Codes related to individual' situation:</b> without freedom, without responsibility, personal situation, labour situation.</p>

After the encoding process in the fifteen transcribed interviews, we analysed each interview and later we analysed them all in block following the suggestions of Miles and Huberman (1994) and Jurgenson (2007) with the goal of obtaining a specific vision of each case and a final conclusion for all cases. The first step of code analysis of codes was to group into families (*e.g.*, external aid and environment). This step allows the identification of the codes by subject and a preliminary analysis of cases without focusing on the vision of the reality perceived by interviewee. Through the code families, we can identify quickly the predominant concept of each segment of the interview. The next step consisted in examining the relations that exist between codes in all interviews through co-occurrence level. The co-occurrence level is a useful tool to study the relations between the concepts and the repeatability of the codes (Friese, 2014). The definition of co-occurrence intervals and their interpretation during the analysis is: values below 0.05 indicate little probability for the relation between codes, values between 0.06 and 0.15 indicate a moderate probability for the relation between codes, values between 0.16 and 0.50 indicate a high probability for the relation between codes and values above 0.5 indicate a systematic relation between codes. The result of the co-occurrence analysis is a conceptual map of the case studies where the relations between codes are highlighted, so the transitions between states of change, the emergence of new states or the interaction of the organization with the employees during the organizational change can be identified and tracked.



### 3.4 Results and Discussion

The results of the qualitative analysis of the interviews are threefold: (1) the states of grief in the organizational change, where we put name to the emotional states that organizational members may experience during organizational change; (2) the transitions between states, where we identifying the relation between the different states (emotional states) experienced in organizational change and how organizational members can jump from one state to another and (3) how it is affected the relationship between key elements of the social environment and organizational members (friends, family, co-workers, supervisor and organization) when the later are experiencing the emotional states described here.

#### 3.4.1 The states of the organizational change

The analysis of co-occurrence for the codes described above shows the emergence of a process similar to the five states of grief described in the literature by Kübler-Ross (1969) for the terminally ill patients, but with some relevant differences. Despite identifying the states of denial, anger, bargaining, depression and acceptance in the fifteen cases, the results reflect an overlap between the first two states (denial and anger) with a considerable level of co-occurrence (0.61). This fact has led us to collapse these two sates into one, which we call denial and anger. This fact is reflected in the following extract from the case J. It is to note that all the extracts of this research have been translated from Spanish to English trying to keep the same meaning.

**“Researcher:** Sure, you have been together from the beginning and this unites to both, of course... and outside of work... at the time of relapse and the demotivation?

**Interviewee:** Same... even of anger with my parents. Because my parents did not say, well at first they told me: wait, wait, wait, wait (silence), and I told them: I cannot anymore. I cannot anymore. (...) As they do not live it, I do not know ... it is a little hard to explain. I do not know if I explain well.”

An expected result of analysis of the co-occurrence for the codes is the emergence of two new states through which passes the individual during an organizational change, and we have called revising and deserting based on the results of Schalk and Roe (2007). Sets of evidences exist in the literature to support the need to include both states in the initial model. For example, Schalk and Roe (2007) presented that when the employees feel that their conditions of workplace have been infringed and violated, they can have a range of corrective responses to address discrepancies using self-regulation. These actions can be classified into balance (negative actions on the part of the organization are answered in the same way by the individuals), revising (organizational members reconsider the terms of their job) and deserting (the individuals leave the organization, usually through waiver). For example, the cases A, K and O recognised having wishes to leave the company (revising) by the disagreements with the organization at some point in the process of change, while the case J even ended up giving up his job to be able to release himself of the organization and overcome the process of change (deserting). We do not find evidences in our samples of the existence that the balance is a state of the organizational change, but this does not mean it does not exist. The following is an example of revising that corresponds to the case A:

**“Researcher:** And, how do you feel when you lose the strength to coping the change?

**Interviewee:** I wanted to desert... many times, especially at the beginning (...) It was like a lot of changes, a lot, and suddenly it was like ‘pfft’, I must not spend... more tasks to do

and (...) I couldn't stand any more (...); Then, I adapted more or less to the changes, well, I resigned to them.”

Thus, we suggest the existence of six states that an individual may move during an organizational change by the results of our analysis of fifteen cases studies and contributions of Schalk and Roe (2007). Therefore, we propose Proposition 1, where the order of appearance of the states does not correspond to the order of transition that is detailed in the following section.

**Proposition 1:** The emotional states of organizational change are: (1) denial and anger, (2) bargaining, (3) depression (4) revising, (5) deserting and (6) acceptance.

### 3.4.2 The transitions between states

Although the original model of the five states of grief (Kübler-Ross, 1969) suggests a certain linearity in the transition from one state to another, it results to show that an individual can start directly in any of the six states of organizational change that we previously identified. However, these same results also show a greater probability that the individual begins at a specific state rather than the other. In order to identify the states with more probability at the beginning of the organizational change, we have calculated the relative probability adding the total number of segments related to the codes of a specific state (e.g., depression and acceptance) in the questions related to the sensations at the start of change and it normalized with the total of segments codified with any state. The final result is the following list of states in descending order of probability: denial and anger (50.70%), bargaining (22.54%), depression (11.27%), revising (7.04%), acceptance (5.63%), and deserting (2.82%). A second goal about the study of the transitions between states is to identify the relations that exist between them. To do this, we used the value of co-occurrence as proxy to the existence of direct transitions between two states. Atlas.ti software gives the level of co-occurrence through the C-coefficient, which ranges between 0 and 1. The co-occurrence count of each pair of codes is taken into account according to the following formula (García, 2005):

$$(3.1) \quad C = \frac{n_{ij}}{(n_i + n_j) - n_{ij}}$$

The analysis of the transitions between states reveals forward and backward transitions between different states, perhaps because organizational change is a continuous and nonlinear process. These results agree with the proposals of Ashford and Taylor (1990) and Scheck and Kinicki (2000). Figure 3.1 shows a summary of the identified transitions between states with their value of co-occurrence.

When the individual is in the state of denial and anger, the results reflect a transition to three possible states according to their level of co-occurrence: the state of bargaining with a co-occurrence level of 0.24, the state of depression with a level of 0.12 and the state of revising with a level of 0.08. The co-occurrence of staying in the same state is 0.56. Four possible transitions have been identified starting from the bargaining state: a regression to the denial and anger state with a co-occurrence level of 0.24, a progress towards to the depression state with a value of 0.07, a progress towards to the deserting state with a value of 0.03 and finally a progress towards to acceptance with a value of 0.04. The co-occurrence of staying in the same state is 0.62. When starting from depression state where we detected up to four possible transitions: two regression to the denial and anger state and the bargaining state with co-occurrence levels of 0.12 and

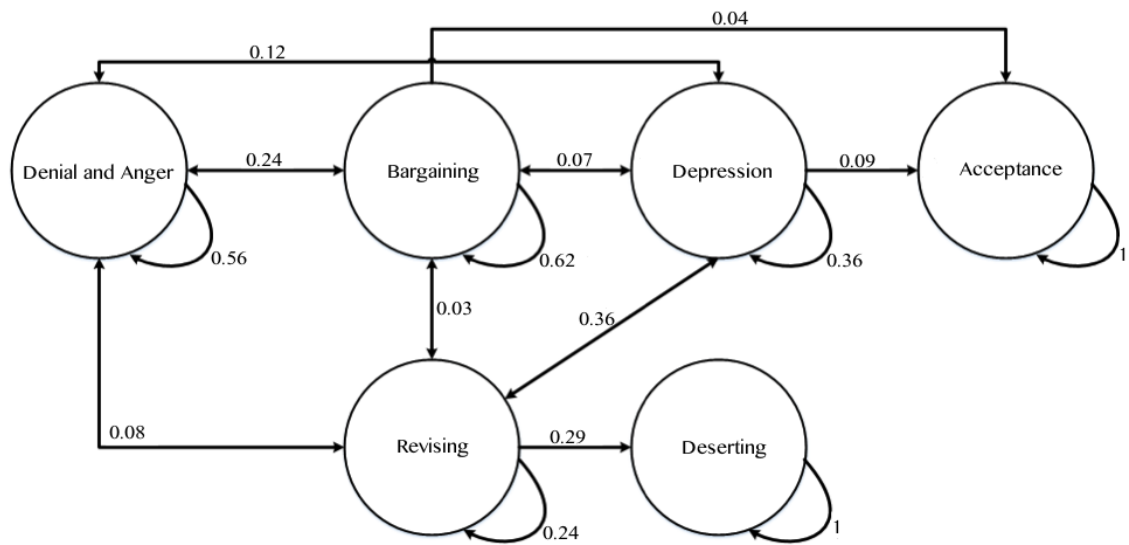


Figure 3.1: The relations between the six states of organizational change with their values of co-occurrence.

0.07 respectively; and two progresses towards to the deserting or acceptance state with a values of 0.36 and 0.09 respectively. The co-occurrence of staying in the same state is 0.36. Finally, four possible transitions have been identified when starting from the revising state: three regressions to the depression, denial and anger or bargaining state with co-occurrence values of 0.36, 0.08 and 0.03 respectively. Likewise, it can also progress towards to the deserting state with a value of 0.29. The co-occurrence of staying in the same state is 0.24. The results do not show possible transitions from the states of deserting and acceptance. The first one involves leaving with the organization so the individual ceases to be part of it without possible return. The acceptance state, as Kübler-Ross (1969) presented, is considered the final state, the resolution state. In it, there are only two possible endings: the individuals have been able to embrace change with all its consequences or they reject it openly or indirectly. Following the results previously exposed on transitions between states, we suggest the following proposition:

**Proposition 2:** During the organizational changing process, an individual can transit between the emotional states of denial and anger, bargaining, depression and revising. Deserting and acceptance are final states; therefore an individual will not return to any other state from either of these.

### 3.4.3 Influence of states in the relation with the social environment

In the literature there are several studies addressing the social interactions of the individual during the process of change. For example, Turnley and Feldman (1999) indicate that the individuals try to participate actively with their supervisors or co-workers to improve the situation in front of an organizational change, leading them to act differently to how they were doing so far the change. Other studies (e.g., Kinicki et al., 1996; Schweiger et al., 1987; Terry et al., 1996; Viswesvaran et al., 1999) show that social interactions play a key role in the process of dealing with stress. The stress is one of the possible consequences of organizational

changes, as organizational change may generate uncertainty and organizational members may feel neglected in their needs by the organization (Lazarus and Folkman, 1984; Rhoades and Eisenberger, 2002). Based on this, Hobfoll (1989, 1998, 2002) states that stressors affect to the individuals because they exhaust their personal resources and reduce the links with their social environment such as family or friends. Consequently, these individuals often have to replace their sources of support.

Based on these results, we decided to analyse the individual's relation with his social environment during each of the states of the organizational change through collected cases. We define five possible external agents with which the individual can relate to in their daily lives, at work and personally: family (including partner), friends, co-workers, direct supervisor and organization (business environment in general). Table 3.2 shows the values of co-occurrence between states and external agents, also indicating the trend of the evolution of relation: positive or negative. To identify the polarity of the relation, we reviewed all extracts where we had encoded a state and an external agent, so we could check if the evolution of the relations was positive (+), negative (-) or it tended to stay the same (=).

According to Cacioppo and Gardner (1999) and Larsen et al. (2001), emotions (positive and negative) are not strictly bipolar and orthogonal, so it is possible their concurrency. Therefore, Lazarus (1991) presented that we should consider variables for positive and negative emotions and that organizational members can respond to the organizational change with a higher or lower value of both. In addition, it can happen that positive and negative emotions can increase simultaneously but not in the same proportion (e.g., Cacioppo and Gardner, 1999; Folkman and Moskowitz, 2000). Table 3.2 does not show the states of revising, deserting and acceptance because the results of the analysis of the case studies do not identify any connection between the codes of the states of the organizational change and relationship with external agents.

Table 3.2: The values of co-occurrence between states and external agents.

	<b>Denial / Anger</b>	<b>Bargaining</b>	<b>Depression</b>
<b>Family</b>	+0.30	+0.17	-0.25
<b>Friends</b>	+0.31	+0.13	-0.27
<b>Co-worker</b>	+0.58	+0.19	+0.21
<b>Supervisor</b>	-0.39	=0.03	-0.11
<b>Organization</b>	-0.27	=0.03	-0.07

(+) The relationship improved after the organizational change.

(-) The relationship worsened after the organizational change.

(=) The relationship remains the same after the organizational change.

Table 3.2 shows that the individual tends to relate positively to family and friends during the states of denial and anger and bargaining but negatively during the depression. In all the case studies the relation between the individuals and their co-workers at the states of denial and anger, bargaining and depression always evolved positively. This coincides with the results of Turnley and Feldman (1999) that the individuals attempt to interact positively with their co-workers during a process of organizational change. The individuals of our case studies considered their co-workers as a support and ally to combat the organizational change, so they empathize each other for living the same situation. Here is an excerpt of transcript of case study J related with this part.

**“Researcher:** And...Then, in the moments when you are angry or you have rage, as you commented me, how are your behaviours with co-workers? Is it the same? (...)

**Interviewee:** This improves.

**Researcher:** This improves. Why? What do you think?

**Interviewee:** Because it is shared we are all going through the same, so that has created a group among us. ”

As for the supervisor and the organization, the relationship with the individuals tends to evolve negatively during the states of denial and anger and depression, while it remains stable in the state of the bargaining. All individuals in the sample regarded the organization and the supervisors as chief culprits of the situation experienced and of organizational change. Colquitt et al. (2013) found that the perception of justice in all its dimensions is related to the confidence and commitment with the organization. So those negative perceptions of the individuals about organizational changes and their sense of injustice about this, cause the relation between the individuals and their supervisor and the organization to deteriorate. Here is an excerpt from transcript of case O that reflects this fact.

**“Researcher:** So, what are your feelings at the beginning of the organizational changes?

**Interviewee:** (...) I was pissed and furious, I could say... I did not have bad blood, but... I had some fear; as well (...) I had bewilderment (...) because they had promised us a thing and after, they are doing another thing (...) I had disappointment (...) I was not believed in the tasks that I did.

**Researcher:** Do you lose the commitment with the organization?

**Interviewee:** Totally, of course, obviously. And still more when I am seeing that... ‘puff’, the organization does not care about this situation. If you do or not do, it is just that. From here. ”

Finally, the results also highlight that the greater co-occurrence with the five external agents occurs in the state of denial and anger. According to Kübler-Ross (1969), during the state of denial and anger, the individuals are experiencing a strong emotional outburst and their psyche is rebelling against the organizational changing process and they refuse intensely to accept the situation. This basic and necessary feeling implies a closer relation with its surroundings and it is manifested in many forms: against the instigators of the organizational change (organization or supervisor), against those being close to the individual (friends or family) or against of third parties not clearly identified (government, God, etc.). Thus, we conclude that the relations will be more intense with the external agents in the early states of the organizational change than in the other states. Following these results, we suggest the following proposition:

***Proposition 3:*** In the states of denial and anger and bargaining the relation with family, friends and co-workers will evolve positively, while in the depression state the relationship with family and friends will evolve negatively, and positively with co-workers. As for the supervisor and the organization, the relationship evolves negatively in the states of denial and anger and depression, while in the bargaining will remain stable.

### 3.5 Conclusions

The results of this study also reveal that some emotional states did not correspond with states in the Kübler-Ross model. They were associated with the intention to leave or desert the organization. Although a desire to abandon could be related to the 'death wish' state (depression) in the Kübler-Ross model, it was more appropriate to define specific states for these feelings. A state that better defines the feelings of individuals who were not sad, angry or in denial, but wanted to change their lives and wished to leave the organization was needed. Schalk and Roe (2007) defined two emotional states, revising and deserting, which fit these needs. Individuals experiencing revising reconsidered the terms of their jobs, and those who left the organization, usually through waiver, were experiencing deserting. The resulting model defines six emotional states: denial and anger, bargaining, depression, revising, deserting and acceptance. The definitions suggested by Kübler-Ross (1969) and by Schalk and Roe (2007) were maintained. Extant research has applied the Kübler-Ross model directly, and the states developed for grieving death or terminal illness were not adapted to the situation (*e.g.*, Blau, 2008; Davey et al., 2013; Marks and Mirvis, 2001; Zell, 2003). However, future research modelling emotional processes using the Kübler-Ross model should test the pertinence of the specific states for the particular phenomenon studied.

A second purpose of this study was to describe the evolution through the various emotional states when experiencing organizational change. Because organizational changes are dynamic and nonlinear processes (Ashford and Taylor, 1990; Scheck and Kinicki, 2000), and because individuals can move between the states in the Kübler-Ross model, probabilities of an individual moving forward or backward through the states were defined using co-occurrence analysis. Results show that during negatively-perceived organizational change processes, the individual can move between denial and anger, bargaining, depression and revising, but it ends with deserting or acceptance. Because these probabilities were calculated using a small sample, more precise values could be obtained using a qualitative, confirmatory research design on a larger sample of informants. In addition to the nonlinear appearance of progression through the emotional states, transitions between them were compared to theory and confirmed. For example, Wortman and Silver (1989) indicate that emotional evolution caused by pain resulting from loss cannot be understood as an ordered sequence of events but rather by a succession of states. Individuals evolve through each moment of organizational change, and this process corresponds to a period of cognitive and emotional adaptation (Huy, 2001). Thus, the transition between states is a natural, intrinsic part of the changing process.

The final purpose of this work was to determine how relationships between individuals and their social environments are affected by negatively-perceived organizational change. Previous research, such as that by Hobfoll (2002), stresses the importance of individuals' relationships with their social environments during organizational change. Results showing that relationships with family, friends and co-workers evolve positively during denial and anger and during bargaining, but only those with family and friends do so during depression supports other studies (Griffin et al., 2007; Parker et al., 2006). Those studies indicate that co-workers are among the primary supports that individuals turn to at work, especially during hard times such as organizational change processes. Relationships with supervisors and the organization were found to evolve negatively during denial and anger and during depression but remain stable during bargaining, and this can be explained by the Kübler-Ross model. Relationships with family, friends and co-workers are positive in the early states because individuals need support from them not to be outdone by the novelty of the changes. As organizational changes occur, individuals can perceive their social environments as something to rely on. However, during depression, they blame their loved ones for their strife. Because they can find nobody who understands them, relationships with friends and family

deteriorate. The literature provides examples such as the study by Hobfoll (1998), who indicates that stress generated via an organizational change process affects relationships with family and friends. Similarly, Kübler-Ross (1969) indicates that during depression, individuals experience strong tensions and stresses precipitated by the situation that is being experienced. On the contrary, during depression, relationships with co-workers improve, because individuals feel that because their peers are experiencing the same loss, they are the only ones who can understand them. In the Kübler-Ross model, individuals blame God (a higher entity) for their problems; likewise, during the worst states of organizational change (denial and anger or depression), relationships with their supervisors and the organization (superior entities) deteriorate. Individuals blame their supervisors and the organization for the changes, and they see them as enemies. However, this feeling is minimized during bargaining, when individuals seek reasons to overcome the organizational change. One explanation for this result is that during bargaining, individuals seek reasons for, and try to convince themselves to accept the changes. It is at this point when individuals become oriented to the change and subsequently with their relationships with supervisors (Detert and Burris, 2007; Dyne et al., 2008), and the organization becomes a source of support for the individual during the process (Ng and Feldman, 2012; Ng and Sorensen, 2008; Tekleab and Chiaburu, 2011). If individuals intend to accept the changes, they will feel that the organization and their supervisors are supportive and therefore, at this state, relationships with them should not worsen. Instead relationships with supervisors and the organization can revert to what they were before the organizational changes. Only the evolution of relationships as organizational change unfolds were evaluated during the analysis of relationships between individuals and their social environments. Exploring the nature of these relationships in-depth at each emotional state is a promising avenue for future research, along with considerations for exploiting the model. For instance, it would be interesting to extend the research from the individual level to the organizational level using social simulation (Squazzoni et al., 2014) to assess how organizations evolve during negatively-perceived organizational change processes.

In this study, the individuals experienced denial and anger simultaneously, and the two were combined. Kübler-Ross (1969) predicted this overlap. Future research should explore the reasons for this systematic overlap in the context of negatively-perceived organizational change, examining its consistency through confirmatory research design. Future research could also explore explanations for why organizational change is perceived as negative (*e.g.*, organizational justice). Cropanzano and Schminke (2001) and Konovsky (2000) indicate that individuals construct their perceptions of organizational change assessing the justice of decisions and actions taken by the organization. Other research, such as that by Clay-Warner et al. (2005) suggests that organizational changes such as downsizing affect and influence the perception of distributive justice, making this the most important predictor. On the other hand, the roles of the individuals in the organization were not considered in this work; nor were the contents of the tasks performed before the organizational change. Future researchers can pursue the influence of an employee's organizational role and of the content of tasks performed on the emotional states during negatively-perceived organizational change processes. Finally, researchers are encouraged to conduct longitudinal studies in which individuals are interviewed while organizational change takes place. Interviewing an individual a long period (up to three years) after an event can lead to distortion of the events. Levine et al. (2012) indicates that individuals tend to reconstruct events over time and they cannot remember all the emotions experienced. While it is true that other studies such as Talarico et al. (2004) indicate that the passage of time may help improve the memories of emotions experienced, but faulty memories must be expected and taken into account (*e.g.*, Howe and Malone, 2011). Several researchers report that

people, when in altered emotional states, encode their experiences differently (*e.g.*, Schaefer and Philippot, 2005; Storbeck and Clore, 2005). Future research can mitigate this limitation by giving notebooks to informants for recording experiences as they occur. Explanations of their feelings at each moment could be subsequently provided (Mazzola et al., 2011).

The practical implications of this research include serving as a guide so that managers can foresee and anticipate actions for reducing the negative impact of organizational change on employees. Behaviours and corrective actions can be planned. This point is very important for organizations (Kotter and Schlesinger, 2008) because these actions could reduce, for example, negative effects on productivity or an increase in direct and indirect costs (Bowman and Singh, 1993; Bowman et al., 1999). Leaders of organizational change can use these results in a way to reduce the stress and emotional tension generated by organizational change (Kelloway et al., 2005) by generating confidence in their subordinates in the initial state of denial and anger (Harvey et al., 2003). In addition, they must know the needs of each of their subordinates by measuring communications and considering the period of emotional adaptation (Huy, 2001). The theoretical implications of this work include the provision of a cognitive and emotional perspective that identifies six states through which the individual moves during a negatively-perceived organizational change. Agents of change must know that when initiating organizational change, the predominant state in their workers will be denial and anger. According to the Kübler-Ross model, individuals will experience sensations such as anger toward those in their social environments, disbelief over the even or irritability. In addition, these results tune the use of the Kübler-Ross model, which was originally defined for medical application, for the context of negatively-perceived organizational change. Future researchers should use this six-state model in studies of organizational change.

In summary, this research expands the literature and addresses organizational change from another perspective. Conceptualization of organizational change as dynamic or nonlinear (Ashford and Taylor, 1990; Scheck and Kinicki, 2000) requires a model that allows such flexibility. Thus, this model allows framing the emotions of individuals during negatively-perceived organizational change through a dynamic and nonlinear model. Future research will expand and further improve this model. Further studies of these six emotional states is forthcoming.





## A SIMULATION MODEL FOR PROPAGATION IN ORGANIZATIONAL/SOCIAL NETWORKS BASED ON MARKOVIAN PROCESSES

Considering that the relationships among the individuals of an organization are complex to study, appear new tools such as the simulation of virtual realities that allow the elimination of temporary and sample size barriers arise. For this reason, this second study proposes a model of simulation that allows studying the evolution of the states of individuals simultaneously in an organization taking into account their interactions. For that, we have followed the guidelines and recommendations of the literature: problem definition, data collection and configuration of model parameters, conceptual model, testing of the programmed model and analysis of the results of the simulation, as can be observed from the following pages.

### 4.1 Introduction

The complexity of human beings and organizations has sometimes forced the use of sophisticated conceptual tools to address their nonlinear character and dynamic interaction (*e.g.*, Kammeyer-Mueller et al., 2005) due to the limitations of the verbal, mathematics and statistic representation. One of these tools is a simulation model: algorithms that describe a process to be executed through a computer program (Taber and Timpone, 1996). In complex social phenomena, the simulation often represents them more efficiently than natural or mathematical language (Harrison et al., 2007; Hulin and Ilgen, 2000; Vancouver et al., 2008, 2010). The literature shows a large number of social phenomena investigated from simulation models such as organizational learning (*e.g.*, Carley and Hill, 2001), motivation (*e.g.*, Lord et al., 2003) and propensity to the search of information (*e.g.*, Carley and Hill, 2001; Vancouver et al., 2008). The use of these models of simulation has solved many of the problems that exist in the study of social phenomena due to the limitations of human capacity, such as the analysis of probabilities and the recognition of patterns of behaviour. At present, the number of investigations that use model simulation to study social phenomena

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has increased significantly (*e.g.*, Vancouver et al., 2008; Vancouver and Weinhardt, 2012), especially in situations where networks appear of interaction.

Over the last few decades, the research on the organizational environment has focused mainly on the individual, it analysing aspects such as leaving the workplace (Brennan and Skarlicki, 2004), the perception during company mergers (Scheck and Kinicki, 2000) and the improvement of the commitment based on the organizational' social responsibility (Flammer and Luo, 2016). All this is because the individual has become a fundamental part of the operation of companies. Their behaviour and reactions have direct and significant consequences on the functioning and results of the organization, which can hundreds of millions of dollars (Bennett and Robinson, 2000). Therefore, the organizations need to know how individuals react to certain situations and, consequently, identify strategies that allow them to manage behaviours efficiently that are most detrimental to the organization. The literature shows a great deal of research on predictors to certain individual states (*e.g.*, Booth et al., 2016; Martínez-Íñigo and Totterdell, 2016; Shead et al., 2016) the counterproductive consequences of their actions (Berry et al., 2007) and their identification by the organization (Omar et al., 2016). However, some research of this type has used simulation models, it is missing the opportunity to explore social and organizational phenomena beyond the case study itself. For the study of emotional states it is necessary to know from the beginning what they are and how they originate. In the first instance, emotional states arise directly from the emotions of individuals, which are defined as psychophysiological reactions that represent methods of adaptation to certain stimuli in front of, for example, a person, an object or a certain situation (Lyons, 1993). Thus, emotional states become the repository of the set of experienced emotions that constitute the same feeling and finally the same language (Lyons, 1993). For example, if during an organizational change perceived as negative the individual experiences the emotions of sadness, anger and melancholy we can indicate that he is in an emotional state of denial and anger (Castillo et al., 2017). We must consider that emotional states have certain invariant and indivisible characteristics between different individuals, groups and cultures (Levenson, 1994). Thus, taking into account all of the aforementioned, our proposed computer simulation model proposed will allow future research to analyse the behaviour of any individual state within an organization, taking into account the influence of its social environment. A few examples of possible researches to be explored include: the affectation in the individual's emotional states depending on the emotional state in which his supervisor is found (*see* Pohl and Galletta, 2017), the affectation of the individual's emotional states when one or several co-workers have been dismissed (*see* Brockner et al., 1995), the affectation of emotional states in the individual's leadership (*see* George, 2000), the affectation in the emotional states when the organizational change is perceived as negative (*see* Castillo et al., 2017), the labour commitment and emotional states (*see* Young and Steelman, 2016) and the abuse of power by supervisors with the individual emotional states (*see* Arenas et al., 2015). So, the longitudinal study of organizational phenomena through the proposed simulation model allows solving some of the main problems with which researchers find themselves in these situations: sample size, data collection time, flexibility in the scenarios, the complexity of the interaction and so on. The simulation allows the generation of artificial social / business worlds in which to test predictive models of organizational behaviour in the real world. While it is true that simulation models are only a simplification or reflection of actual organizational behaviours, experience shows that they share a close similarity (Elman et al., 1998). The purpose of this second study is to propose a simulation model that allows the study and analysis of the evolution of the states of several individuals simultaneously within an organization. For this, we will take into account not only their own idiosyncrasy but also the influence of the rest of individuals about them.

## 4.2 Literature Review

### 4.2.1 Models of simulation in the social sciences

The need to use simulation models in research, and specifically in the context of social sciences, arises mainly because of the complexity to do the empirical part of the research, either due to the lack of availability of data (it is not observable or it is difficult to measure) or by its complex interaction (Gershenson, 2002). Despite the emergence of researches that using simulations models in social sciences (*e.g.*, Cohen et al., 1972; Lomi and Larsen, 2001; Vancouver and Weinhardt, 2012), it still represents a tiny proportion compared to the rest of possible strategies to follow. It is complex to determine the reasons why simulation models lack greater acceptance; however, there are some indications that may clarify this. Troitzsch (2009) suggests that the difficulty of simply and elegantly expressing a model of simulation (and its software) in comparison with more traditional mathematical models makes many researchers opt for other options. The use of simulation models forces the researcher to make an overexertion in the abstraction of the phenomenon that is not usually simple. In addition, many of these researchers believe that the level of abstraction required for the development of a simulation model does not allow conclusions to be drawn relevant to professional use. From a different perspective, Axelrod (2006) states that the development of simulation models force to define a certain set of initial assumptions of the phenomenon to investigate, which could be interpreted as a little transparent manipulation by the scientific community.

In spite of all this, the simulation model has proved their usefulness under certain circumstances, as well as the rest of more traditional methods. Deffuant et al. (2006) propose that the use of simulation models is very useful to research when the purposes is to analyse the behaviour of individuals from their interaction with the elements of a social system, as well as their evolution over time. Taking as a premise the conclusions of Deffuant et al. (2006) and the recommendations of Law (2008) for the construction of valid and credible simulation models, we have developed a tool based on a simple simulation model to configure and execute, and enable to analyse the evolution of the states of individuals simultaneously inside of an organization, taking into account various levels of interaction. To represent the interactions between the individuals that are part of the simulation model, we have opted for the use of social networks within organizations.

### 4.2.2 Interaction between individuals and social networks

As previously mentioned, the simulation model must contemplate the interactions of individuals within organizations. Despite the various possible abstraction options, the most common is the formal and informal structure of the organization (*e.g.*, Chen and Krauskopf, 2013; Sykes et al., 2014). Mintzberg (1979) defines formal structure (or formal organization chart) as the rational, conscious and institutionalized disposition of the division of work, so this is the bureaucratized image of the organization (Weber, 2014). From the social network analysis (SNA) point of view, the formal structure defines internal relationships within the organization and is stipulated by the management team; In contrast, Molina (1995) defines the informal structure (or informal organization chart) as existing relationships within the organization that have not been formalized, thus differentiating two levels of informal relationship: (1) friendship and (2) advice networks. The relationships that are established through the formal and informal structures within the organization are a key element since they allow identifying the channels of influence to which each individual is subjected. The explanation of the structure of formal relations is relatively simple since it

is defined by the same organization. However, and as Bastin and Delgado (1966) point out, the workers are often not aware of the social groups to which they belong within their organization. For this reason, the representation of informal structures tends to be complex, so sociometric tests are used (Arruga et al., 1974; Bastin and Delgado, 1966; Tagiuri, 1952). Consequently, the proposed simulation model uses two networks, one for the formal structure and another for the informal one, to represent the interactions and influences that the individuals receive in their organization over time. The combined characteristics of the two networks represent the structure of the organization so the simulation model allows simulating completely different organizations with a much lower resource cost (*e.g.*, time) to other more traditional research approaches.

### 4.3 Development of the simulation model

Law (2008) presents a set of recommendations for the development of valid and credible models simulation, which is based on several steps. Then, the simulation model proposed is developed and presented based on his recommendations.

#### 4.3.1 Definition of the problem

The purpose of the simulation model is to be able to analyse the propagation and evolution of several individuals through a set of states (*e.g.*, mood states) based on different interaction networks simultaneously. The simulation model consists of a set of individuals  $\{A, B, C, \dots\}$ , each of who can be found in  $n$  different states at time  $t$  (*e.g.*,  $A_t \in \{A_1, A_2, \dots, A_n\}$ ). The evolution of individuals throughout the  $n$  states is modelled as first-order Markovian processes, that is, the future state depends only on the current state of individuals. In addition to the current state of an individual, the probabilities of change from one state to another also depend on their environment (Sykes et al., 2014), more concretely of the individuals that are directly connected to them (direct connectivity) and of the state of these individuals. In this case, the effect of the individuals on the rest is also modelled through a Markovian process of the first order. Finally, a principle of additivity is applied to the combined effect of individuals on the rest. This aspect is dealt with in more detail in the following point.

#### 4.3.2 Compilation of the information and configuration of the parameters of the model

After defining the problem and the main focus for its modelling, the next step is to determine the different states in which individuals may be. For this, a review of the deep literature is necessary, as well as a possible inductive study to describe and define the social phenomenon that is under the research focus (Bonilla-Castro and Sehk, 2005). The purpose of this study is to improve the current understanding of the situation and identify its properties as well as its dynamics (Bernal, 2010), leaving for the simulation model the analysis of the interaction between the states of the individuals and their social environment. After identifying the states of the individuals, the next step is determining the probability that an individual has to begin in each of the existing states. Thus, if we define  $n$  as the number of possible states of an individual,  $E_i$  as the set of possible states of an individual and  $p_i^{(0)}$  as the probability of that the individual is initially in a state  $E_i$ , we can conclude that the sum of their probabilities will be equal to one:

$$(4.1) \quad \sum_{i=1}^n p_i^{(0)} = 1$$

In the same way, if we consider  $p_j^{(1)}$  as the probability that an individual has to reach the state  $E_j$  with after a single transition, the total probability theory of Bayes (1763) allows to calculate it based on the previous state:

$$(4.2) \quad p_j^{(1)} = \sum_{i=1}^n p_i^{(0)} p_{ij} = 1$$

Now we can express these probabilities in vector form, where  $p^{(0)}$  represents the probability that an individual will be in some of the possible states at the beginning of the process and  $p^{(1)}$  represents the probability that an individual is in one of the available states after a transition from the beginning of the process.

$$(4.3) \quad p^{(0)} = (p_1^{(0)}, \dots, p_n^{(0)})$$

$$(4.4) \quad p^{(1)} = (p_1^{(1)}, \dots, p_n^{(1)})$$

To conclude, we can represent the probabilities that an individual is in a state as a function of its previous state in matrix form.

$$(4.5) \quad p^{(1)} = [p_j^{(1)}] = \left[ \sum_{i=1}^n p_i^{(0)} p_{ij} \right] = p^{(0)} M_T$$

Where  $M_T$  is the first order state transition matrix for an individual.

$$(4.6) \quad M_T = [p_{ij}] = \begin{pmatrix} p_{11} & p_{12} & p_{13} & \cdots & p_{1n} \\ p_{21} & p_{22} & p_{23} & \cdots & p_{2n} \\ p_{31} & p_{32} & p_{33} & \cdots & p_{3n} \\ \vdots & \vdots & \vdots & \ddots & \vdots \\ p_{n1} & p_{n2} & p_{n3} & \cdots & p_{nn} \end{pmatrix}$$

The  $p_{ij}$  elements of the matrix  $M_T$  represent the probability that an individual will change from state  $i$  to state  $j$  after a transition, so we will have  $i \cdot j$  transition probabilities.

$$(4.7) \quad p_{ij} = P(X_n = j | X_{n-1} = i)$$

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With the initial probability vector  $p_i^{(0)}$  representing the starting point of the process, and the first-order transition ( $M_T$ ) probability matrix representing the evolution of individual states, the following step is to define and include in the simulation model the influence of the rest of individuals. Similar to the state transition matrix, it is proposed to create an influence matrix of the social environment on the individual ( $M_I$ ), which increases and decreases the probabilities of the transition matrix ( $M_T$ ). The ability to influence an individual depends on three elements: the existence of a direct relationship between them, the current state of the influenced individual, and the current state of the influential individual. Therefore, the influence matrix is formed by probabilities of influence  $p'_{ijk}$  where  $i$  represents the current state of the influenced individual,  $j$  represents the current state of the influential individual, and  $k$  represents the future state of the influenced. In order to operate the influence matrix more easily, it is possible to define an influence matrix for each current state of the influenced individual. So the influence matrix for state  $E_i$  would have the following structure:

$$(4.8) \quad M_{I_i} = [p_{ij}] = \begin{pmatrix} p'_{i11} & p'_{i12} & p'_{i13} & \cdots & p'_{i1n} \\ p'_{i21} & p'_{i22} & p'_{i23} & \cdots & p'_{i2n} \\ p'_{i31} & p'_{i32} & p'_{i33} & \cdots & p'_{i3n} \\ \vdots & \vdots & \vdots & \ddots & \vdots \\ p'_{in1} & p'_{in2} & p'_{in3} & \cdots & p'_{inn} \end{pmatrix} \begin{matrix} = 0 \\ = 0 \\ = 0 \\ \vdots \\ = 0 \end{matrix}$$

As the influence matrix ( $M_I$ ) is additive to the transition matrix ( $M_T$ ), we must ensure that the condition continues to be met so that the sum of probabilities of the transition matrix for the current state is equal to one. Therefore, the sum of probabilities for the current state of the influence matrix must be equal to zero. The values  $p'_{ijk}$  can take positive and negative values depending on the phenomenon studied. For example, if the current state of the individual influenced is  $E_i$ , and the current state of the only influential individual is  $E_j$ , the probabilities of ending up in another state are:

$$(4.9) \quad \begin{bmatrix} p_{i1} + p'_{ij1} & p_{i2} + p'_{ij2} & \cdots & p_{in} + p'_{ijn} \end{bmatrix}$$

In situations where there is more than one individual that influences, we work in an analogous way. For example, if the current state of the individual influenced is  $E_i$ , and the current state of the only two influential individuals are  $E_j$  and  $E_m$ , the probabilities of ending up in another state are:

$$(4.10) \quad \begin{bmatrix} p_{i1} + p'_{ij1} + p'_{im1} & p_{i2} + p'_{ij2} + p'_{im2} & \cdots & p_{in} + p'_{ijn} + p'_{imn} \end{bmatrix}$$

In situations where the final probability is greater than one, it will be necessary to establish termination criteria, or probability distribution. However, this decision will depend exclusively on the phenomenon studied. Finally, it is proposed to use an absorbing state at least in the simulation model, which represents the state or final states to which an individual can reach. Therefore, in the transition probability matrix ( $M_T$ ), it must be satisfied that the absorbing state ( $E_i$ ) is:

$$(4.11) \quad p_{ii} = 1$$

$$(4.12) \quad p_{ij} = 0 (i \neq j, j = 1, \dots, n)$$

### 4.3.3 Final modelling and conceptual simulation engine design

After defining the necessary parameters for the construction of the simulation model, the next step is the development of a computational motor that allows simulating the evolution of the model over time. For this, the following heuristic is proposed where the term node is used as representation of the individuals of an organization. Finally, it is necessary to verify that the heuristic behaves as described in the definition of the problem through a simple example.

#### **Initial data:**

1. *Table*  $\{p_i^{(0)}\}$ : Probability table representing the probability that an individual starts in state  $E_i$ .
2. *Table*  $M_T$ : Transition matrix for the individual.
3. *Table*  $M_I$ : Matrix of influence of the individual' social environment.
4. *Table*  $M_{TI}$ : Matrix of combined transition of the matrix  $M_T$  and  $M_I$ .

#### **Constants:**

1.  $S_N$ : Size of the network (number of nodes).
2.  $S_S$ : Sample size (number of simulations).
3.  $M_N$ : Identifies in the network the different types of relationship that can have the individual and specifies the number of maximum relationships that may exist. For example:  $M_1$  (maximum number of relationships with other individuals of type 1),  $M_2$  (maximum number of relationships with other individuals of type 2), ... ,  $M_{N-1}$  (maximum number of relationships with other individuals of type N-1) and  $M_N$  (maximum number of relationships with other individuals of type N).

#### **Variables:**

***RES\_n[i, j]***: State of the individual  $[i]$  ( $1 \div SS$ ) at time  $[j]$  ( $0 \div \infty$ ) in the simulation  $n$  ( $\div SS$ ).



***Heuristic:***

***Pre-Processing:***

**begin**

Define the rules of creation for each of the networks of interaction between the individual and his social environment  $M_N(M_1 \div M_N)$ .

**end**

***Process:***

**begin**

We start the simulation counter at  $n = 1$ ; (Label = simulation).

We create each of the networks related to the individual ( $M_N$ ) according to the rules established in the pre-process.

We start the state of the individuals of the sample ( $S_N$ ) according to the probabilities of the table  $\{p_i^{(0)}\}$ .

We save the initial state of each individual of the network in the corresponding box. The total number of individuals will be the equivalent of the sample ( $S_N$ ):

$RES\_n[1,0] + RES\_n[2,0] + \dots + RES\_n[S_N-1,0] + RES\_n[S_N,0]$ .

**end**

**while** *during the time simulation* **do**

We start the timer at  $t = 1$ ; (Label = time).

For each individual in the network we must calculate the probabilities of transition between states of the system.

We select the transition probabilities of the individual based on the  $M_T$  table according to the state in which it is at  $t = 1$ .

Calculate the relationships that the individual has with other individuals in the network ( $M_N$ ) differentiating them by the state in which each of them is.

We update the value of the transition probability between states of the individual ( $M_{T_i}$ ) taking into account the influence table ( $M_I$ ) of each of the individuals with whom it is related in the defined network.

We calculate the transition of the analysed individual and save it in the corresponding table:

$RES\_n[1,1] + RES\_n[2,1] + \dots + RES\_n[S_N-1,1] + RES\_n[S_N,1]$ .

**if** *the individuals in the network are in any of the absorbing states of the system at time  $t = 1$*

**then**

**if** *the individuals are not in absorbing states* **then**

We must advance the timer at  $t = t + 1$ ; (Label = time).

**end**

**if** *the individuals are in some absorbing states* **then**

we must check if all the predicted simulations have been performed ( $S_S == n$ ). **if** *all the simulations have not been performed* **then**

We must advance the simulator counter to  $n = n + 1$ ; (Label = simulation).

**end**

**if** *all the simulations have been done* **then**

We will have finished.

**end**

**end**

**else**

**end**

**end**

**Algorithm 1:** Heuristic model simulation

#### 4.3.4 Basic results of the simulation

Finally, after checking the correct operation of the simulation model, we start the simulation of our instance. The model and the simulation engine allow obtaining different results of interest for the analysis of the organizational phenomenon. Here are the basic results that we can obtain from the simulation. Nonetheless, other types of results can be obtained from the simulation depending on the idiosyncrasy of the social or organizational phenomenon.

#### 4.4. EXAMPLE OF SIMULATION BY SIMULATION OF THE PROPAGATION OF EMOTIONAL STATES DURING AN ORGANIZATIONAL CHANGE

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##### 4.3.4.1 Number of iterations

The number of iterations shows the amount of time it takes for the system to become stable. Due to the large number of simulations carried out on the same specimen, it is possible to obtain the mean of iterations and represent its graphically through histograms. This information is interesting because it allows us to identify under what circumstances the transient state of a process is lengthened or reduced over time.

##### 4.3.4.2 Number of individuals in the absorbing states

As previously defined, the simulation model must contain at least one absorbing state. In the case of models with two or more absorbent states, it is possible to obtain the mean of individuals that end up in each absorbent state and graph them through histograms. This information allows to discover the final consequences of the process, allowing to predict groups of individuals according to their states.

##### 4.3.4.3 Representation of a simulation

From the simulated data, it is possible to simultaneously visualize the evolution of all the individuals of a specific simulation. This representation allows the identification of patterns of evolution of individuals throughout a process.

##### 4.3.4.4 Represent global simulation

Another possible visualization that can be extracted from the simulated data is the mean number (as well as its standard deviations) of individuals that are in a state over time. This representation allows to study the transient state in detail and how it evolves according to the established model.

#### 4.4 Example of simulation by simulation of the propagation of emotional states during an organizational change

In this section, an example of an application of the simulation model is carried out in order to improve its understanding. The first step, as previously described, is to perform a search of the literature that allows to define the problem and the model of simulation that suits it best. In this case, we have chosen to use the study by Castillo et al. (2017) that develops a theoretical model that describes the evolution of the emotional states of individuals during a negatively perceived organizational change, as well as explains the evolution of their behavioural patterns taking into account their social environment (family, friends, co-workers, supervisors and organization). The theoretical model proposed by Castillo et al. (2017) comprises six emotional states: denial and anger ( $E_1$ ), bargaining ( $E_2$ ), depression ( $E_3$ ), revising ( $E_4$ ), deserting ( $E_5$ ) and acceptance ( $E_6$ ). Their results show that individuals ‘circulate’ freely among the first four states, while deserting and acceptance states behave as final states of the process. It should be noted that for our research, the stages that defined by the authors are called states in our Ph.D. thesis. Castillo et al. (2017) also identify that sources of social influence (*e.g.*, family, friends, and co-workers) have different effects depending on the current state of the individual who has undergone organizational change. Experiencing these emotional states can influence relationships between individuals and their

## CHAPTER 4. A SIMULATION MODEL FOR PROPAGATION IN ORGANIZATIONAL/SOCIAL NETWORKS BASED ON MARKOVIAN PROCESSES

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social environments. For example, relationships with supervisors deteriorate during denial and anger and depression, but remain stable during bargaining.

Thus, and we based on the results of Castillo et al. (2017), we elaborated a proposal of the simulation model. To do this, it is necessary to define its parameters, as explained in the previous sections. The simulation model will consist of six states, where the probability that an individual is initially in the state  $E_i$  is defined by the vector  $p_i^{(0)}$ . This initial probability that we indicated in equations 4.13 and 4.14 is given by Castillo et al. (2017).

$$(4.13) \quad \sum_{i=1}^n p_i^{(0)} = E_1 + E_2 + E_3 + E_4 + E_5 + E_6 = 1$$

$$(4.14) \quad \sum_{i=1}^n p_i^{(0)} = 0.5070 + 0.2254 + 0.1127 + 0.0704 + 0.0282 + 0.0563 = 1$$

The next step is to model the behaviour of an individual through its matrix of first-order transition ( $M_T$ ) probabilities. We obtain the following matrix based on the results of Castillo et al. (2017). In this matrix of transition probabilities of the individual does not consider the influence of their social environment within the organization:

$$(4.15) \quad M_T = \begin{pmatrix} 0.56 & 0.24 & 0.12 & 0.08 & 0 & 0 \\ 0.24 & 0.62 & 0.07 & 0.03 & 0 & 0.04 \\ 0.12 & 0.07 & 0.36 & 0.36 & 0 & 0.09 \\ 0.08 & 0.03 & 0.36 & 0.24 & 0.29 & 0 \\ 0 & 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 & 0 & 1 \end{pmatrix} \begin{matrix} = 1 \\ = 1 \\ = 1 \\ = 1 \\ = 1 \\ = 1 \end{matrix}$$

The next element of the simulation model is the probability matrix representing the influence of the social environment ( $M_I$ ). The theoretical model of Castillo et al. (2017) suggests two types of influences: those exerted by those directly connected through the informal network (friendship), and those exerted by individuals that are directly connected through formal network (work-flow). Each of these sources of influence have different effects on individuals depending on their current state. In this way we elaborate two influence matrices ( $M_{IFn}$  related to the informal network and  $M_{IWn}$  related to the formal network) in which we obtain the increments and decrements for each of the individual's emotional states during a perceived negative organizational change. In order to be able to visualize and work more easily with the influence tables (formed by three dimensions), we decided to transform each one into six sub-matrices, one for each current state of the influenced individual. Then, we can observe one of the influence matrices when the individual is initially in the state  $E_1$  (denial and anger). The rest of influence matrices are in the Appendix B.

#### 4.4. EXAMPLE OF SIMULATION BY SIMULATION OF THE PROPAGATION OF EMOTIONAL STATES DURING AN ORGANIZATIONAL CHANGE

$$(4.16) \quad M_{IFE_1} = \begin{pmatrix} 0.04 & -(\frac{0.04}{3}) & -(\frac{0.04}{3}) & -(\frac{0.04}{3}) & 0 & 0 \\ -(\frac{0.02}{3}) & 0.02 & -(\frac{0.02}{3}) & -(\frac{0.02}{3}) & 0 & 0 \\ -(\frac{0.02}{3}) & -(\frac{0.02}{3}) & 0.02 & -(\frac{0.02}{3}) & 0 & 0 \\ -(\frac{0.02}{3}) & -(\frac{0.02}{3}) & -(\frac{0.02}{3}) & 0.02 & 0 & 0 \\ -(\frac{0.02}{3}) & -(\frac{0.02}{3}) & -(\frac{0.02}{3}) & 0.02 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix} = 0$$

After defining the model states, the transition probabilities matrix ( $M_T$ ) and the influence probability matrices ( $M_{IFn}$  and  $M_{IWn}$ ), the next step is to define the number of individuals that are part of the simulation model and the direct relationships that exist between them. As an example, we have proposed a model formed by ten individuals, and two networks representing the relationships of the formal and informal structure. Figure 4.1A shows the formal network defined for the simulation model. In this case, we have chosen a network in the form of a tree, although it could be any other. For its part, Figure 4.1B shows the informal network defined for the simulation model. In this case, a random network has been proposed.

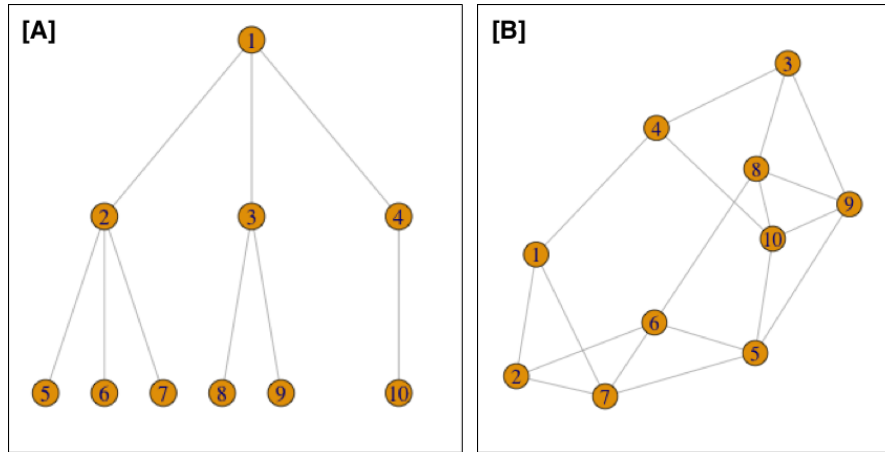


Figure 4.1: [A] Formal network of the example; [B] Informal network of the example.

After defining all the parameters of the simulation model, the next step is to establish the parameters of the simulation, in other words, the initial conditions and the number of simulations to be performed. In this example, it has been proposed to define 100 initial situations of the system based on the probabilities  $p_i^{(0)}$ . And for each of them, 100 simulations have been performed using the simulation engine (the previously proposed heuristic). The final result is equivalent to 10.000 simulations of the proposed problem. The first results obtained from the experiment are the number of iterations that have been necessary to reach a stable situation in each one of the simulations and the number of individuals that have finished in each one of the final states. Table 4.1 shows a sample of these results.

The number of iterations to reach a stable situation in the system allows to evaluate the process of cognitive and emotional adaptation to which the individual has been subjected (Huy, 2001). In other words, the greater the number of iterations performed, the greater the adaptation effort of the individual since it is usually linked to a greater number of transitions due to possible emotional states. The difficulty of adaptation translates into resistance to change, which sometimes results in unwanted or counterproductive

Table 4.1: Number of iterations necessary to reach a stable situation and number of individuals those finish in each final state.

#Simulation	Iters	#Individuals	
		State $E_5$	State $E_6$
1	19	5	5
2	59	4	6
3	27	6	4
...	...	...	...

work behaviours (Bowling and Eschleman, 2010). Thus, knowing the initial state of each individual and the number of iterations that have been necessary to arrive at a stable situation allow the change managers to focus actions that counter this resistance. Although the results in Table 4.1 are interesting, the representation of each of the separate simulations is not efficient for analysis. One way to condense such information is through histograms. Figure 4.2 shows an example of two histograms to represent the number of individuals ending in state  $E_5$  and  $E_6$  in the 10.000 simulations performed. Similarly, a histogram could be performed for the number of iterations for the 10.000 simulations.

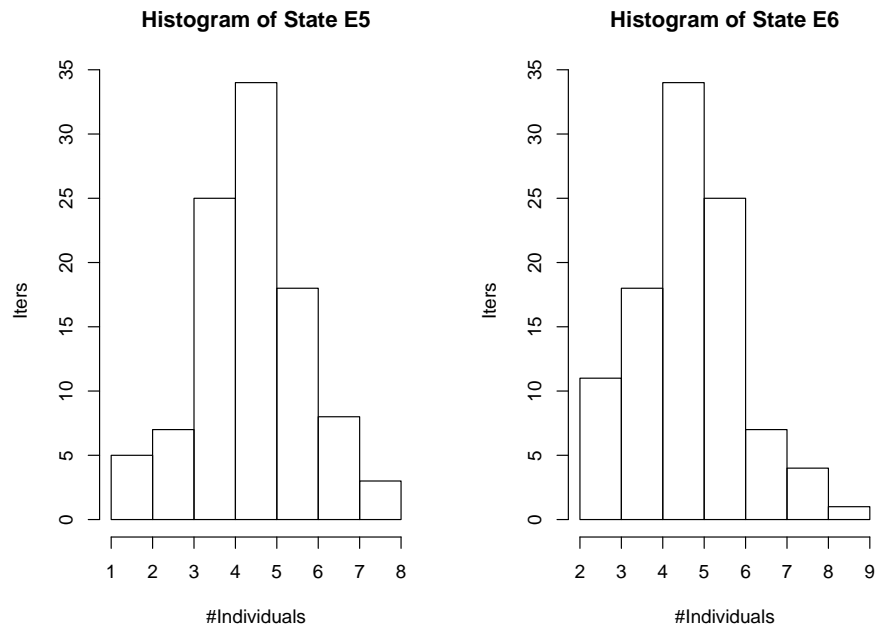


Figure 4.2: Histograms of the meanings of iterations and the number of individuals in states  $E_5$  and  $E_6$ .

The representation of a simulation, more specifically the evolution of each individual over time for a specific simulation, can also be considered of interest in the analysis of the problem. Figure 4.3 shows how organizational changes are nonlinear and dynamic processes (Ashford and Taylor, 1990; Scheck and

#### 4.4. EXAMPLE OF SIMULATION BY SIMULATION OF THE PROPAGATION OF EMOTIONAL STATES DURING AN ORGANIZATIONAL CHANGE

Kinicki, 2000) as each individual experiences different transition to finally reach one of the two absorbing states. During this process, we observe how some individuals have oscillated repeatedly between different states, which Kübler-Ross (1969) interprets as emotional instability and difficulty accepting changes.

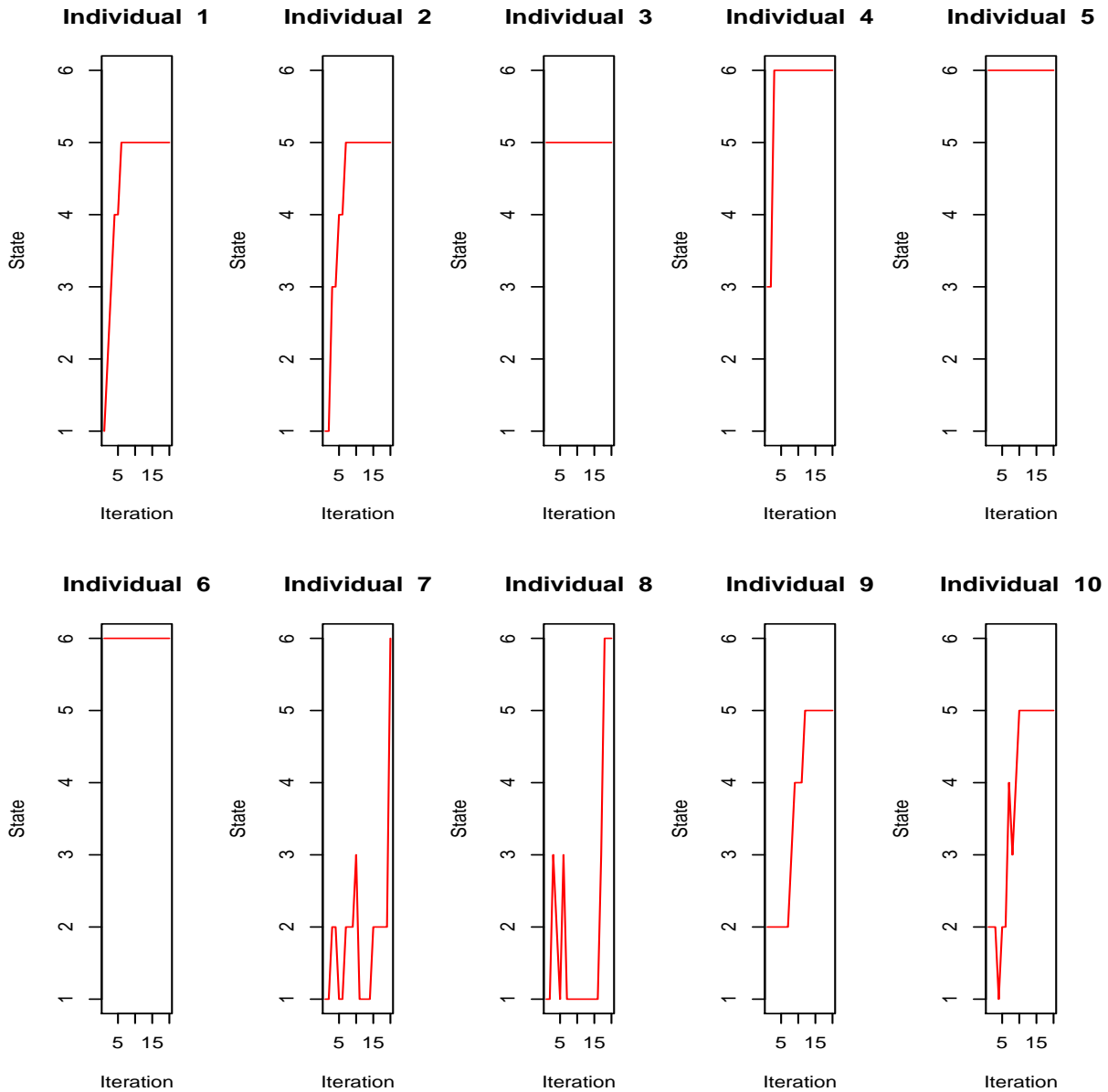


Figure 4.3: Evolution of the states of each individual during the simulation time.

For example, the individual 7 who initiates the simulation in the state of denial and anger and ends in the state of acceptance passes numerous times between the states of denial and anger, bargaining and depression. On the other hand, we observe that certain individuals (*e.g.*, 5 and 6) transit directly into the acceptance state. It is possible to consider that this transition does not cause them an emotional situation

complicated by the change produced, as happens to the individual 7. Finally, it is also possible to make a visual representation that shows the results simultaneously of several simulations. Figure 4.4 shows the mean number (as well as their confidence intervals with a margin of error of 99.5%) of individuals found in each of the six states over time. This representation allows us to observe the transient state in detail, and how it evolves according to our simulation model.

The results of Figure 4.4 show that 50% of the individuals begin the process in the state of denial and anger, this being the state in which they experience greater confrontation and rejection by the lived situation (Castillo et al., 2017; Kübler-Ross, 1969). However, at the end of the simulation, 40% of the individuals are in the acceptance state while the remaining 60% do so in the deserting state. Both states are absorbent and therefore are considered as the two final states of change. Based on these results, two strategies can be established to improve the management of an organizational change: (1) we establish an initial favourable process situation, which would affect the simulation model in the start probabilities, and (2) we promote a structure formal and informal that allows better results, which would affect the effective transition probabilities of individuals. The rest of the parameters and variables of the simulation model are constant to strategies that a manager or organization can carry out. From this point, we can establish two other strategies for the analysis of the simulation: focusing on only the results in the first iterations, what we could call the first transient state, and focusing only on a sample of the simulations. Of course, it is also possible to combine both strategies to represent the results. The Figure 4.5A shows the results but only between iterations 1 and 10, whereas Figure 4.5B shows the same results, but only of the simulations that have the same initial situations (in other words, the same number of individuals in each of the states at the beginning of the process). These representations are only an example of the possible ways of representing the data obtained and the multitude of possibilities offered by the proposal of our simulation model.

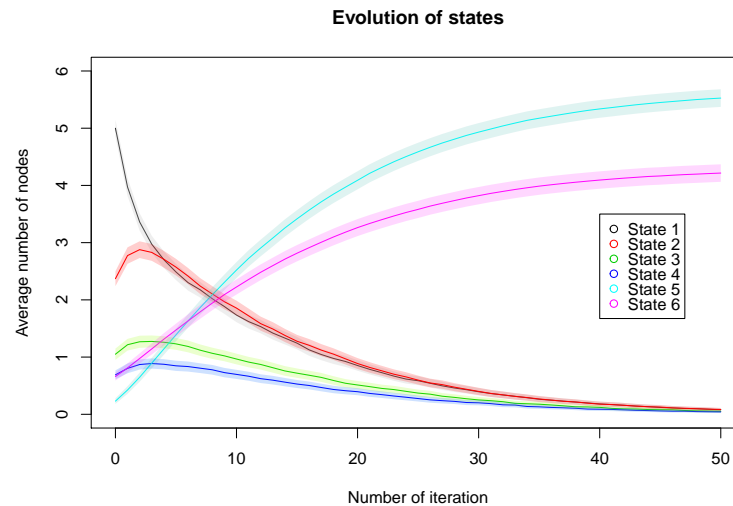


Figure 4.4: Evolution of the states and average of individuals that are in them during the course of the simulation.

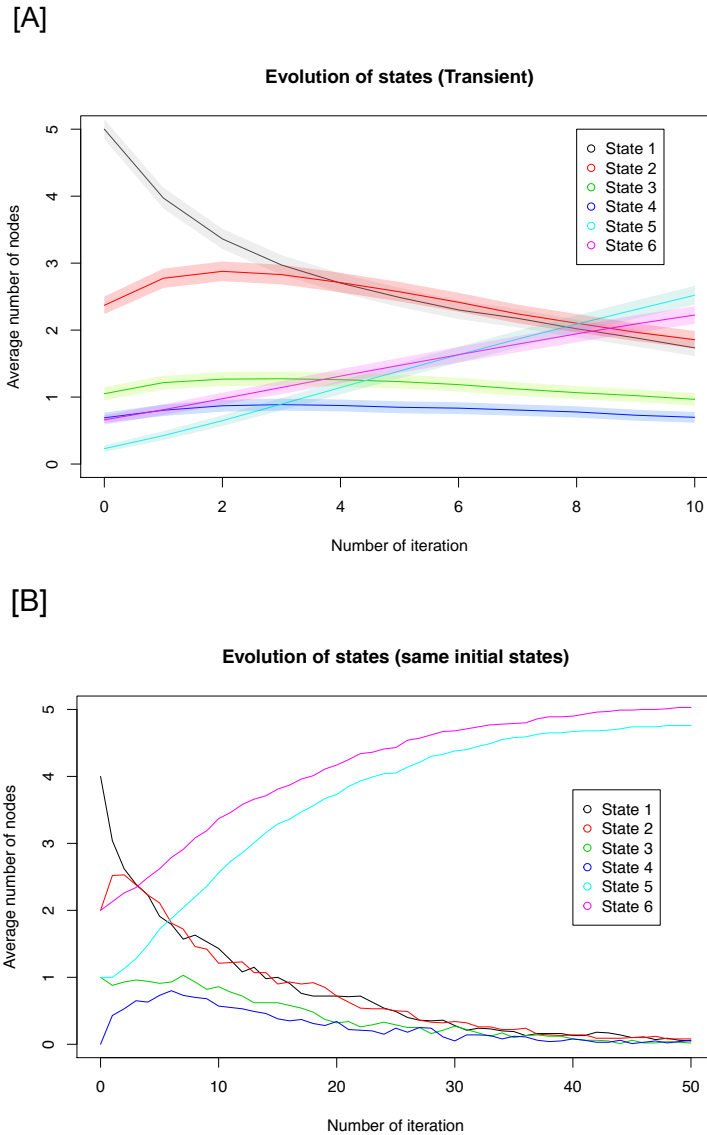


Figure 4.5: [A] Examples of the evolution of states only the first 10 iterations; [B] Examples of the evolution of states only those that share the same initial situation.

## 4.5 Conclusions

We have presented a simulation model that gives researchers in the social sciences a simple but powerful tool for the study and analysis of the possible states of an individual within the organizational context. In addition, this model contemplates the individual's own idiosyncrasy, as well as the influence that the environment exerts on him. We must take into account that, for the correct use of the simulation model, researchers should be aware of its limitations. In this sense, the parameters of the simulation model (*e.g.*, initial probabilities, transition probabilities, and probabilities of influence) must be established from a preliminary study. This will, in many cases, compel detailed information on the organizational phenomenon



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to be able to represent and interpret in greater detail the results obtained from the simulation (Law, 2008). On the other hand, the model only contemplates the influences of individuals directly connected through the formal and informal network. Other influences that might exist are not taken into account (*e.g.*, groups of people). Finally, to emphasize that the system has been modelled as a Markovian process of the first order, that is, that the future state depends only on the current state of the individuals. This implies that the simulation model has little historical memory about the evolution of the process. All these limitations are what allow any social science researcher to carry out simulation of social phenomena without the need to be an expert in operational programming or research.

## FINAL CONCLUSIONS

The perception of organizational change is largely dependent on how individuals give meaning to the experience of change in relation to risk with the new situation (Lazarus and Folkman, 1984). The knowledge of how individuals' perception behaves is fundamental to any organization, since it facilitates change agents to anticipate the reactions it provokes in individuals (*e.g.*, Bareil et al., 2007). On the other hand, this knowledge also facilitates the explanation of why the reactions of employees in front of the same situation are so different (*e.g.*, Fugate and Kinicki, 2008b). This difference lies mainly in the individual emotions that play a fundamental role in shaping their perception and evaluation of organizational changes, thus elaborating their reactions and coping strategies (*e.g.*, Fugate et al., 2002). Therefore, the intensity and sign of the emotions that individuals experience in front of organizational changes can influence how they will cope with them (O'Connor and O'Connor, 2003).

Based on this, our first study extends the knowledge about emotions during organizational changes with the objective of continuing to provide tools that allow the correct management of changes. As important elements to highlight of our results as well as their contribution we find the adaptation of Kübler-Ross' model to the organizational context, from which the six emotional states presented in the Ph.D. thesis are extracted. Thus, although the Kübler-Ross' model has already been successfully used in studies of organizational change (*e.g.*, Blau, 2008), in future the research will now have to take into account our results and apply our states of change, because it does arise from the analysis of individuals' emotional states during an organizational change perceived as negative and not from a period of change derived from a terminal illness or death (same context of loss but with important nuances). Taking into account that the success of the changes is when they are planned (Zeira and Avedisian, 1989), we propose that leaders of change consider our results. Thus, denial and anger will be the predominant emotions at the beginning of organizational changes, so that leaders of change will have to work previously to reduce their effects. Noting that uncertainty is what generates the first negative reactions to the changes (Lazarus, 2006), the leaders should increase the communication with workers before carrying out the process of change (Allen et al., 2007).

While it is true that the leaders of change does not have the ability to control the dynamic essence of the organizational changes (Jennings and Dooley, 2007), they can foresee their behaviour. In order to do

this, they must be borne in mind that the processes of change are open systems composed of interdependent elements that in turn are interrelated (Paton and MacCalman, 2006). As we showed in our first study, the organizational changes have both direct implications with the individuals and their social environment, and the latter plays a key role in coping to the changes. Therefore, it is important for the leaders of change to look at the structure of their organization, taking into account the formal and informal structures (Molina, 1995). Our results help to predict how each relationship will be with the social environment, depending on the individuals' emotional state, which can provide the leader with strategies to mitigate negative reactions to the change. For example, our results can be used to reduce the emotional stress generated by organizational change (Kelloway et al., 2005), generating trust in subordinates in the initial state of denial and anger (Harvey et al., 2003). And if the leaders of change are able to instill confidence and generate enthusiasm in individuals, they will manage to channel with less uncertainty problems (Bass and Riggio, 2006).

However, the analysis and study of all that emotionally involves the organizational changes as a complex subject that it can hardly be carried out with traditional tools. While it is true that our first study provides the basis on how the changes affect emotionally the individuals, we find the inherent need to apply this analysis to reality. Therefore, through our second study we present a simulation model that offers to researchers in social sciences as well as to the leaders of change the tool for the study and analysis of the possible states of an individual within the organizational context. The simulation model we propose is aimed to people with little or no programming knowledge, so that the lack of computer knowledge does not become a barrier to the use of this kind of simulation tools.

Finally, we can indicate that the theoretical implications of the Ph.D. thesis extend the literature and approach the organizational change from another perspective. If something that can be deduced throughout the document, it is that the organization is a living system (Morgan, 1998) and as such, any change generated becomes dynamic (Ashford and Taylor, 1990; Scheck and Kinicki, 2000) so for it to be explained requires a model that allows such flexibility. Thus, our model achieves this goal and frames the emotions of individuals during a process of organizational change. However, we must be aware of the multitude of models that add to our purpose and therefore it aims to respond to how changes in individual emotions influence (*e.g.*, Huy, 1999; Liu and Perrewé, 2005). Hence, the best option for the future researchers and leaders of change is to get input from all available change studies in the literature and they develop their best strategies for combating them (Raineri, 2001).

## 5.1 Personal implications

One of my professional goals that it has accompanied me since a young age is to dedicate myself to university teaching. Reason why I decided to study my Ph.D., which is an essential requirement for the development of this work. While it is true that I had prior research experience through my final university master project in which a quantitative research on organizational justice and university students was addressed, I could not imagine all the difficulties that would bring me a Ph.D. thesis. And is that if the Ph.D. thesis requires a great dedication, having to share the time with the responsibilities of a full-time job in the private sector makes the Ph.D. thesis project was a personal challenge.

One of the challenges encountered was to carry out qualitative research using the interview as the main data source. Mainly because in all my academic experience I had not dedicated myself to something so typical of the social sciences, so I had to leave my comfort zone and deepen on aspects that until the

moment were unknown to me. The development of a protocol of interviews for the subsequent codification are examples of the methodology learned thanks to the Ph.D. thesis. Aspects that I have been able to apply later in my current position as production and quality manager. But, if I must highlight the main difficulty found, I must refer to the sending of the papers made to the impact journals for publication. I am absolutely convinced that the gold test that I have had to face as a researcher apprentice is to have to deal with journals. How to fit all requested modifications without feeling that everything that has been done so far has not served anything?; Fortunately, the support of my Ph.D. advisors Vicenç Fernández and Oriol Lordan as well as the collaboration of José M. Sallán allowed me to go ahead and get my best version thanks with their long experience in complying with the recommendations of the journals.

The result can not be more satisfactory: a paper presented at congress, published papers, several papers prepared to be sent to journals and multiple seminars that I have done and that it has enriched my experience as a researcher. In addition to having finished my Ph.D. thesis not only with the sensation of having culminated a dream but of having learned what really represents a research.

## 5.2 Further researches

The results presented in this Ph.D. thesis contribute to the knowledge about the individuals' behaviour in organizations but just as the results of this research have answered some questions, it has also generated others. In this section, I summarize with three questions the possible continuations to our research that I find the most interesting. One of the first questions that is deduced from our results and of which I am interested in being able to continue studying is: What are the main differences in the evolution of the six states of change between the subordinates and their supervisors? The literature shows how supervisors and their workers relate in multiple ways, recognizing their differences and commonalities (*e.g.*, Aquino and Thau, 2009; Turban and Jones, 1988). For this reason it would be interesting to conduct a first inductive study with qualitative data that allows to find the differences in the behaviour of supervisors and subordinates during an organizational change when it is perceived as negative. Later, with the first bases established, a second deductive study could be carried out with quantitative data.

On the other hand, another question that arises from our results is: How does it affect to have higher studies completed in the states of revising and deserting?, that is to say, the individuals with more studies may find it less difficult to leave their jobs because they may consider that they have more opportunities to find a new one than, for example, an individual without studies. For example, Swider et al. (2011) indicate that the job search-turnover is greater when individuals have greater opportunities for job embeddedness. In this sense, the behaviour of the states of revising and deserting will be very different between both individuals, being probably more related to the depression in the individuals with less studies. Thus, we propose the accomplishment of a deductive study with quantitative data that allows approach to this continuation of the research. Finally, and more related to the simulation programme, the following question arises: How to transfer the proposed heuristic simulation to a programme for its use?, and is that a very interesting continuation of our research would be to apply in a programme the proposed heuristic simulations. We propose to apply it with R software, in order to become a further download package for future researchers. The best way to do it is through a programmer that allows correcting possible difficulties in real time and advising on the best way to present the programme. We must remember that the final goal of the simulation package to be used, for example, in the R software must be very intuitive and easy, as it should be used by individuals without high computer skills.





## INTERVIEW PROTOCOL

### A.1 Research question during the interviews:

Can the worker's emotional states be identified before the organizational changes according to the five states of grief of Kübler-Ross (1969)?

### A.2 General purpose:

We want to know the relation between the organizational changes and the emotions of its workers to anticipate its possible consequences.

### A.3 Specific objectives:

The identification of the different emotional states of the individual during an organizational change when it is perceived as negative.

### A.4 Kind of interview:

- Directivity: Directed interview.
- Structuring: Semi-structured interview.
- Kind of research: University research.
- Participants: Individual.

## A.5 Selection criteria of the sample:

- The individuals have minimum one year seniority in the company when they experimented the negative changes.
- The individuals have not spent more than three years since the start of the negative changes.
- The organization where the individual(s) experimented the changes is located in Spain.

## A.6 Sample:

The final sample consists of fifteen individuals from different professional backgrounds, who acknowledged to have gone through an organizational change perceived as negative. More specifically, the final sample is formed by five individuals working in a company that served the public sector (cases A, B, C, D and E), five individuals working in a company (cases F, G, H, I and J) and five other individuals working in the public sector (cases K, L, M, N and O). The cases N and O working at a public university.

## A.7 Interviewer checklist during the interview:

- **For the identification of the denial state:**
  - ☐ Behaviour at the beginning of the change.
  - ☐ Behaviour with social environment at the beginning of the change.
  - ☐ Behaviour of co-workers during the change.
  - ☐ Behaviour of friends and family during the change.
  - ☐ Behaviour of supervisors / managers during the change.
  - ☐ Opinion on the change at the beginning of this one.
  - ☐ Emotions when the individual knows about changes.
  - ☐ Help elements used at the beginning of the change.
  - ☐ Motivation and work performance in the organization before the change.
  - ☐ Motivation and work performance in the organization just at the moment of knowing the changes.
- **For the identification of the anger state:**
  - ☐ Behaviour after a time to know the changes.
  - ☐ Behaviour with social environment after a time of knowing the changes.
  - ☐ Behaviour of co-workers during the change.
  - ☐ Behaviour of friends and family during the change.
  - ☐ Behaviour of supervisors / managers during the change.
  - ☐ Opinion on the change after a time of knowing it.
  - ☐ Emotions soon to coexist with the changes.
  - ☐ Help elements used shortly to know the changes.
  - ☐ Motivation and work performance in the organization soon to know the changes.

#### A.7. INTERVIEWER CHECKLIST DURING THE INTERVIEW:

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- **For the identification of the bargaining state:**

- ☐ Point of inflection: from the anger of the change to try to leave it.
- ☐ Behaviour with social environment during the inflection point.
- ☐ Behaviour of co-workers during the change.
- ☐ Behaviour of friends and family during the change.
- ☐ Behaviour of supervisors / managers during the change.
- ☐ Opinion on the change during the turning point.
- ☐ Emotions during the inflection point.
- ☐ Help elements used during the tipping point.
- ☐ Motivation and work performance in the organization during the turning point.

- **For the identification of the depression state**

- ☐ Relapse to discouragement after a period of bargaining.
- ☐ Behaviour with social environment during a relapse period.
- ☐ Behaviour of the co-workers during the change.
- ☐ Behaviour of friends and family during the change.
- ☐ Behaviour of supervisors / managers during the change.
- ☐ Opinion on the change during relapse.
- ☐ Emotions during the relapse.
- ☐ Help elements used during the relapse.
- ☐ Motivation and work performance in the organization during the relapse.

- **For the identification of the acceptance state:**

- ☐ Feeling of acceptance or resignation to change.
- ☐ Behaviour with social environment during a period of acceptance.
- ☐ Behaviour of the co-workers during the change.
- ☐ Behaviour of friends and family during the change.
- ☐ Behaviour of supervisors / managers during the change.
- ☐ Opinion on the change during the acceptance.
- ☐ Emotions during the acceptance.
- ☐ Aid elements used during the acceptance.
- ☐ Motivation and work performance in the company during the acceptance.
- ☐ Understand the changes.





## MATRIX OF INCREMENTS AND DECREMENTS

Matrix of increments and decrements based on Equation 4.15 for the Friendship relationship when the individual is in the emotional state of bargaining (E2):

$$(B.1) \quad M_{IFE_2} = \begin{pmatrix} 0.02 & -0.005 & -0.005 & -0.005 & 0 & -0.005 \\ -0.010 & 0.04 & -0.010 & -0.010 & 0 & -0.010 \\ -0.005 & -0.005 & 0.02 & -0.005 & 0 & -0.005 \\ -0.005 & -0.005 & -0.005 & 0.02 & 0 & -0.005 \\ -0.005 & -0.005 & -0.005 & 0.02 & 0 & -0.005 \\ -0.005 & -0.005 & -0.005 & -0.005 & 0 & 0.02 \end{pmatrix} \begin{matrix} = 0 \\ = 0 \\ = 0 \\ = 0 \\ = 0 \\ = 0 \end{matrix}$$

Matrix of increments and decrements based on Equation 4.15 for the Friendship relationship when the individual is in the emotional state of depression (E3):

$$(B.2) \quad M_{IFE_3} = \begin{pmatrix} 0.02 & -0.005 & -0.005 & -0.005 & 0 & -0.005 \\ -0.005 & 0.02 & -0.005 & -0.005 & 0 & -0.005 \\ -0.010 & -0.010 & 0.04 & -0.010 & 0 & -0.010 \\ -0.005 & -0.005 & -0.005 & 0.02 & 0 & -0.005 \\ -0.005 & -0.005 & -0.005 & 0.02 & 0 & -0.005 \\ -0.005 & -0.005 & -0.005 & -0.005 & 0 & 0.02 \end{pmatrix} \begin{matrix} = 0 \\ = 0 \\ = 0 \\ = 0 \\ = 0 \\ = 0 \end{matrix}$$

Matrix of increments and decrements based on Equation 4.15 for the Friendship relationship when the individual is in the emotional state of revising (E4):

$$(B.3) \quad M_{IFE_4} = \begin{pmatrix} 0.02 & -0.005 & -0.005 & -0.005 & -0.005 & 0 \\ -0.005 & 0.02 & -0.005 & -0.005 & -0.005 & 0 \\ -0.005 & -0.005 & 0.02 & -0.005 & -0.005 & 0 \\ -0.010 & -0.010 & -0.010 & 0.04 & -0.010 & 0 \\ -0.005 & -0.005 & -0.005 & -0.005 & 0.02 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix} \begin{matrix} = 0 \\ = 0 \\ = 0 \\ = 0 \\ = 0 \\ = 0 \end{matrix}$$

Matrix of increments and decrements based on Equation 4.15 for the Friendship relationship when the individual is in the emotional state of deserting (E5):

$$(B.4) \quad M_{IFE_5} = \begin{pmatrix} 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix} \begin{matrix} = 0 \\ = 0 \\ = 0 \\ = 0 \\ = 0 \\ = 0 \end{matrix}$$

Matrix of increments and decrements based on Equation 4.15 for the Friendship relationship when the individual is in the emotional state of acceptance (E6):

$$(B.5) \quad M_{IFE_6} = \begin{pmatrix} 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix} \begin{matrix} = 0 \\ = 0 \\ = 0 \\ = 0 \\ = 0 \\ = 0 \end{matrix}$$

Matrix of increments and decrements based on Equation 4.15 for the Work-Flow relationship when the individual is in the emotional state of denial and anger (E1):

$$(B.6) \quad M_{IWE_1} = \begin{pmatrix} 0.02 & -(\frac{0.02}{3}) & -(\frac{0.02}{3}) & -(\frac{0.02}{3}) & 0 & 0 \\ -(\frac{0.01}{3}) & 0.01 & -(\frac{0.01}{3}) & -(\frac{0.01}{3}) & 0 & 0 \\ -(\frac{0.01}{3}) & -(\frac{0.01}{3}) & 0.01 & -(\frac{0.01}{3}) & 0 & 0 \\ -(\frac{0.01}{3}) & -(\frac{0.01}{3}) & -(\frac{0.01}{3}) & 0.01 & 0 & 0 \\ -(\frac{0.01}{3}) & -(\frac{0.01}{3}) & -(\frac{0.01}{3}) & 0.01 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix} \begin{matrix} = 0 \\ = 0 \\ = 0 \\ = 0 \\ = 0 \\ = 0 \end{matrix}$$

Matrix of increments and decrements based on Equation 4.15 for the Work-Flow relationship when the individual is in the emotional state of bargaining (E2):

---


$$(B.7) \quad M_{IWE_2} = \begin{pmatrix} 0.01 & -(\frac{0.01}{4}) & -(\frac{0.01}{4}) & -(\frac{0.01}{4}) & 0 & -(\frac{0.01}{4}) \\ -0.005 & 0.02 & -0.005 & -0.005 & 0 & -0.005 \\ -(\frac{0.01}{4}) & -(\frac{0.01}{4}) & 0.01 & -(\frac{0.01}{4}) & 0 & -(\frac{0.01}{4}) \\ -(\frac{0.01}{4}) & -(\frac{0.01}{4}) & -(\frac{0.01}{4}) & 0.01 & 0 & -(\frac{0.01}{4}) \\ -(\frac{0.01}{4}) & -(\frac{0.01}{4}) & -(\frac{0.01}{4}) & 0.01 & 0 & -(\frac{0.01}{4}) \\ -(\frac{0.01}{4}) & -(\frac{0.01}{4}) & -(\frac{0.01}{4}) & -(\frac{0.01}{4}) & 0 & 0.01 \end{pmatrix} = 0$$

Matrix of increments and decrements based on Equation 4.15 for the Work-Flow relationship when the individual is in the emotional state of depression (E3).

$$(B.8) \quad M_{IWE_3} = \begin{pmatrix} 0.01 & -(\frac{0.01}{4}) & -(\frac{0.01}{4}) & -(\frac{0.01}{4}) & 0 & -(\frac{0.01}{4}) \\ -(\frac{0.01}{4}) & 0.01 & -(\frac{0.01}{4}) & -(\frac{0.01}{4}) & 0 & -(\frac{0.01}{4}) \\ -0.005 & -0.005 & 0.02 & -0.005 & 0 & -0.005 \\ -(\frac{0.01}{4}) & -(\frac{0.01}{4}) & -(\frac{0.01}{4}) & 0.01 & 0 & -(\frac{0.01}{4}) \\ -(\frac{0.01}{4}) & -(\frac{0.01}{4}) & -(\frac{0.01}{4}) & 0.01 & 0 & -(\frac{0.01}{4}) \\ -(\frac{0.01}{4}) & -(\frac{0.01}{4}) & -(\frac{0.01}{4}) & -(\frac{0.01}{4}) & 0 & 0.01 \end{pmatrix} = 0$$

Matrix of increments and decrements based on Equation 4.15 for the Work-Flow relationship when the individual is in the emotional state of revising (E4).

$$(B.9) \quad M_{IWE_4} = \begin{pmatrix} 0.01 & -(\frac{0.01}{4}) & -(\frac{0.01}{4}) & -(\frac{0.01}{4}) & -(\frac{0.01}{4}) & 0 \\ -(\frac{0.01}{4}) & 0.01 & -(\frac{0.01}{4}) & -(\frac{0.01}{4}) & -(\frac{0.01}{4}) & 0 \\ -(\frac{0.01}{4}) & -(\frac{0.01}{4}) & 0.01 & -(\frac{0.01}{4}) & -(\frac{0.01}{4}) & 0 \\ -0.005 & -0.005 & -0.005 & 0.02 & -0.005 & 0 \\ -(\frac{0.01}{4}) & -(\frac{0.01}{4}) & -(\frac{0.01}{4}) & -(\frac{0.01}{4}) & 0.01 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix} = 0$$

Matrix of increments and decrements based on Equation 4.15 for the Work-Flow relationship when the individual is in the emotional state of deserting (E5).

$$(B.10) \quad M_{IWE_5} = \begin{pmatrix} 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix} = 0$$

Matrix of increments and decrements based on Equation 4.15 for the Work-Flow relationship when the individual is in the emotional state of acceptance (E6).

$$(B.11) \quad M_{IWE_6} = \begin{pmatrix} 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix} \begin{matrix} =0 \\ =0 \\ =0 \\ =0 \\ =0 \\ =0 \end{matrix}$$



## R PROGRAM FOR THE SIMULATION EXAMPLE WITH OUR PROPOSED COMPUTATIONAL MODEL

The following is the code used in the RStudio program for the simulation example used to test the potential of the proposed model in this Ph.D. thesis. Before we start we must take into account that the commands of R presented in **black** correspond to the instructions that have been given to the program while the ones that are **blue** correspond to the results given by the program.

```
install.packages("dplyr")
library(dplyr)
##We have 100 initial states, each one has 100 simulations, so we have 10,000 simulations in
total.
num_sim = 100
num_initStates = 6
num_simTotal = num_sim*num_initStates
#####
## 0. Reading and checking files
#####
#Values of each simulation
vals <- readRDS("example_valest.RDS")
str(vals)
List of 2
$ valors: num [1, 1:6] 36.62 4.88 5.12 16.12 1.35 ...
.. attr(*, "dimnames")=List of 2
.. ..$ : NULL .. ..$ : chr [1:6] "m_iters" "m_f5" "m_f6" "sd_iters" ...
$ estats:Classes 'data.table' and 'data.frame': 100 obs. of 4 variables:
..$ ID : int [1:100] 1 1 1 1 1 1 1 1 1 1 ...
```

## APPENDIX C. R PROGRAM FOR THE SIMULATION EXAMPLE WITH OUR PROPOSED COMPUTATIONAL MODEL

---

```
..$ iters: num [1:100] 19 59 27 34 48 40 37 24 24 15 ...
..$ f5 : num [1:100] 5 4 6 5 4 6 5 5 7 6 ...
..$ f6 : num [1:100] 5 6 4 5 6 4 5 5 3 4 ...
.. attr(*, "internal.selfref")=<externalptr>
```

```
str (vals$valors)
num [1, 1:6] 36.62 4.88 5.12 16.12 1.35 ...
- attr(*, "dimnames")=List of 2 ..$ : NULL ..$ : chr [1:6] "m_iters" "m_f5" "m_f6" "sd_iters" ...
vals$valors
m_iters m_f5 m_f6 sd_iters sd_f5 sd_f6
[1,] 36.62 4.88 5.12 16.12375 1.350496 1.350496
str (vals$estats)
Classes 'data.table' and 'data.frame': 100 obs. of 4 variables:
 $ ID : int 1 1 1 1 1 1 1 1 1 1 ...
 $ iters: num 19 59 27 34 48 40 37 24 24 15 ...
 $ f5 : num 5 4 6 5 4 6 5 5 7 6 ...
 $ f6 : num 5 6 4 5 6 4 5 5 3 4 ...
 attr(*, "internal.selfref")=<externalptr>
head(vals$estats)
```

	ID	iters	f5	f6
1	1	19	5	5
2	1	59	4	6
3	1	27	6	4
4	1	34	5	5
5	1	48	4	6
6	1	40	6	4

```
tail(vals$estats))
```

	ID	iters	f5	f6
95	1	27	3	7
96	1	53	5	5
97	1	40	8	2
98	1	32	5	5
99	1	49	5	5
100	1	21	7	3

```
# Graphs
graphs <- readRDS("example_graphs.RDS")
str (graphs)
```

```
List of 2
```

---

```

$ graph.cow:List of 10
..$: num 10
..$: logi FALSE
..$: num [1:18] 1 3 6 5 6 5 6 8 9 6 ...
..$: num [1:18] 0 0 0 1 1 4 4 4 4 5 ...
..$: num [1:18] 0 1 11 3 5 2 4 6 9 12 ...
..$: num [1:18] 0 1 2 3 4 11 12 13 17 5 ...
..$: num [1:11] 0 0 1 1 3 3 5 9 11 14 ...
..$: num [1:11] 0 3 5 8 9 13 15 15 17 18 ...
..$:List of 4
.. ..$: num [1:3] 1 0 1
.. ..$: Named list()
.. ..$: list()
.. ..$: list()
..$:<environment: 0x10cd48fc8>
..- attr(*, "class")= chr "igraph"
$ graph.sup:List of 10
..$: num 10
..$: logi FALSE
..$: num [1:9] 1 2 3 4 5 6 7 8 9
..$: num [1:9] 0 0 0 1 1 1 2 2 3
..$: num [1:9] 0 1 2 3 4 5 6 7 8
..$: num [1:9] 0 1 2 3 4 5 6 7 8
..$: num [1:11] 0 0 1 2 3 4 5 6 7 8 ...
..$: num [1:11] 0 3 6 8 9 9 9 9 9 9 ...
..$:List of 4
.. ..$: num [1:3] 1 0 1
.. ..$: Named list()
.. ..$: list()
.. ..$: list()
..$:<environment: 0x10cd48c28>
..- attr(*, "class")= chr "igraph"

```

```

# All data of simulations
## estin: estado inicial
allData <- readRDS("example_all.RDS")
str(allData)
'data.frame': 413338 obs. of 13 variables:
 $ 1 : int 1 2 3 4 4 5 5 5 5 5 ...
 $ 2 : int 1 1 3 3 4 4 5 5 5 5 ...
 $ 3 : int 5 5 5 5 5 5 5 5 5 5 ...
 $ 4 : int 3 3 6 6 6 6 6 6 6 6 ...
 $ 5 : int 6 6 6 6 6 6 6 6 6 6 ...

```



# APPENDIX C. R PROGRAM FOR THE SIMULATION EXAMPLE WITH OUR PROPOSED COMPUTATIONAL MODEL

```
$ 6 : int 6 6 6 6 6 6 6 6 6 ...
$ 7 : int 1 1 2 2 1 1 2 2 2 3 ...
$ 8 : int 1 1 3 2 1 3 1 1 1 1 ...
$ 9 : int 2 2 2 2 2 2 2 3 4 4 ...
$ 10 : int 2 2 2 1 2 2 4 3 4 5 ...
$ iter : chr "0" "1" "2" "3" ...
$ sim : int 1 1 1 1 1 1 1 1 1 1 ...
$ estin: int 1 1 1 1 1 1 1 1 1 1 ...
```

```
allData$iter <- as.integer(allData$iter)
head(allData)
```

	1	2	3	4	5	6	7	8	9	10	iter	sim	estin
1	1	1	5	3	6	6	1	1	2	2	0	1	1
2	2	1	5	3	6	6	1	1	2	2	1	1	1
3	3	3	5	6	6	6	2	3	2	2	2	1	1
4	4	3	5	6	6	6	2	2	2	1	3	1	1
5	4	4	5	6	6	6	1	1	2	2	4	1	1
6	5	4	5	6	6	6	1	3	2	2	5	1	1

```
tail(allData)
```

	1	2	3	4	5	6	7	8	9	10	iter	sim	estin	
41333	3	6	5	6	6	5	6	5	1	6	5	77	10000	100
41333	4	6	5	6	6	5	6	5	1	6	5	78	10000	100
41333	5	6	5	6	6	5	6	5	1	6	5	79	10000	100
41333	6	6	5	6	6	5	6	5	4	6	5	80	10000	100
41333	7	6	5	6	6	5	6	5	3	6	5	81	10000	100
41333	8	6	5	6	6	5	6	5	6	6	5	82	10000	100

```
#####
## 1. Number of iterations
#####
# average of the number of iterations
vals$valors[1]
[1] 36.62
# SD of the number of iterations
vals$valors[4]
[1] 16.12375
# histogram of the number of iterations
hist (vals$stats$iters)
#####
## 2. Number of states f5 at the end
```

---

```
#####
# average of the number of states f5 at the end
vals$valors[2]
[1] 4.88
# SD of the number of states f5 at the end
vals$valors[5]
[1] 1.350496
# histogram of the number of states f5 at the end
hist (vals$estats$f5)
#####
## 3. Number of states f6 at the end
#####
# average of the number of states f6 at the end
vals$valors[3]
[1] 5.12
# SD of the number of states f6 at the end
vals$valors[6]
[1] 1.350496
# histogram of the number of states f6 at the end
hist (vals$estats$f6)
#####
## 4. Evolution of the states in each nodes (TOTAL)
#####
#####
## Evolution of the nodes: state in each iteration
#####
myInitialState <- 1
myInitialSim <- (myInitialState-1)* num_sim + 1
par(mfrow=c(2,5), oma = c(0, 0, 2, 0))
sapply (1:10, function (x) plot (1:nrow(filter (allData, sim == myInitialSim & estin == myInitial-
State)), t(as.vector (filter (allData, sim == myInitialSim & estin == myInitialState) %>% select
(x))), type = "l", col = "red", xlab = "Iteration", ylab = "State", ylim = c(1,6), main = paste ("Indi-
vidual",as.character(x)))) mtext("Evolution of each individual over iteration", outer = TRUE,
cex = 1.5)
#####
## Evolution of the states: number of nodes in each iteration (TOTAL)
#####
par(mfrow=c(1,1))
max_iter <- max (select (allData, iter))
#This is not necessary because from 50 is residual
max_iter <- 50
tableAll <- sapply(0:max_iter, function(x)
table (filter (allData, iter == x) %>% select (1:10) %>% data.matrix ) / nrow (filter (allData, iter
```

```

== x)))
plot (0:max_iter, tableAll[1,], type="l", col = 1, main = "Evolution of states", ylab = "Average
number of individuals", xlab = "Number of iteration")
textLegend <- c("E1", "E2", "E3", "E4", "E5", "E6")
legend(list(x = max_iter-10,y = 3.5), textLegend, pch =1, col = 1:6)
sapply (2:6, function(x) lines (0:max_iter, tableAll[x,], type="l", col = x))
#We zoom in on the initial transient state
max_iter <- 10
plot (0:max_iter, tableAll[1,1:(max_iter+1)], type="l", col = 1, ylim = c(0,7), main = "Evolution of
states (Transient)", ylab = "Average number of individuals", xlab = "Number of iteration")
textLegend <- c("E1", "E2", "E3", "E4", "E5", "E6")
legend(list(x = max_iter-2,y = 7), textLegend, pch =1, col = 1:6)
sapply (2:6, function(x) lines (0:max_iter, tableAll[x,1:(max_iter+1)], type="l", col = x))
#####
## Evolution of the states: number of nodes in each iteration (in the fist initial state)
#####
myInitialState <- 1
max_iter <- max (filter (allData, estin == myInitialState) %>% select (iter))
# This is not necessary because from 50 is residual
max_iter <- 50
tableAll <- sapply(0:max_iter, function(x)
table (filter (allData, iter == x & estin == myInitialState) %>% select (1:10) %>% data.matrix ) /
nrow (filter (allData, iter == x & estin == myInitialState)))
myTableAll <- matrix (1:(6*(max_iter+1)), nrow = 6)
myTableAll <- transformMatrix ()
plot (0:max_iter, myTableAll[1,], type="l", col = 1, ylim = c(0,5), main = "Evolution of states",
ylab = "Average number of individuals", xlab = "Number of iteration")
textLegend <- c("E1", "E2", "E3", "E4", "E5", "E6")
legend(list(x = 40,y = 3.8), textLegend, pch =1, col = 1:6)
sapply (2:6, function(x) lines (0:max_iter, myTableAll[x,], type="l", col = x))
#We can superimpose other results from initial states
myInitialState <- myInitialState + 1
tableAll <- sapply(0:max_iter, function(x) table (filter (allData, iter == x & estin == myInitial-
State) %>% select (1:10) %>% data.matrix ) / nrow (filter (allData, iter == x & estin == myInitial-
State)))
myTableAll <- transformMatrix ()
sapply (2:6, function(x) lines (0:max_iter, myTableAll[x,], type="l", col = x))
myInitialState <- myInitialState + 1
tableAll <- sapply(0:max_iter, function(x) table (filter (allData, iter == x & estin == myInitial-
State) %>% select (1:10) %>% data.matrix ) / nrow (filter (allData, iter == x & estin == myInitial-
State)))
myTableAll <- transformMatrix ()
sapply (2:6, function(x) lines (0:max_iter, myTableAll[x,], type="l", col = x)) tableAll <- sap-

```

---

```

ply(0:max_iter, function(x) table (filter (allData, iter == x & estin == myInitialState) %>% select
(1:10) %>% data.matrix ) / nrow (filter (allData, iter == x & estin == myInitialState)))
myTableAll <- transformMatrix ()
sapply (2:6, function(x) lines (0:max_iter, myTableAll[x,], type="l", col = x))
#Or we can zoom in to the initial transient state
max_iter <- 10
tableAll <- sapply(0:max_iter, function(x) table (filter (allData, iter == x & estin == myInitial-
State) %>% select (1:10) %>% data.matrix ) / nrow (filter (allData, iter == x & estin == myInitial-
State)))
myTableAll <- matrix (1:(6*(max_iter+1)), nrow = 6)
myTableAll <- transformMatrix ()
plot (0:max_iter, myTableAll[1,1:(max_iter+1)], type="l", col = 1, ylim = c(0,8), main = "Evolu-
tion of states", ylab = "Average number of individuals", xlab = "Number of iteration")
textLegend <- c("E1", "E2", "E3", "E4", "E5", "E6")
legend(list(x = max_iter-2,y = 8), textLegend, pch = 1, col = 1:6)
sapply (2:6, function(x) lines (0:max_iter, myTableAll[x,1:(max_iter+1)], type="l", col = x))
#####
## Functions:
#####
transformMatrix <- function() {#To solve the problems of iterations that have 0 nodes in a
state
for (i in 1:(max_iter+1)) {
if (dim (tableAll[[i]]) <6) {
tmp_j <- 1
tmp_j2 <- 0
for (j in 1:6) {
if (names (tableAll[[i]][j-tmp_j2])==as.character(tmp_j)) {
myTableAll[tmp_j,i] <- as.numeric(tableAll[[i]][j-tmp_j2])
tmp_j <- tmp_j + 1
} else {
myTableAll[tmp_j,i] <- 0
tmp_j <- tmp_j + 1
tmp_j2 <- tmp_j2 + 1
}
}
} else {
myTableAll[i] <- as.matrix
(tableAll[[i]])
}
}
return (myTableAll)
}

```



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