Innovation From The Autopoietic System Theory Perspective

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Abstract: *Without a comprehensive and generally accepted definition, but with a long history, the innovation concept is used, in different approach, for almost all areas of live. It has been, and continues to be an important topic of study in all spheres of science and a term often used by policymakers, practitioners and academics from various fields. The "need for innovation" appears in all spheres of science, new innovation theories continue to develop, and a tendency to shift the innovation models from macro-level to organization (firm) level is manifested. The paper offers, from the autopoietic system theory perspective, a new vision of the innovation concept, which can be interpreted as similar, but not equal, with the survival knowledge process. We propose a new approach of the concept of innovation as knowlegde, both for new possibilities of evolution of the organisation, as well as for new, yet inactive, perturbation in enviroment and internal organisation (structure). Moreover, the more knowlegde is embeded in the organisation, about the enviroment and internal structure, the numer of possibilities is reduced (even if the reduction is from a high number of infinities to a lower numer of infinities).*

Keywords*:* innovation, autopoietic system theory, creativity, knowledge, system view of creativity

JEL Classification :A10, O00, O30

Introduction

Innovation, as concept, is perceived as the generation, acceptance and implementation new ideas, processes or services. The concept of innovation has been defined differently, depending on the field in which it was used. In general, innovation was defined, similar to creativity, as either an outcome or as process. In fact, the process and outcome are inseparable, from each other. It was CsikszentmihaIyi (1999) who combined the twoo concepts into a system view of creativity. He found that creativity and innovation are not distinct phenomena and explain the complexity of relationship between the process and outcome (change in structure) and the past („old"), which is a precondition of novelty and actual and possible („new"). Recently, the interlinking of the „old" and the „new" was investigated by Bakken (2009) and Iba (2010), from the autopoiesis perspective. Bakken points that the innovation is dependent on the level of redundancy, while Iba provides an autopoietic system theory of creativity. According to the thoery, an autopoietic system is an system self-reproducing and autonomous unit, which interacts with its environment though structural coupling. The organization of knowledge, creativity and innovation embedded the autopoietic system cognition, social autopoiesis and organizational autopoietic theory. The study reveals the need to link innovation to evolution in a different path from the survival evolution and for this to happen there is a neccesity for a different process, created by cognition at a higher level, and, most important, it has to have a purpose that is fundamentally different from the survival of the organisation. That means that if we consider innovation a necessary process from a survival point of view, we maximise the risk of enviromental distruction and own (individual and species) distruction.

1.Conceptual approach of innovation from historical perspective

Along its tumultuous way, the innovation concept has had an interesting development: from the general opposition, in all fields - economics, politics, law, science, education and religion, the dominant perception until the beginning of the nineteenth century, till nowadays, when it has become a buzzword, used for any change, often without any scientific rationale. That's why it was impossible to formulate a generally accepted definition, that would present all the aspects under which innovation is known.

Depending on the relevant aspects considered by the different fields of science, this complex and broad concept appears under different conceptions. In the Organization for Economic Cooperation and Development (OECD) view, innovation consists in "the implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organizational method in business practices, workplace organization or external relations" (OECD, 2005, p.46).

We consider important to mention that during the "golden age" of innovation (1960-s – 1990-s), were developed new models for analysis the innovation processes and several studies have tried to define, classify the different types of innovations. In the works of Cooper (1998) and Gopalakrishnan & Damanpour (1997), [quoted by Kotsemir, Abroskin, (2013)], the innovation concept is define as (i) a process that encourages change

or (i) an event, object, or a discret product, characterized by novelty. Damanpour, (1996) defines innovation as an outcome, too:„ ...innovation is here broadly defined to encompass a range of types, including new product or service, new process technology, new organization structure or administrative systems, or new plans or program pertaining to organisation members.". (Godin, 2008) consider that „innovation is everywhere"and that it „has become the emblem of the modern society, a panacea for resolving many problems, and a phenomenon to be studied". He analyses the innovation as category identifying its meanings and distingues several interpretations. listed concisely by Kotsemir, Abroskin, (2013):

• innovation as process of doing of something new:
  - innovation as imitation;
  - innovation as invention;
  - innovation as discovery;
• innovation as human abilities to creative activity:
  - innovation as imagination;
  - innovation as ingenuity;
  - innovation as creativity;
• innovation as change in all spheres of life:
  - innovation as cultural change;
  - innovation as social change;
  - innovation as organizational change;
  - political change;
  - technological change;
• innovation as commercialization of new or improved product or process.

From historical perspective, the innovation concept and models were developed since the last decades of the XIX century till nowadays. A detailed analysis of evolution of innovation studies' as well as concepts and models of innovations since 1890-s till 2000-s splitted in decades belongs to Kotsemir & Abroskin, (2013), of which we mention the developments of 2000-s (table 1)

Table 1. Development of innovation concepts amd models in the 2000-s

The innovation concept	**The research' author**
financial innovation concept	Friedman, 2000; Goodhart, 2000; Woodfor, 2000; Tufano, 2003; Alvarez and Lippi, 2009;
the eco-innovation concept	Jones and Harrison, 2000; Rennings, 2000; Jones et al. 2001; Nuij, 2001; Smith, 2001; Rai and Allada, 2005; Beveridge and Guy, 2005; Pujari, 2006; Carrillo-Hermosilla del Río and Könnölä, 2009;
the lead user concept in the framework of user innovation concept	Luthje, 2000; Lilien, et al. 2002; Intrachooto, 2004; Luthje and Herstatt, 2004; Skiba and Herstatt, 2009; Skiba, 2010, Oliveira and Von Hippel, 2011;
national systems of innovation mode (in theoretical as well as empirical direction)	Chudnovsky Niosi and Bercovich, 2000; Etzkowitz and Leydesdorff, 2000; Nasierowski and Arcelus, 2000, 2003; Nelson, 2000; Edquist, 2001, 2004; Lundvall, 2002, 2007; Lundvall et al., 2002, Niosi, 2002; Monttobio, 2008, Pan, Hung, Lu, 2010;

theories of growth of regional clusters of innovation and high technology	Keeble & Wilkinson, 2000;
emergence of the toolkits for user innovation concept in the framework of user innovation concept	von Hippel, 2001; von Hippel and Katz, 2002;
the methodology for the international and national R&D statistics and STI policy measuremen	Gokhberg, Gaslikova and Sokolov, 2000; Boekholt et al., 2001; ESCWA, 2003; Katz, 2006; Tijssen and Hollanders, 2006; Gokhberg L. and Boegh-Nielsen, 2007; OECD, 2007; Gokhberg, Kuznetsova and Roud, 2012;
the theory of social innovation	Mumford, 2002; Moulaert and Sekia, 2003; Westley, Zimmerman and Patton M. 2006; Kohli and Mulgan 2007; Mulgan Ali and Tucker 2007; Nichols, 2007; James, Deiglmeier and Dale, 2008; Nambisan, 2008, 2009; MacCallum, Moulaert, Hillier and Vicari, 2009; Goldsmith, 2010; Howaldt and Schwarz 2010; Murray, Caulier- Grice and Mulgan, 2010; Gill, 2012;
innovation intermediary concept	Wolpert, 2002; Stewart and Hyysalo, 2008; Sieg, Wallin and von Krogh, 2010;
technological innovation system concept	;Bergek, 2002; Smits, 2002; Hekkert et al., 2007; Negro, 2007; Bergeck et al, 2008; Suurs, 2009;
open innovation concept	Chesbrough 2003; Vemuri and Bertone, 2004; Zhao and Deek, 2004; Chesbrough, Vanhaverbeke and West, 2008; von Hippel, 2011; Penin, Hussler and Burger-Helmchen, 2011; Pearce, 2012;
the collaborative innovation network concept in the framework of open innovation concept	Gloor, 2005; Gloor and Cooper, 2007; Silvestre and Dalcol, 2009;
user innovation concept	von Hippel, 2005; Braun, 2007; Bilgram, Brem, Voigt, 2008; Nambisan and Nambisan, 2008; Bogers, Afuah, Bastian, 2010.

Source: Maxim N. Kotsemir, Alexander S. Abroskin, 2013, „Innovation concepts and typology – an evolutionary discussion" – Basic research program, Series: Science, technology and innovation -Working Papes BRP05/STI/2013

Even if, at the companies level, the dimension of impact from innovation is neglected, it seems that companies or countries investing in innovation are the most successful ones. (Kotsemir, Abroskin, 2013).

2.The system view of creativity and innovation

At the organisation level, "innovation represents the core renewal process in any organisation. Unless it changes what it offers the world and the ways in which it creates

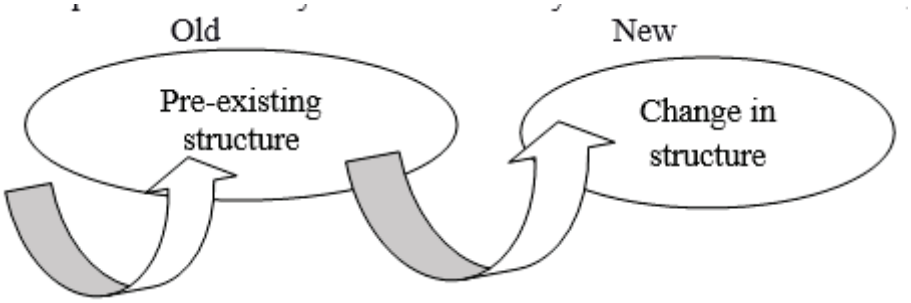
and delivers those offerings it risks its survival and growth prospects. But innovation is not an automatic attribute of organisation; the process has to be enabled through sophisticated and active management." (Bessant, Lamming, Noke, & Phillips, 2005).

The innovation, similar to creativity, can be define as process and as outcome, not only one or the other. „Innovation can be seen as a dynamic network or system, which renews existing structures of products, services, processes, systems, businesses. This renewal is accepted and preserved in society and commercially utilised. It can be seen then that both phenomena of creativity and innovation have been defined as both an outcome and a process. The process and outcome are inseparable from each other"(Auernhammer, 2012).

The creativity and the innovation were introduced into a system of creativity by Csikszentmihalyi (1990, 1996, 1999). In his view, creativity and innovation occur when a person produces a change in a domain, that will be transmitted through time and this change is inserted into society and the domain adaps it. Innovation and creativity cannot be interpreted as being outside the system in which the phenomena occurs. The production of novelty and change of the system („New") emerges in relation to the existing system structures („Old"),:

"The 'New' is only meaningful in reference to the 'Old'. Original thought does not exist in a vacuum. It must operate on a set of already existing objects, rules, representations, or notations. One can be a creative carpenter, cook, composer, chemist or clergyman because the domains of woodworking, gastronomy, music, chemistry, and religion exist and one can evaluate performance by reference to their traditions. Without rules there cannot be exceptions, and without tradition there cannot be novelty." [Csikszentmihalyi, (1999), quoted by Auernhammer, (2012)].

Figure 1. Self-production of a system and creativity and innovation as a change in structure



Source: Auernhammer, (2012), p. 37

From a system view, innovation and creativity were investigated using a self-reproducing systems theory (autopoietic system theory), [Bakken, et aL (2009a, 2009b), Iba (2010, 2011)], which provides both the interlinking of the 'Old' and the 'New' as self-reproducing systems and the interlinking of the process and outcome of creativity and innovation. (Figure 1). The system reproduces itself through the interaction of structure and process and innovation. According to Morgan (2006), "any system with an ability to self-organise must have a degree of redundancy: a kind of excess capacity that can create room for innovation and development to occur. Without redundancy, systems are fixed and complete static." In this context, we consider important to emphasize that a system is able to change with its own components and resources, only when it have a degree of redundancy and that innovation can be understood as a change in the system structure [Csikszentmihalyi, (1999) and Bakken, et aL (2009a, 2009b), quoted by Auernhammer, (2012]. A system which recursively reproduces itself through its own structure and operation, is an autopoietic system (Maturana & Varela, 1980, 1992).

3. Knowledge and innovation in the autopoietic systems theory

If we want to discuss the issue of innovation, we first need to refer to a autopoietic system theory that will help in framing our approach. For that, we consider important to point the three approach of the organizational theory:

- „absolut view" (current mainstream approach) – organisation is a concrete input-output entity with organisational structure and culture, there processes are interactions between golas and structure. Even if, this view, allows for a perspective of the organisation as a open-system and is focused on how the system survives at the environment fluctuations, the problem with such static structure is the imposibility to describe emergent processes and structural change that occurs in complex, dinamic entities;
- „process view" – organisation is defined as processes of combined events. Order or structure within the flow is constituted by relatively stable patterns of behaviour that repeat themselves, which change relatively slowly (March & Simon, 1958, p. 170). In the 'process view' change must not be thought of as a propeliy of organisation, but rather organisation must be understood as an emergent property of change (Tsoukas & Chia, 2002);
- „self-reproducing view" - 'The organisation' and 'organising' should not be seen as separate phenomena, but rather as a recursively interacting phenomenon (Hernes, 2004, pp. 30-40). In a entity, „organisation" (structure) and „organising" (process) are different aspects of unitary phenomenon. The dynamics or organisations (process) produce the boundaries and structure (entity) and the boundary and structure (entity) is essential for the operation of the organisation (process) (Maturana & Varela, 1992, p. 46).

Using the autopoietic system theory, for our view on societal organisation, allows for creating the perspective of the organisation as an entity, a self-reproducing system with embeded structure and processes.

Autopoietic system theory has been applies and developed in several fields. Autopoiesis in biology and cognition has been developed by Maturana & Varela (1980,

1992) and it has been applied and developed for human systems and social theory. The social autopoiesis theory has been developed by several scholars such as Luhmann (1986, 1995, 2003, 2009) and Fuchs (2002, 2003, 2008; Fuchs & Hofkirchner, 2009 More recently scholars started to investigate creativity and innovation from an autopoietic system theory (Bakken, et al., 2009a, 2009b; Iba, 2010, 2011).

The organisation of knowledge, creativity and innovation incorporates (Auernhammer, 2012):

- the autopoietic systems of cognition (knowledge creation, thought collectives and creation of creative discoveries);
- social autopoiesis (communication, interaction and social structures) and
- organisational autopoietic theory (regulations and organisational structures)

From the literature we can extract ideeas that are usefull for undestanding the perspective of autopoiectic systems :

- The autopoietic system realises itself through a particular structure and the changes it can undergo are determined by this structure as long as self-reproduction is maintained (Mingers, 1995, p. 35);
- Autopoietic units can interact with other systems and their environments, by which structural change can occur within the system through the interaction (Maturana & Varela, 1980, pp. xx-xxi; 1992, pp. 74-75; 180-201). Structural copuling is an important atribute, as it allows for change in the structure, but the change is not directly caused by exterior factors, but indirect by interactions that can lead to such structural change. Moreover, the change is not bound to be permanent, only if the change afects the processes of reproduction it will perpetuate, otherwise the change will be lost;
- Autopoietic systems are autonomous unities. Autonomous unities are operationally closed. Two important ideas emerge from this caracteristics : firstly, the system produces its own boundary and secondly, within its boundaries it can specify its own laws (Maturana & Varela, 1992, pp. 46-49).

Varela et al. (1974) listed six criteria they considered to be necessary and sufficient conditions for recognizing a system to be autopoietic:

- Bounded. People know what organizations they belong to by bounderes that can be in physic forms or non-physic.;
- Complex. Organization members are individually unique, recognize one another as members, and are identified as such within the organization;
- Mechanistic. Individuals receive rewards and benefits to belong, and are involved in processes that the organization conducts to ensure its survival;
- Self-referential. Rules of association, determined within the organization itself, what people and property belong to the organization;
- Self-producing. Members are recruited from the environment, inducted, trained and managed;
- Autonomous. Most organizations outlive the association of particular individuals, and are readily able to hire, induct and train new individuals to replace other people as they retire or leave the organization.

4. Knowledge, cognition and culture in autopoietic societal systems

During the evolution of organisations is necessary to exist some form of knowlegde

creation and transmitence (in any way possible) to ensure the ability of the system, first, to survive to various internal and external chances that already happend some time in the past and, secondly, to ensure that new members and next generations have the ability to identify and respond to previously know changes.

Two domains of shared knowlegde can be distinguished in the evolution of organisations from simple form of cooperation to autopoietic systems and they can be described using Karl Popper's words, in:

- Social transmission of tacit (world 2) knowledge from one generation to the next with the social involvment of young members (Perry 2006, 2011) via copying, learning;
- Storing and sharing explicit knowlegde (world 3) via tools of recording, preservation and communication sharing. Although collecting and transforming this knowledge from people's heads into explicit forms involves genetically determined capabilities of human cognition, the resulting body of knowledge is now vastly larger than that held in the human genome and is growing exponentially at ever increasing rates as our cognitive technologies become ever more powerful. (Hall 2011).

Evolutionary knowledge generated by organizations is tacitly embodied in the physical and procedural structure of the organization (Nelson & Winter 1982; Dalmaris 2006; Dalmaris et al. 2007), and explicitly in organizational documentation (Hall 2003). Some knowledge specifically relating to the organization is held in human memories, but the "bounded rationality" (Simon 1955, 1957) of organizational members means that no one person can know everything the organization needs to know in order to maintain itself and respond adequately to meet organizational imperatives in a changing and competitive environment (see also Else 2004; Nousala et al. 2005; Nousala 2006; Dalmaris et al. 2006; Martin et al. 2009; Philp & Martin 2009; Hall et al. 2011), thus knowledge required for maintenance of the organization must be distributed beyond the limits of any one individual in the organization.

◎ We need to draw the conclusion that all knowlegde is constructed by autopoietic systems and autopoiesis cannot exist without knowledge

Building survival knowledge in self-producing systems is possible only if the system can persist enought to accumulate a connected history among its units. That means that knowlegde is embeded in the system structure and it is used for construction and reproduction of the system.

Hall (2013) defines cognition as the sum of the processes within autopoietic systems by which this survival knowledge is applied to solve problems:„Even if systems that are only partially or temporarily autocatalytic disintegrate to return their assembled components to the environment, those producing more components of kinds involved in their partially autocatalytic structures will facilitate emergence of other autocatalytic systems depending on properties of those kinds of components. This structural heredity determines the dynamic processes maintaining autopoiesis."

Hall's view serves very well for explaining the concept of culture as social sharing knowledge at a higher level of organisation: „Culture can be defined as patterns of behavor and knowledge shared by a population of individuals that depends on capacities for learning and transmitting knowledge

between individuals and from individuals of one generation to the next. This is contrasted to the genetic transmission and inheritance of knowledge in the form of instincts and innate behavioral propensities. The development of culture in this sense depends on fairly high degree of cognitive capacity, beyond the development of a genetically programmed behavior, involving individual abilities to observe, orient, decide and act.Thus, cultural transmission builds a heritable body of adaptive knowledge that is held at a level of organization above that of the molecular and structural oranization of living individuals, i.e., at a level of "social" organization."

5. Innovation as higher level of knowlegde?

We can investigate, from this perspective, the linkes between structure constrains, individual interactions and the dynamic and emergent nature of innovation within the organisation as an autopoiectic system.

Nousala and Hall (2008) described how new levels autopoietic organization can emerge from existing levels of complexity. This have involved the formation of third order autopoietic organizations such as new companies involving second order people working within the higher level supersystem of the economy (Nousala et al 2005, 2009, Hall et al. 2009), the emergence of knowledge-based communities within existing third order companies or other social structures (Nousala 2006; Nousala et al. 2005, Hall et al. 2010) and the emergence of 4th order industry clusters between component companies and the higher level supersystem of the economy (Hall 2006; Hall & Nousala 2007).

We must stress that any emergence of new knowlegde is bound, as demonstrated, by structural coupling, system history and the structure of enviroment. This knowlegde is refering only to the survival of the organisation, based on events that already happened and from which the entity was able to substract permanent and usefull knowlegde for the survival.

Using this perspective we propose to introduce the concept of innovation as knowlegde :

- For new possibilities of evolution of the organisation, and
- For new possible perturbation in enviroment and internal organisation (structure)

The main issue is, of course, the unlimited possibilities that involves processes in complex systems.

But, as proven in the evolution of computer algoritms (Google DeepMind vs Lee Sedol) it is now neccesary to process ALL the possibilities, as it is sufficient to select a few scenarios.

Moreover, the more knowlegde is embeded in the organisation, about the enviroment and internal structure, the numer of possibilities is reduced (even if the reduction is from a high number of infinities to a lower numer of infinities).

Drawing the paralel with survival knowlegde we can describe innovation as evolution knowlegde.

Innovation is still bound to enviroment structural limits (as it is part of the enviroment) but it is not bound to the structure of organisation.

Moreover, another difference is that, if the survival knowlegde is a response to certain events in the past, for the innovation to

emerge, it needs, first, a specific process that is not naturally occuring and, second, to provide :

- Knowlegde about survival of the organisation in the risk of possible future new events from the enviroment (external future new survival risks), or
- Knowlegde about survival of the organisation in the risk of significant structure change (internal future changes)
- Knowlegde about possible internal chances that can make the organisation more efficient, using already existing processes or by developing new processes from the existing ones.

Conclusions

As seens, from the difficulty of defining and explainig the concept of innovation, none of the current theories can easily integrate the concept, and, we believe that this is because the inability of the current theories to embody the neccesity of a higher purpose of the social autopoietic organisation.

Based on the current theories, the only purpose of any entity is survival (or its economic equivalent, profit in form of money, for societal organisation). And for this purpose the science can describe, as we discussed, the necessary processes and framework to explain, partially, the necessary conditions for survival, but not evolution. The concept that „the more, the better", that means that if the organisation is more„experienced " (long history=more survival knowlegde) and has more resources, the chances that it will survive are better is valid only from the „natural selection" point of view. And natural selection process of evolution is valid for entities that forms and compet in the same enviroment.

As we see from past (and all failed) experiments, in natural selection evolution if we take one species from its enviroment and move it into other enviroment (with the same structure) where individual survival is not theatened, the individuals will evolve based on the survival evolution processes even if this evolution is putting in danger the enviroment and the whole species (egoistic gene theory).

That means that if we consider innovation a necessary process from a survival point of view, we maximise the risk of enviromental distruction and own (individual and species) distruction.

Innovation must be linked to evolution in a different path from the survival evolution and for this to happen there is a neccesity for a different process, created by cognition at a higher level, and, most important, it has to have a purpose that is fundamentally different from the survival of the organisation.

We believe that is from its two elements – specific cognition process and purpose – that the framework for innovation in an organisation must be created.

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