Available online at http://www.journalcra.com

International Journal of Current Research
Vol. 7, Issue, 10, pp.21916-21925, October, 2015

INTERNATIONAL JOURNAL OF CURRENT RESEARCH

ISSN: 0975-833X

REVIEW ARTICLE

THE SYSTEM OF INNOVATION IN THE EDGE OF CHAOS: PROPOSITIONS IN A REGIONAL CASE

[1]Danielle Nunes Pozzo, [2]Uiliam Hahn Biegelmeyer, *[,2]Maria Emilia Camargo, [2]Marta Elisete Ventura da Motta, [2]Tania Craco and [3]Suzana Leitão Russo

[1]Catholic University of Rio Grande do Sul, Graduate Program in Management, Porto Alegre, Brazil
[2]University of Caxias do Sul, Graduate Program in Business Administration, Caxias do Sul, Brazil
[3]Federal University of Sergipe

ARTICLE INFO

Article History:
Received 10th July, 2015
Received in revised form
29th August, 2015
Accepted 25th September, 2015
Published online 31st October, 2015

Key words:

Strategy of the edge of chaos,
System of Innovation,
Innovation.

ABSTRACT

The systems of innovations are sets of agents, politicies, resources and technologies that, articulated, promote one or more innovations, radical or incremental. Besides the individual changes of each agent in the process of innovation, the inter organizational relation creates common management factors between the involved agents. These factors turn out to be an extrinsic result of the relation, guided by the common objective that the parts share. The present article analysis these factors from the theory of the edge of chaos, proposing the application of it to the system of innovation. This proposal has the objective to enlarge the empiric application of the edge of chaos theoretical approach, at the same time that contributes to the comprehension of the systems of innovation. Through the semi-structured interviews with representative agents from the system, in the state of Rio Grande do Sul, in south Brazil, it has obtained information, after crossed with the theoretical reference. The results of the research created propositions about the resources, technologies, politics and learning. It is expected to reply the study in national extent in order to confirm the obtained data in this stage.

Citation: Danielle NunesPozzo, Uiliam Hahn Biegelmeyer, Maria Emilia Camargo, [1]Marta Elisete Ventura da Motta, Tania Craco and Suzana Leitão Russo, 2015. "The system of innovation in the edge of chaos: Propositions in a regional case", *International Journal of Current Research*, 7, (10), 21916-21925.

INTRODUCTION

With the view to make position in the current competitive market, a lot of organizations are looking for differentiation in the perspective of innovation (Nelson, 1993; Coutinho; Ferraz, 1995; Christensen, 2002). According to the Manual of Oslo (Oecd, 2010), the innovation consists in a significant improvement of product (goods or service), process, organizational method or marketing. The innovation, however, does not depend on one person or organization, but an articulated group that could happen. So, an innovation or several innovations come from systems of innovation: set of means agents, politics and technologies, properly articulated with this common objective (Freeman, 1995; Nelson 1993). Attending its purpose of bringing something new applied to the organization generating profit and competitive differential, the system of innovation (SI) carries with it the principle of change, however, the kind of change and in what it consists is not totally knownby the organizations that they are in. In the sense of analysis of change and management of changes in the organizations, it has been using as mean of reflection the theory of edge of chaos, that affirms the organizations oscillate in the edge of chaos, in which it has a constant challenge of looking for the balance between total flexibility and absolute inflexibility from the organizational factors (Brown and Eisenhardt, 1998).

The threshold of chaos, as equilibrium point, has the following characteristics: occurrence of complicated behavior, the existence of basic rules, the necessity of working to maintain this equilibrium, the occurrence of surprises and the occurrence of mistakes, due to slips in the threshold (Brown and Eisenhardt, 1998).

In an organization, such points had already been proposed and analyzed in studies of previous cases, however this approach is still new and it is liable of new explorations (Brown and Eisenhardt, 1998).

Considering the system, the agents need manage their innovations together with the other agents. So, besides the changes that will create in it and the factors that will need to control in the edge of chaos individually, still there will be extrinsic and inter organizational factors shared by the elements, in the intersection that form as a common objective of innovation.

Corresponding author: Maria Emilia Camargo
Catholic University of Rio Grande do Sul, Graduate Program in Management, Porto Alegre, Brazil

In these conditions, the present article proposes to analyze the system of innovation from the perspective of the edge of chaos. It hopes, so, contributes as for the empiric application of the theory of the chaos, as for the deepening of the knowledge about the systems of innovation, theme still not pronounced by the existent studies.

System of innovation

According to the conceptualization from the Manual of Oslo (OECD, 2010), the innovation can be related as goods, as services and process, being possible to innovate as incremental level (significant improvement about something existing) as radical (something inedited in its conception, that comes from several knowledge and previous technology, not constituting a direct increase to a determined previous innovation). Beyond this conceptualization, still could be considered the pragmatic vision from the "4P's" of innovation, from Tidd, Bessant e Pavitt (2008), that categorizes the innovation in product, process, position (changes in the context in that the product or service is inserted) and paradigm (mental underlying models that guide the organization). The systems of innovation, on the other hand, can create innovation in one or more areas, swing between incremental and radical (PAEZ, 2001; NASSIF, 2007).

Lundvall (1992) still proposes the comprehension of the systems of innovation under two perspectives: in a strict way (organizations and institutions involved directly in the search and exploration of innovations) and in a wide way (including parts and aspects from the economic structure and the institutional configuration, that affect the learning and search by the innovation).

The initial conceptualization of systems of innovation firstly showed by List (1841) and defended, between others, by Nelson (1993) and Freeman (1995), considered a national system and it was gradually adjusted to globalized reality. In which refers to environment, Lundvall (1992) emphasizes that, considering the system of innovation a national delimitation, the perspective of nation and culture intersects with the politics characteristics of it, but it is impracticable to isolate it, so that there are external factors, coming from the globalization.

In the same way, Freeman (2002), in a posterior work, attested that the system of innovation goes from the objective of development and it can, in fact, have a different geographic limitation of the national territory, being regional, subcontinental or it has other cutting that justifies the agents' organization to obtain the economic growth. Such premise comes upon Chesbrough (2007) work, who defends the opened innovation – extension of the processof innovation to more organizations, partitioning in levels and optimizing means, exceeding, even, the national barriers –this for definition would increase the quantity of elements to be considered in a system of innovation, as well its way of analysis, that could be or not national.

Locational factors, or local specificities can affect the system's dynamic, so that several wide questions or strict to the system of innovation can explain its development (Lundvall, 1992; Freeman, 2002).

In addition, it is appropriate the Kretzer's (2009) mention about regional systems:

In terms of politics of regional innovation, regional systems involve theunderstanding of evolution of global technological systems or sector systems, that help to define the necessities of coordination and establishmentof supranational rules (Kretzer, 2009).

So, not only the consideration of the regional systems is necessary, but also the sectorial systems. The market segments suffer a great incidence of circumstances specificities, once the agents' behavior and the politics approach can be lineated to attend particular aspects of market (Paez, 2001; Paz *et al*., 2005).

In regard to the agents, Etzkowitz e Leydesdorff (2000) identify the triple helix "university – industry – government" as essential elements in the conception of innovation. In the same direction, reinforce the importance of the politics as empowering of interaction between the human necessities, science, research goals and mean providers (Etzkowitz and Leydesdorff, 2000).

According to Etzkowitz e Leydesdorff (2000), it is possible to mention the consumer as other element of the system of innovation (Paez, 2000). The availability of innovation to the society (List, 1841) and its commercialization are determinant factors to characterize as effective innovation (Oecd, 2010), what reinforces the importance of the consumer agent in the system of dynamic. They are also seeing as agentsproviders, competitors, investment banks and another actors that interact in the creation of knowledge, information and other means (Edquist, 1997).

So, the flow of innovation in the system can start from several agents, equally arising in the construction of shared knowledge (Santos; Solleiro, 2006; Chesbrough, 2007; Kretzer, 2009).

Focusing in the relations, Gregerson e Johnson (1997) emphasized the learning generation as one of the main products of interaction between the agents from the system of innovation. Kretzer (2009) divides it in learning by experience (providing from the development and internal knowledge) and learning by communication (resulting from the information exchange with other agents).

The first categorization connects directly with the proposal development of innovation of the market leaders, who firstly realize the process of innovation internally (Nelson *et al*., 2004). This process *a posteriori* tends to be imitated by the competitors, creating one new market equilibrium and the necessity of new innovations (Nelson *et al*., 2004). The communication learning, on the other hand, reinforce the sets of projects from the several agents, already mentioned by Etzkowitz e Leydesdorff (2000) and can be exemplified by the innovation of opened idea from Chesbrough (2007). From another point of view, Van de Ven (1986) emphasizes possible problems in the management of innovation, as: the human difficulty to manage the attention, obstacles to transform good ideas in commercialized products, structural obstacles in how

to manage the relations "part-all" and difficulty of implementation of a strategic leadership. Such citation is equally fortuitous for understanding of the system's dynamic, once the *performance*of each element – in this case, the companies –given its interrelation, affects the development of all agents (Cooke *et al*., 1997; Freeman, 2002).

Systems of innovation in Brazil

In view of the coverage of the concept of systems of innovation, it is important to review some national works, in a manner to contextualize the environment where the research is inserted.

According to Nassif (2007), the Brazil is in an inferior position even in relation to other countries in evolution when refers to innovation due to the fragility of the implemented politic since the decade of 80, when the country inserted as competitive global agent. The little incentive to innovation, in part occasioned by the inflation and the economic difficulties faced by the country delayed the evolution in the aspect of innovation, even with high potential and technological growth (Nassif, 2007).

In this aspect, the 4ª Science and Technology National Conference shows that, in the last years, the received support to innovation has been grown extensively, as in volume as in incentive areas, in view of the government recognizing in respect of the necessities of growth and national sustainability (Brasil, 2010). The financial factor, as described by Cooke, Uranga e Etxebarria (1997) is determinant to the efficient development of the system.

The Brazil today through the Innovation Law and federal financial programs have gotten to increase the availability of means and technologies, relieving considerable this obstacle to the development of national innovations (Brasil, 2010).

However, Melo (2009) says that, in certain cases, the problem of the Brazilian financing to innovation and research projects is not available, but in the disclosure of the sources and in the bureaucratic obstacles, so that the mean can be available and, even with the demand, not being used by no performance of regulation dispositions of determined program. Lima e Teixeira (2001), on the other hand, contribute for the vision of Brazilian system of innovation since the finding of a fragmented system, in which fomentation, regulation and politics establishment by the govern part and the action of the companies without interaction with all the existent actors is decentralized, creating considerable deficit in the dynamic.

In regard to the agents, besides de triple-helix "university-company-government", Lima e Teixeira (2001) identified the action of an intermediated institution between the university and company as facilitator of these relations, by the induction with initiative of benefice for all the elements and propagation of information, besides the contribution in the related politics. Chaves e Albuquerque (2006), in their turn, emphasized the importance of associations of the segment, class organs and support institutions to the principal members of the system, as influencers and enhancers of the dynamic of information.

The difficulty of interaction between the agents of the systems of innovation is a repeated finding in the national scientific productions, in several sectors and geographic cuttings (Lima; Teixeira, 2001; Chaves; Albuquerque, 2006; Santos; Solleiro, 2006; Souza; Arica, 2006; Tomaél *et al*., 2007; Rauen; Furtado; Cário, 2009). Such obstacle tends to stop the total functioning of the system, once the collaboration between the parts becomes limited (Rauen *et al*., 2009).

One example of the literature for the lack of interaction is the report of Valente e Tomaél (2006) in Londrina, where it was found that, although there is available qualification for the people focusing in local innovation, there is not groups of research in the educational institutions that comes to this qualification, creating an imbalance in the scientific and technological development of the local system. The cooperation between the agents for the compilation of information and results do not seem to be considered important by the agents from the lacteal system of innovation in Brazil, as related by Paz *et al*. (2005). Rauen, Furtado e Cário (2009), in their turn, emphasize as mainly problem in the studied case, the distrust between the agents and the concern about weaken their business by sharing information.

One of the possible solutions for this resistance is in the registries and patents, defended by Alburquerque (1996) as interference mode of the government that can contribute positively in the relations of the system. In a general way, the legislation that allows increase of the security in relation between agents is unexpected for the development of the systems of innovation (Albuquerque, 1996). Santos e Solleiro (2006) reiterate this demand once that, although the investment and the involvement of the agents with the innovation, in special companies, is increasing, the volume of registered patents is still very inferior to scientific productions, that confirm the growing technological development in the country.

Other elapsing risk of barriers in the communication is the formation of groups inside the system, where just one part of the agents act and, in this manner, not all of them have benefits of the means and information coming from the core (Tomaél *et al* ., 2007). Roese (2000) had already verified serious obstacles in the supposed system of innovation in the geographic region in the state of Rio Grande do Sulcalled Serra Gaúcha as result of the disintegration and consequently unlinked actuation of certain agents, but with the same objective. So there is one fragmentation of the system that can create considerable loss of its dynamic and potential growth (Chaves and Albuquerque, 2006).

Other relevant aspect in the interrelation is the difficulty of entrance. Révillione Padula (2008) emphasize that the system of innovation of lacteal gauchos, the big companies already inserted on it, difficult the acceptation of new incomings as strategy of protection. Such hindrance can be indicative of replication in other segments and intrinsically relate as a condition of high competitive edge alerted by Coutinho e Ferraz (1995).

As before exposed, the communication between the agents, for the most several purposes, has shown essential for the success

of the system of innovation (Vargas and Zawislak, 2006; Wolfe, 2001). In the same way, the agents' knowledge that compose the system about its structure become crucial for the establishment of the relations and success, not only for the communication, but for the optimization of the means available in the system (Lima and Teixeira, 2001).

THE EDGE OF CHAOS THEORETICAL APPROACH

Based on the present work, there is the scientific production of Brown e Eisenhardt (2004), taking as central concept of competition in the edge of chaos, the central nucleus the theory in three basis:

1. The edge of chaos: it is described as a natural estate between the order and chaos, a big agreement between the structure and the surprise, there is, the edge of chaos is one kind of semi-structured stage. In this stage the strategies and respective organizations are hard enough that the changes can occur, but, not too rigid that can prevent them. In the edge of chaos, the organizations are never in a stable equilibrium, but do not come down, it is in this intermediate zone that the subsystems reach the top of vibration, of the surprise and the flexibility, causing the emergency of a complex and adaptive behavior. The critical challenge in management level in the edge of chaos is to determine what to organize and what not to organize.
2. Edge of time: the change requires the consideration of the experiences in the past, concentration in the execution of the present and still thinking in the future. The challenge of the edge of time is not to grab to any dimensions of the time, but consider the three at the same time.
3. Control by the time: the change occurs by the passage of the time, and not by the occurrence of the punctual events. The control by the time implies an internal rhythm of change, understanding the force of this rhythm and the importance of the transitions. The challenge of the control by the time is, precisely, in how to define the right rhythm of the change and the transitions.

In the manner of this definition, there is the express concept byMarietto *et al*. (2006), who defines the limit of the chaos as it follows:

The limit of the chaos is the local where there is as emphasis in the competition and adaptation of the existent model as in the creation and development of new models. There is equilibrium of the maintenance, development and innovation (Marietto *et al*., 2006, p.10). According to Stacey (1995), the organizations are complex and adaptive systems, so just can survive, grow and develop in the limit between the order and disorder, there is, functioning in the maximum point of its capacity, under a constant estate of imbalance. This estate out of imbalance is paradoxical, because the behavior is stable enough that the system cannot disintegrate, unstable enough that not to stay stagnant, and both simultaneously interact. According to the author, it is only in this estate, in the edge of chaos, that the system is creative and alive, however if it impends more to the orderly or disorderly estate, the system can disintegrate.

With respect to their intellectual roots, the strategy in the edge of chaos motivates the research about the adaptive complex behavior, evolutionary change and the velocity origin. According to Brown e Eisenhardt (2004), the intellectual roots of the edge of chaos count with two presuppositions. The first of them is that the market is in a constant flow, there is not space to the static equilibrium, but yes to the vision that the competitors come and go. The markets increase and decrease, divide, collide and even finish. The technology changes constantly, because being precursor is important.

The second presupposition is the companies are composed of several parts or agents, when these parts interconnect in the thresholds of the chaos and the time, they form adaptive complex systems. Here, the adjective complex does not refer to some kind of complication, but to a complicated behavior, innovator and self-organized that emerge from them. They are adaptive because they can change with efficiency, adjusting to the obstacles and only based on small number of simple rules.
The attribute of the edge of chaos

According to Brown e Eisenhardt (2004), the edge of chaos consists in the theory of complexity and it serves to show where the systems can change with higher efficiency. These systems that own bigger structure that the one pointed in the edge of chaos are very hard to change. The other ones that own less structure are much disorganized. So, the edge of chaos is not only the anodyne equilibrium between "the very hot and the very cold". Insteadof it, it isthe point that:

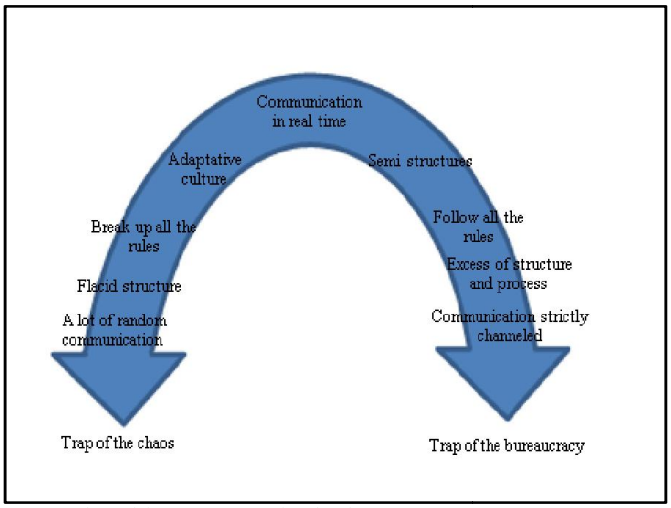
- Complicated behaviors (such as execution and innovation, but not just one or the other) occur. It describes, for example, improvisational music.
- A few rules (like priorities) exist that are not arbitrary and not compromises between extreme values. They are specific rules that can create, for example, the flight of boids.
- Work is required to maintain balance on the edge of chaos because it is a dissipative equilibrium. There is a constant tendency to fall into the attractors of structure and chaos.
- Surprise exists. Expect the unexpected, because control is not tight and because the system is adapting in real-time to unpredictable changes.
- Mistakes occur because systems at the edge of chaos often slip off the edge. But there is also quick recovery and, like jazz musicians who play the wrong note, there is the chance to turn mistakes into advantages (Brown e Eisenhardt, 2004).

Based on these attributes, Brown e Eisenhardt (2004) try to illustrate the fragility of the edge of chaos, expressed through a figure in shape of hyperbole, where the higher point means "stage" where there is the threshold between the chaos and the structure, where the accentuated displacement to any sides, can submit to excess organization of structure or total absence of it. This kind of exceeding accentuated movement can represent, according to the authors, traps of the chaos and the bureaucracy, as it shows in the Picture 1:

Chart 1

Characteristics	Description	Exemplification
Complicatedbehavior	With the execution and innovation, but not only one or other.	The improvisatorymusic
Existence of some rules (priorities)	They are not arbitrary neither are concessions made between extreme values, but specific rules that can create	The flightof*boids*
Necessity of work to maintain the equilibrium	The equilibrium is dissipative - there is a constant tendency to fall down in the attractors of the structure and chaos.	
Incidenceofsurprises	Wait the unexpected, because the control is not rigid and the system adapts itself in real time to unpredictable changes	
Mistakes	The systems in the edge of chaos usually slip in this threshold. But the recuperation is fast.	The jazz musicians who miss a note and transform mistakes in advantages

Source: Adaptedfrom Brown e Eisenhardt, 2004, p.44.



Source: Adapted from Brown e Eisenhardt, 2004, p. 46

Figure 1. The threshold of improvisation

In this sense, according to Brown e Eisenhardt (2004), they explain that the positioning accentually polarized in one side or other, can expose the organization to traps of the chaos or bureaucracy, as they follow:

- Trap of the chaos: the left side of the picture 1, there is the trap of the chaos. The organization can be attracted by an impetus to foment the creativity and in the innovation, with the view to obtain changes. The positive points of this position are to impress in the organization more emotion, vibration, creativity and as result, obtain innovator products and services. However, the setback of the total chaos is the excess of confusion, lateness in relation to the commercialized products and services, quality problems and loss of the competitive or technical positions. These negative factors can menace the strategy of the organization;
- Trap of the bureaucracy: on the right side of the picture 1, there is a trap of the bureaucracy. In this point, the organization is characterized by the search of process, routine and control structuration. The attractors of this position are the obtainment of rigid controls of process and as consequence, larger organizational efficiency. However imprison the organization in process so bureaucratic, can become inflexible, withered of their creative capacities and also, become the strategy of the predictable organization, what is totally unwanted in environments of high competitive edge.

Other concept adapted from Brown e Eisenhardt (2004), for the reality of the strategy, is the dissipative equilibrium. According to this concept brought to this text, the system is not technically in equilibrium, but in organized disequilibrium. The system only will be in stable equilibrium (of low energy) when its potential energy will be minimized. This concept can also be illustrated and visualized in the Picture 1, where the related stable equilibrium, represents for the organization, be positioned in some of the longitudinal poles in stable equilibrium (with low level of energy). However, according to the authors, these states reserve the traps of the chaos and bureaucracy, mentioned before.

According to Brown e Eisenhardt (2004) the most important thing in the approach of the competition in edge of chaos is that the strategy is something resultant of the capacity that the company has to organize to change constantly and to open space for the emergency of a strategic direction from this organization. Starting from this presupposition, it treatsto connect the two parts of the strategy attacking at the same time where it wants to go e the manner to arrive there.

The strategic direction develops in a semicoherent manner and in a distinct form of what traditionally is called strategy. For Brown e Eisenhardt (2004) what distinguishes it, are the follow characteristics:

- Unpredictable: the competition of the edge of chaos evolves the surprise element. The question is not to do an approach plan, knowing before how it is going to unroll. The future is so uncertain for all this precision. The question is much more to take some initiatives, observe what happen and keep the ones that are functioning. Although the past and the future, import, the attention is concentrated in the present.
- Uncontrolled: it does not treat to resort to the precision planning neither to the capture of the principal executives of the company. Simply there are many things happening in the industries that change so fast for that each action be orchestrated for a determined group. What happen in fact is that a lot of people in the company need to take many

initiatives on their own. The competition in the edge of chaos implies to create strategies centered in the level of the own company and not only in the headquarters of the corporation.

- Ineffective: the competition in the edge of chaos is not necessary effective in a short time, it is a strategy that presupposes to insert in wrong markets, commit mistakes, return and go inside the right ones. There is, it implies duplicity, inadequacy and mistake. Sometimes, it also implies the increase of randomness. To compete in the edge of chaos does not mean be the most efficient company or the most profitable in some determined moment. It does not treat to promote the adequacy, but to use the change to reinvent continuously the company, discovering new growth opportunities and let the profit be a consequence.
- Proactive: to compete in the edge of chaos there is nothing to do with expect passively the occasional discontinuation neither expects that the other companies act before taking the initiative. On the contrary, implies act early, trying to anticipate and, always that is possible, leads the change.
- Continue: it treats to print with the time, a rhythm to the actions, and not to act in disjointed and unsystematic manner. The competition in the edge of chaos does not cover little or big isolated initiatives, as the business massive transformations and the mega-fusions, but the recurrent and unceasing change, to become endemic in the company.
- Diversified: finally, to compete in the edge of chaos, it is necessary to take a serial of different initiatives of variable scales and risks. So, the key to a successful performanceis not in only one generic strategy, in a determined competence neither in only one amazing initiative. Instead of it, it consists to create a strong and diversified strategy, which includes several initiatives. Some will be brilliant, the most will be good and some will fail. Brown e Eisenhardt (2004, p.22).

In conclusion the stage of the bibliographic research, Brown e Eisenhardt (2004) defend the maintenance of the estate of edge of chaos, when affirms the organizations that can "surf" in the edge of chaos, there is, always keep in this limit, gets anoutstanding performance, over the industry average and change the strategy according they change the environment conditions. Besides, the companies that can get this effect capitalize the most diversified strategies as from the concurrence because they can change quickly and also used to get over in the discovery of unexplored niche of the market and accumulate competitive advantages, because improvise, create unpredictable products and services and successful.

In a similar way, conclude Marietto *et al*. (2006), affirming that, to compete in complex and dynamic environments, the organizations need to operate in the limitof the chaos, because considering the reality of the complex adaptive systems, it is dangerous being sluggish in the adaptive process to the environment, to respond the environmental transformations, as being excessive in the process of innovation, in the provocation of changes in the environment.

Marietto *et al*. (2006) still complement that when act in the edge of chaos, the organizations can be excellent competitors and excellent developers. In this manner, having a strategy is not enough for an organization. The organization in the reality needs strategic alternatives. The authors explain that this variety of strategies are the basic tools to the innovation and the adaptive process. In the reality the organizations need to compete in advantage in the selected position and develop new way of advantage, adapting or implying directly in the market by means of innovation.

METHODOLOGY

As before exposed, the systems of innovation own specificities, that are related to environmental factors in which it is inserted, as the cutting (sector and comprehensiveness) in which is related (Freeman, 2002). In these conditions, it is necessary delineate a universe of system.

By convenience, the authors defined by analyzing the regional system of innovation, covering thus, situated elements in the state of Rio Grande do Sul. The initial proposal glimpsed by the authors consisted in the definition of a sectorial cutting. However, in a way to provide an analysis more embracing, only the geographic design was sustained.

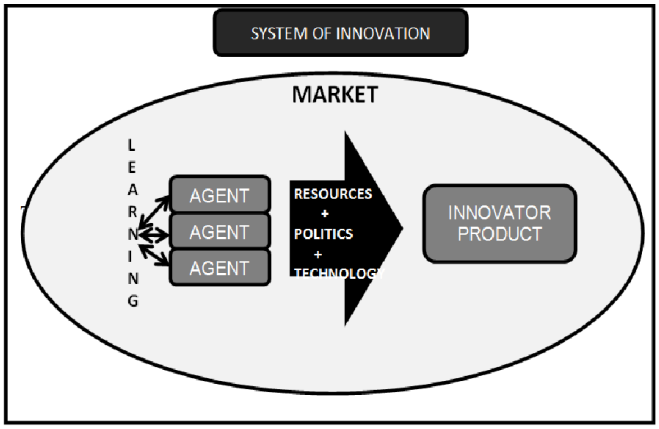
There was an interview with individuals representative of areas related to innovation in a university (Pontifical Catholic University from RS – PUCRS), in the state government (Science, Innovation and Development Technological Secretariat from the State of Rio Grande do Sul – SCT) and in the part of class in the local industries (Industries Federation of Rio Grande do Sul – FIERGS), with the view to obtain different expectations of the system, without necessarily focus in an industry or specific segment. Through the semi-structured interviews, the individuals were questioned about their positioning in the innovations, characteristics of the relations, research and development and obstacles of the system.

In a second stage, the data of the field were categorized according to the method of investigation, reduction, presentation and verification from Miles e Huberman (1994) correlated as theoretical reference, so that to provide satisfactory subsidies to the composition of the analysis according to the theory of the edge of chaos. The research, with qualitative character, provided a considerable volume of material. Its content was strictly reduced to attend the goal of this article and the presentation of the results will be applied to the analysis, not being viable the transcription of the interviews.

Analysis: the system of innovation in the edge of chaos

As it was before exhibited, the system of innovation has as elements the agents, the politics, the resources and the technologies (FREEMAN, 1995). In the communication between the agents, still emerges the perspective of learning, leaving from the shared knowledge gives the origin to one or more innovations (GREGERSON; JOHNSON, 1997).

For a better comprehension of this scenery, it is shown in the picture 2 below:



SOURCE, the author

Figure 2. System of innovation

Thus, the results of this research will be analyzed according to these dimensions.

In relation to politics, the ones that are intrinsically connected with the interaction between the agents and the dynamic characteristics of the system, the edge of chaos consists rightly in the maintenance of the condition of the articulated interaction, where all the agents relate with moderate flexibility. As it was provided in Brown and Eisenhardt's (2004) model, there are basic rules of behavior between the agents, as the process' documentations and the clarification of the participation of each element in all. There is also congruent to the model the appearance of surprises, circumstances not provided in the previous agreement between the parts that demand articulation to keep the equilibrium, other premise brought by the edge of chaos.

The occurrence of complicated behavior raised by Brown e Eisenhardt (2004) is shown in the system through the variety of elements: although the common objective of innovation, the agents own different goals and contexts, what generate obstacles, once in some moments, each agent search predominantly to bring advantages for oneself in detriment of the group.

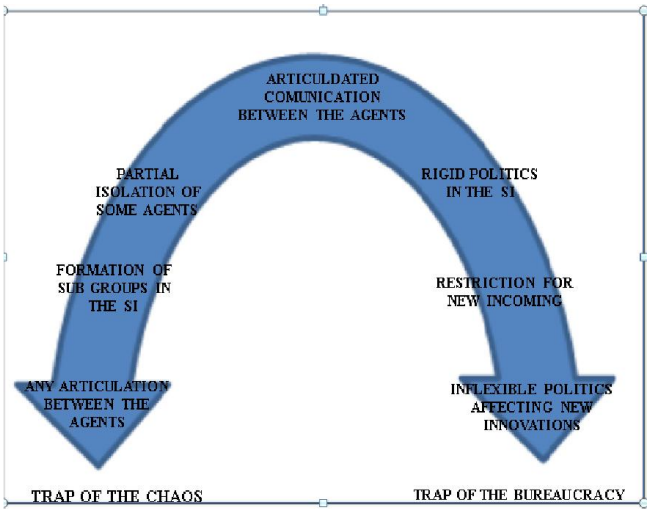
The last distinctive aspect in the threshold, the mistakes make part of each organizational context. In the application of the system, the mistake is more perceived by the interviewee in the constructions of agreement and plans of innovation, because, once the scenery of changes is not totally mapped, preview combinations cannot include crucial points and demand posterior corrections. Even the new rules or inserted agreements in the politics of the system of innovation be established, the system suffer with the mistakes of the previous organization.

Advancing to the trap of the chaos, the first aspect shown in the literature and reinforced in field is the partial isolation of some agents. It gives in big part to the ignorance from the agents that make part of the system by the own agents. The uncertainty of their function can create obstacles to innovation. In the same direction, the creation of sub-groups become a more advanced stage in the dissociation of the elements and fragmentation of the system, where the agents put themselves in separated groups inside the same objective of innovation and only collaborate inside a smaller set. Besides causing parallel researches and waste of resources, technologies and learning, the sub-groups only articulate in an intrinsic form, avoiding the politics of the system as a whole.

Such condition takes to the extreme the trap of the chaos: the sub-groups, tapering increasingly can take to the absolute isolation of the agents in their personal interests, not existing articulation, what would totally mischaracterize the concept of system.

In the opposite way, the rigid politics in the system of innovation can tend to the trap of the bureaucracy, once the flexibility shows itself necessary when there is no certainty of the scenery post changes. The restrictions created for the new incoming, already referenced in the Brazilian works, had been repeated in the interviews and constitute one point in front of the trap of the bureaucracy, once the excess of requirements can avoid the entrance of a new essential element for the development of the system or even the achievement of a specific innovation. The politics, in this case, would let rigid the new interaction, what takes to the upshot of the trap of the chaos: the excess of rigidity of the politics affecting new innovations or even preventing that determined innovation be obtained by the system in question.

In order to illustrate the analysis of the edge of chaos for the politics and interactions, it is shown the picture 3 that follows, explaining the points discussed before.



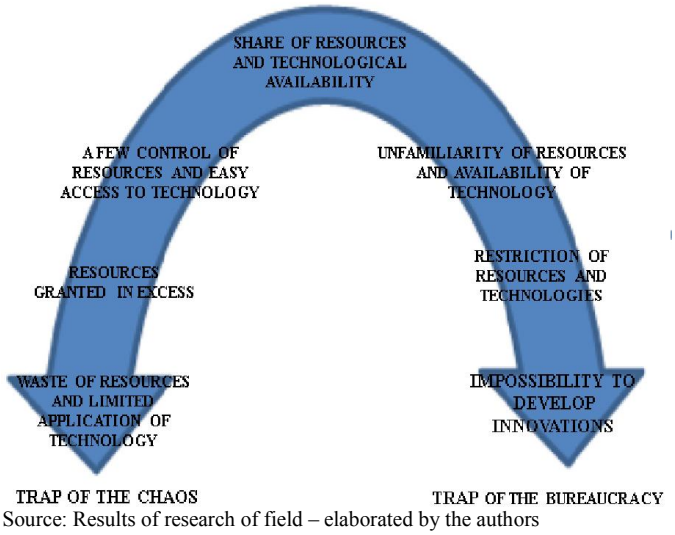
Source: Results of the research of field – Elaborated by the authors

Figure 3. Edge of chaos: politics and interaction

The second perspective of analysis, defined as "resources and Technologies", involves two distinct elements of the concept of SI, the ones that were aggregated in only one dimension due to the congruence of their results, when considered in the vision of the edge of chaos. It is understood by resources the tangible and the intangible, being included the financial resources, qualified people, machinery, infrastructure and others that come to converge to the objective of the system in question. Technologies, on the other hand, are taken here as intermediate where one can obtain the innovation, transformed knowledge in tools.

The edge of chaos, following the same perspective of the previous model, is the flexible articulation, in this case represented by the share of resources and technologies by the agents of the system. The chaos has as first stage the little control of resources and the easy access to technology, what can take to a less conscious use of the available contingent. The conception of resources in excess – being these propitiated by government agencies or private companies – can be shown as deficiency of individual management or system's governance, that takes to the culminant point of the trap of the chaos: the waste of resources and the limited application of the technology due the bad exploration of the same.

In the opposite way, the bureaucracy starts with the ignorance of resources and available technologies. This point, actually, expresses the available tools that are not rightly revealed or directed, as financing federal notices that are not tightly indicated to the interested ones. This condition takes to a restriction of resources and technologies, second stage, once lots of the available demand execution of bureaucratic requirements that can limit the access because of the agents of a system of innovation. The critical point of the bureaucracy for this dimension would be the impossibility to develop new innovations due to the lack of access to the necessary resources and technologies to enable them. The following picture shows the discussions of these dimensions, in a manner to facilitate the comprehension of this dimension and its comparison as the previous one.



Source: Results of research of field – elaborated by the authors

Figure 4. Edge of chaos: Resources and technologies

As politics, resources and technologies, the learning, although it is not inserted in the concept of system, it is a fundamental aspect of its analysis and, considering innovation part of the learning, it is also subjected to analysis in the perspective in the edge of chaos.

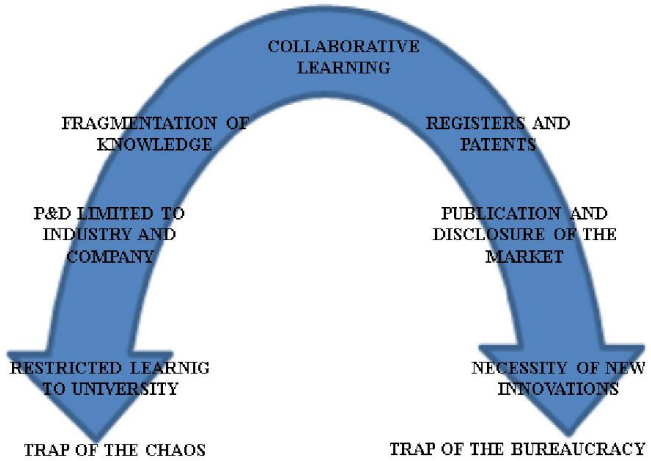
Following the perspectives of the previous dimensions, the collaborative learning is the point in the edge of chaos, once it is the result of the articulated interaction and the share of resources and technologies between the agents of the system.

The chaos starts in the fragmentation of the knowledge, when the agents start to work and learn total or partially dissociated from the rest of the system what approaches of the scenery pictured by the interviewee in the regional system. The research and the development (R&D) only isolated in the university and in the industry developer of the final product is the second step to the chaos, hatching in the restricted learning to university. With the loss of the collaboration, it can also occur the devaluation of this practice, in a manner the learning comes to be isolated inside the education and research institution. This condition would unfeasible the necessary learning for the generation of innovations, besides disrupt the system of innovation by itself.

The bureaucracy on the other hand starts to take force from the registers and patents that, while they are necessary to assure property of determined knowledge, it can move away the agents due to the competition inside the own system. Besides in a small number in Brazil, the literature shows the patents are already seeing as a protection that the agents develop and this bureaucratic shield can equally take to the decrease of the collaboration between the interested parts.

The publications and disclosures of market, as the setting of the product to sell, are bureaucratic traps once the innovation when it goes to the market has on itself marketing interests and it needs to be recognized as from determined company (or companies) that can propitiate the differentiation of the market as it is desired.

However, the disclosure opens the space to popularization of that learning, and with the time tends to transform the innovation into something trivial, taking to the critic point: the necessity of new innovations from the new learning.



Source: Results of research of field – elaborated by the authors

Figure 5. Edge of chaos: Learning

Although different, the three dimensions of analysis take the comprehension of aspects of the system that intersect in a manner to create unique scenery. So, the position about the resources and technologies tend to impact in the learning condition and in the present politics in the system and vice versa.

Final considerations

The present article shows the analysis of the systems of innovation under the perspective of the edge of chaos, from the system of innovation in the state of Rio Grande do Sul. They were identified, through the referential correlation *versus* the field results the analysis dimensions: resources and technologies, learning and politics and interaction. In order to evidence the relation between the theory and the results, it was used the same representation as Brown e Eisenhardt (2004), that consists in a parable where the central point is the edge of chaos and the aspects that advance to the extreme, the traps of the chaos and the bureaucracy. Although it was defined separated dimensions, the considerations of each category impact each other, making together a panorama of analysis of the system of innovation under the vision of the edge of chaos theory.

A relevant finding is that the three parables showed, in their extreme point of the bureaucracy, contain propositions that require, prohibits or limit the innovation, what call the attention to the necessity of keeping flexible the systems of innovation. The chaos, on the other hand, owns in the extreme factors that illustrate the total fragmentation of the system, there is, the inexistence of the system on its basic concept, once there is not the articulation between the factors.

The perspective of the system of innovation in Brazil, as it was shown in the theoretical review reinforced by the interviewee, is still in formation. In this manner, the considerations should be seeing in their transversal perspective, there is, a picture of the present. A longitudinal study, even in a short period could provide considerable different information, once that recently it was not discussed innovation in Brazil as it is done nowadays and the perspectives – in special stimulated by the competitive global scenery each time more persistent are in a big development in a short time. One important limitation of the research is the geographic cutting. According to what was showed by the theoretical reference, specificities of the system can impact in its dynamic and composition, in a manner the parables could contain additional aspects or different from the ones discussed. So, it is not possible to say that a research in other Brazilian state or even out of the country could obtain similar results.

Besides the definition of the state, the choices of the agents can also impact in the results. Even the researches, the information contain the interviewee biases, in a manner there is risk of "evidences contamination". Some more deep studies to comprehension, as the local system, as their parts, are suggested.

Similarly, other applications for the theory of the edge of chaos still keep opened, even in the field of the analysis discussed. It is relevant the promotion of the future researches for the extension of the theoretical relation with practice in the systems of innovation.

REFERENCES

Albuquerque, Eduardo M. Sistemas nacionais de inovação e direitos de propriedade industrial: notas introdutórias a um debate necessário. Estudos Econômicos, v. 26, n. 2, maio-agosto, 1996, p. 171-200.

Brasil. Ministério da Ciência e Tecnologia. Plenária 2: O papel da inovação na agenda empresarial. In: Conferência Nacional de Ciência e Tecnologia, 4, Brasília, 2010. Disponível em: <http://cncti4.cgee.org.br/index.php/banco-de documentos/cat_view/60-4o-conferencia-nacional-de-ctai-2010/103-cadernos-da-conferencia>. Acesso em: 07-12-2010.

Brown, S. L.; Eisenhardt, K. M. Estratégia competitiva no limiar do caos: uma visão dinâmica para as transformações corporativas. São Paulo: Cultrix, 2004.

Chaves, Catari V.; Albuquerque, Eduardo M. Desconexão no sistema de inovação no setor saúde: uma avaliação preliminar do caso brasileiro a partir de estatísticas de patentes e artigos. RevistaEconomiaAplicada, v. 10, n. 4, outubro-dezembro, 2006, p. 523-539.

Chesbrough, Henry W. Why companies should have open business models. *MIT Sloan Management Review*. v. 48, n. 2, 2007. p. 21-28.

Christensen, Clayton M. The rules of innovation. *Technology Review*, v.105, n.5, p.32-38, 2002.

Cooke, Philip; Uranga, Mikel G.; Etxebarria, Goio. Regional innovation systems: Institutional and organisational dimensions. *Research Policy*, v. 26, 1997. p. 475-491.

Coutinho, Luciano (Coord.); FERRAZ, João Carlos. Estudo da competitividade da indústria brasileira.4. ed.Campinas: Papirus, 1995. 510 p.

Edquist, Charles. Systems of innovation approaches: their emergence and characteristics. In: Systems of innovation technologies, institutions and organization. London, 1997. p. 1-35.

Etzkowitz, Henry; Leydesdorff, Loet. The dynamics of innovation: from National Systems and ''Mode 2'' to a Triple Helix of university–industry–government relations. *Research Policy*, v. 29, 2000, p. 109–123.

Freeman, C. Continental, national and sub-national innovation systems-complementary and economic growth. *Research Policy*, v. 31, 2002. p. 191-211.

Freeman, C. The National System of Innovation in historical perspective. Cambridge Journal of Economics, v. 19, 1995. P. 5-24.

Gregersen, B.; Johnson, B. Learning economies, innovation systems and european integration. *Regional Studies,* v. 31, n. 5, 1997, p. 479-490.

Inovação e o diamante de Porter na abordagem de arranjos produtivos locais. Produção, v. 16,n. 1, Jan./Abr, 2006. p. 080-087.

Kretzer, Jucélio. Sistemas de inovação: as contribuições das abordagens nacionais e regionais ou locais. Ensaios FEE, Porto Alegre, v. 30, n. 2, dez. 2009. p. 863-892.

Lima, Marcos C.; Teixeira, Francisco L. C. Inserção de um agente indutor da relação universidade-empresa em sistema de inovação fragmentado. Revista de Administração Contemporânea (RAC), v. 5, n. 2, Maio/Ago, 2001. p. 135-155.

List, Friedrich.The national system of political economy. London: Longman, 1841. 310p.

Lundvall, Bengt-Åke (ed.). National systems of innovation – toward a teory of innovation and interactive learning. London: Pinter, 1992. 342 p.

Marietto, M.; Meireles, M.; Sanches, C.; Silva, O.R. Teoria do Caos: Uma Contribuição para a Formação de Estratégias. Anais do XXX Enanpad, Salvador: Anpad, 2006.

Melo, Luiz M. Financiamento à Inovação no Brasil: análise da aplicação dos recursos do Fundo Nacional de Desenvolvimento Científco e Tecnológico (FNDCT) e da Financiadora de Estudos e Projetos (FINEP) de 1967 a 2006. Revista Brasileira de Inovação, Rio de Janeiro (RJ), 8 (1), janeiro/junho 2009. p.87-120.

Miles, Matthew B.; Huberman, A. M. Qualitative data analysis: an expanded sourcebook .2. ed. Thousand Oaks: Sage, 1994. 338 p.

Nassif, André. National innovation system and macroeconomic policies: Brazil and India in comparative perspective. In: United Nations Conference on Trade and Development (UNCTAD): Discussion papers. n. 184, may, 2007.

Nelson, R; Peterhansel, A. & Sampat, B. (2004).Why and How Innovations are Adopted: A tale of four models. Industrial & Corporate Change, Vol. 13, Nº 5, p. 679-699.

Nelson, Richard R.(Ed). National innovation systems: a comparative analysis. Oxford: Oxford University Press, 1993. 520 p.

Oecd. Organisation for Economic Co-operation and Development. Oslo manual. Disponível em: *<www.oecd.org/dataoecd/35/61/2367580.pdf>*. Acesso em: 27-10-2010.

Paez, Maria L. D. Análise e gestão de sistemas de inovação em organizações públicas de p&d no agronegócio. Comunicação para Transferência de Tecnologia. Brasília: Embrapa, 2000. Disponível em: <http://www.embrapa.gov.br/publicacoes/tecnico/folderTextoDiscussao/arquivos-pdf/texto04.pdf>. Acesso em 27-11-2010.

Paez, Maria L. D. Modelo de análise e gestão de sistemas de inovação do agronegócio: novos horizontes ou caos ?Cadernos de Ciência & Tecnologia, Brasília, v.18, n.2, p.37-67, maio/ago. 2001.

Paz, Sérgio; Révillion, Jean P. P.; Padula, AntonioD.; Federizzi, Luiz Carlos; Martinelli Jr., Orlando. Sectoral innovation systems: an application of the concept in the brazilian and french fluid milk production chain. Revista Eletrônica de Administração (REAd), ed. 46, v. 11, n. 4, jul-ago, 2005.

Rauen, André T.; Furtado, AndréT.; Cário, Sílvio A. F. Processo inovativo na indústria de software de Joinville (SC): uma análise a partir do marco teórico neo-schumpeteriano. Revista Brasileira de Inovação, Rio de Janeiro (RJ), 8 (2), julho/dezembro, 2009. p. 437-480.

Révillion, Jean P.; Padula, A. D. Empresas brasileiras no mercado de lácteos funcionais. Cadeia do Leite, Porto Alegre - RS, p. 9 - 9, 05 mar. 2008.

Roese, Mauro. Política industrial e de C&T regional: sistemas de inovação regionais? O caso da aglomeração moveleira de Bento Gonçalves/RS. Revista Eletrônica de Administração (REAd), ed. 16, v. 6, n. 4, jul-ago, 2000.

Santos, Marli E. R.; Solleiro, José L. Relações universidade-empresa no Brasil: diagnóstico e perspectivas in: Inovação e Empreendedorismo na Universidade, Porto Alegre: EDIPUCRS, 2006.

Souza, Sebastião D. C.; Arica, José. Uma análise comparativa entre sistemas de

Stacey, R. D. A fronteira do caos.Venda Nova: Bertrand, 1995.

Tidd, Joe; Bessant, John; Pavitt, Keith.Gestão da Inovação. 3. ed. Porto Alegre: Bookman, 2008. 599 p.

Tomaél, Maria I. ; Alcará, Adriana R. ; Tanzawa, Elaine C. L.; DI Chiara, Ivone G. ; Uchôa Jr., Plínio P. de M. ; Heckler, V. C. ; Rodrigues, Jorge L. ; Silva, G. A. . Redes Sociais em Alimentos Funcionais no Paraná: relato de pesquisa..EncontrosBibli (UFSC), v. 24, p. 111-138, 2007.

Van DE Ven, Andrew H. Central Problems in the Management of Innovation. Management Science, v.32, n.5, 1986. p. 590-607.

Vargas, Eduardo R.; Zawislak, Paulo A. Inovação em serviços no paradigma da economia do aprendizado: a pertinência de uma dimensão espacial na abordagem dos sistemas de inovação. Revista de Administração Contemporânea (RAC), v. 10, n. 1, Jan./Mar, 2006. p. 139-159.

Wolfe, David A. Globalization, information and communication technologies and local and regional systems of innovation. Program on Globalization and Regional Innovation Systems. University of Toronto, 2001.Disponível em: <www.utoronto.ca/progris/pdf_files/Ictreginnov.pdf>. Acesso em: 10-12-2010.

****