IOSR Journal of Business and Management (IOSR-JBM)
e-ISSN:2278-487X, p-ISSN: 2319-7668. Volume 26, Issue 2. Ser. 5 (February. 2024), PP 54-60
www.iosrjournals.org

Innovations And Complexity Theory

Marcia Rohr Da Cruz[1], Maria Emilia Camargo[2],
Aprígio Teles Mascarenhas Neto[3], Maria Do Socorro Cruz Linhares[4]
[1] *Unopar, Polo De Caxias Do Sul/Rs, Brazil*
[2,3,4]*graduate Program In Intellectual Property Science, Federal University Of Sergipe, São Cristóvão/Se, Brazil*

Abstract:
Background*: This is a study whose objective is to understand the state of the art in the literature on innovation and complexity theory. Innovation is understood as a process of introducing new products, services, and methods into society, with its own levels and dynamics. Complexity theory in organizations is said to be an interaction between order and disorder, with ontological and epistemological foundations.*
Methodology*: A bibliographic study was adopted for theoretical research followed by bibliometrics with a search in the Scopus database to understand the state of the art of the study topics.*
Results*: The first search resulted in 4609 documents, with 2209 articles and 740 in the social science humanities area about innovation. In relation to complexity theory, with the same sequence as the search for innovation, it resulted in 5271 documents, with 691 articles in the study area, of which 33 had their content analyzed.*
Conclusion: *The state of the art of the themes in this study highlights a vast literary production, which allows researchers to better understand and formulate a theoretical model and practical application for society and academia.*
Key Word*: Innovation; Complexity Theory; Measurement. State of the Art.*
Date of Submission: 03-01-2024 Date of Acceptance: 13-02-2024

I. Introduction

Innovation is important in companies' business, comprising different aspects and contributing in different ways to their growth and development. Among the aspects that can be taken into consideration for innovations are the internal aspects related to the context of the organization and the external aspects that involve the entire environment in which the organization is located. It is believed that these aspects influence both the decision to develop innovations and the application of innovation products or processes in the market. It is then about understanding the complexity theory related to the innovation process.

Understanding the state of the art in the literature on innovation and complexity theory is relevant for organizations, this is the objective of the study. To this end, the research uses bibliographical study for theoretical research accompanied by a bibliometric stage in the Scopus database. The results show a large academic production on the topics, whether in scientific articles, theses, or dissertations, which allows us to affirm that the state of the art shown in research is significantly large, contributing to a better understanding of the innovative process associated with the theory of complexity. With this finding, researchers and society can formulate a model with better social applicability.

II. Methodology

From the contextualization and presentation of the problem that surrounds and justifies the study, the investigation requires choosing the type of research to be used. Alves-Mazzotti and Gewandsznajder (2004) emphasize that research in Social Sciences has been marked by studies that use quantitative methods seeking to describe and explain the phenomena studied. Therefore, this investigation will have a qualitative focus, still following the definition, it can be descriptive or explanatory (Gil, 2002). In addition, the complexity theory on innovation is used as a basis for literature studies on the objects of study in the Brazilian apple production chain sector. The bibliometric research used the time from 2003 to 2013 with the keywords "measurement in innovation" and "complexity theory in organizations" in the abstract, in the Scopus database.

III. Innovation

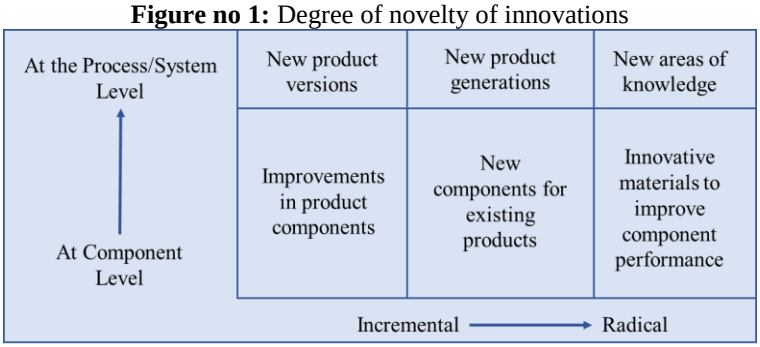
From the more traditional conceptualization that innovation is the commercial and industrial application of a new product, process or method (Schumpeter, 1934), to the widely accepted definition proposed by the Oslo Manual, which prescribes innovation as being the "implementation of a product (good or service) new or significantly improved, or a process, or a new marketing method, or a new organizational method in business practices, workplace organization or external relations" (OECD, 2005, p. 55). Below is a breakdown of the definitions of innovation according to Milbergs and Vonortas (2007).

Table no 1: Innovation definitions

Innovation is the commercial or industrial application of something new, a new product, process or production method, a new market or sources of supply, a new form of commercial business or financial organization. Schumpeter, Theory of Economic Development, 1911.
Innovation encompasses a broad field of activities to improve company performance, including the implementation of a new or significantly improved product, service, distribution process, manufacturing process, marketing method, or organizational method. European Commission, Innobarameter 2004, November 2004.
Innovation success is the degree to which value is created for customers through companies that transform new knowledge and technologies into profitable products and services for the national and global market. The high rate of innovation contributes to the creation of new markets, economic growth, job creation, wealth and a better quality of life. 21st Century Working Group, National Innovation Initiative, 2004.
Innovation is the intersection of invention and perception, leading to the creation of social and economic value. Innovate America Report, Council on Competitiveness, December 2004.
Innovation is the mix of perception, invention and entrepreneurship that leads to growth, generating value and high-value jobs. Ahead of the Curve, The Business Council of New York State, Inc., 2006.
Innovation is the implementation of a new or significantly improved product or process, a new marketing method, or a new organizational method in business practices, workplace organization, or external relations. Innovation activities are scientific, technological, organizational, financial and commercial, steps that are intended and lead to the implementation of innovations. Oslo Manual: Guidelines for Collecting and Interpreting Innovation Data, 3rd Edition, OECD (2005).
The design, invention, development or implementation, alteration of new products, services, processes, systems, organizational models with the purpose of creating value for customers and financial returns for the company. Measuring Innovation in the 21st Century Economy Advisory Committee, Department of Commerce. Federal Register Notice, April 13(2007).

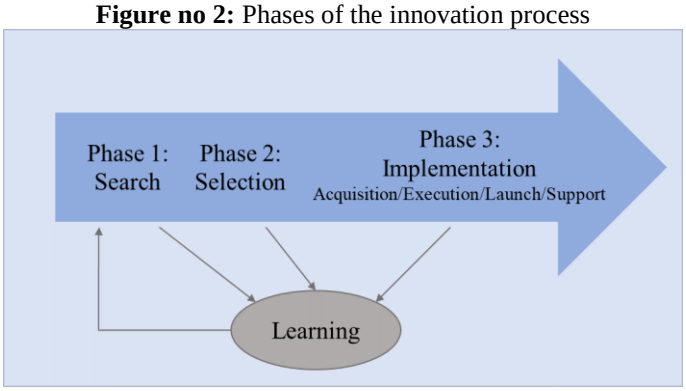
Innovation involves different levels, below is an illustration of the degrees of novelty of the innovative process proposed by Tidd (2001).

Figure no 1: Degree of novelty of innovations



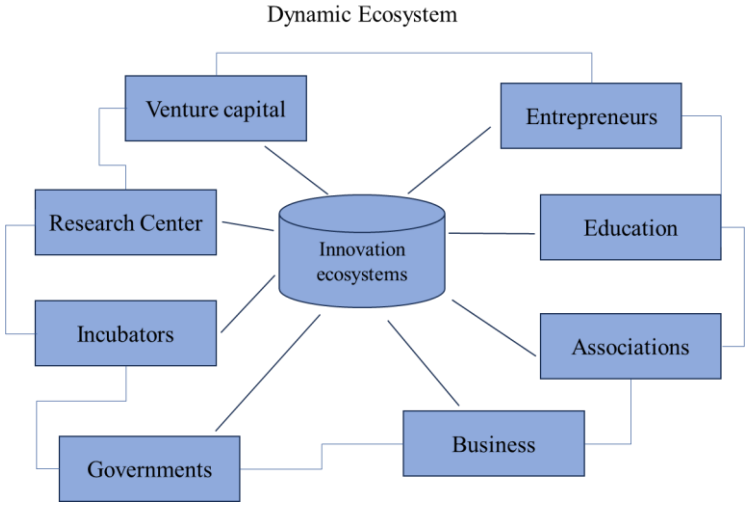
This process goes through some phases, search, selection, and implementation, for Tidd (2001).

Figure no 2: Phases of the innovation process



Brazil has a State innovation policy through the instrument called Technological Innovation Research (PINTEC) within the scope of the Ministry of Science and Technology (IBGE, 2012). PINTEC presents innovation indicators by sector in Brazil, about industry, technological innovation indicators are regional and compared with information from other countries. Its focus is to show the main elements that influence the innovative behavior of companies.

Figure no 3: Phases of the innovation process



The configuration of the innovation process is said to be a dynamic ecosystem, in which interactions and feedback occur between the different elements, in the terms of Milbergs and Vonortas (2007).

IV. Complexity Theory

Defining complexity theory is a task that several scholars have focused on in this mission, the concepts permeate several complex systems, axes, points of view on scientific models and areas of knowledge. Wells (2009) proposes a set of defining elements.

Table no 2: Innovation definitions

Fundamentals	Definition
Ontological foundations of complexity Fundamentals I (COF I)	● Complex adaptive systems, complex dynamic systems; ● Non-linearity, chaos theory and power; ● Network; ● Feedback; ● Hierarchy; ● emergency; ● Self-organization.
Ontological foundations of complexity Fundamentals II (COF II)	● Balance, construction phase, attractor, edge of chaos; ● Connectivity, diversity; ● Interrelation causality network; ● Undesirable consequences, irreversibility and non-renewability; ● Vulnerability, risk; ● Robustness, resistance and sustainability; ● Limit, inflection point, abrupt change; ● Collapse, catastrophe.
Epistemological foundations of complexity (CEF)	● Observer; context; ● System limits; opening; ● Scale; ● Grain; ● Co-evolution, co-production, co-evolution landscapes; ● Models, narratives and other methods.
Axis I: Natural Sciences and Social Sciences	●Classical versus complexity sciences/theories (Morin 1974; Merchant 1980; Dupré 1992; Norgaard 1994); ● Mechanism, order x organization; ● Atomism x network; ● Reductionism x synthesis; ● Essentialism x versatility, emergence; ● Universalism x pluralism, disunity; ● Determinism x intentionality, emergence;
Axis II: Social Theory, Human Sciences and Philosophy	● Compressibility x incompressibility; decomposability x non-decomposability; reducibility x irreducibility; ● Production x emergency; very complicated x complex; ● Weakness x thickness; ● Externalist x internalist; ● Uncertainty x unknowability.

Axis III: Transdisciplinary theories and frameworks	● Transdisciplinary; ● System typology (J-C Lugan 1983); ● Reductive, emergent, holistic; ● Restriction x generalized (Morin 2006);

Therefore, complexity theory (Morin, 2000) explains order and disorder, but between them there is a path to be traced, order goes beyond the notion of a stable, rigid, repeated or regular environment. In addition to the concept of order and disorder, Morin's (2000) assumptions also present the notion of a complex self-organized system. This concept refers to the chain of relationships between individuals producing a complex unit or system (Morin 2002).

V. Measurement of Innovation Studies and Complexity Theory

From the delimitation of bibliometric studies, it was possible to measure studies that address innovation and complexity theory, which helps to identify the main topics being studied and the most relevant in each area (Kneipp et al., 2011).

The first search, with the terms "measurement in innovation", "all documents", resulted in 4609 documents. The second, only in "articles", returned 2209 works; the third, only in the "social science humanities" area, obtained 740 works, of which 35 studies were selected based on the theoretical assumptions that contributed to carrying out the bibliometric research.

Table no 3: Innovation articles

Authors	Title	Periodical/database	Year
GIBSON; NAQUIN	*Investing in innovation to enable global competitiveness: the case of Portugal*	*Technological Forecasting and Social Change*	2011
CAMISÓNA; MONFORT-MIR	*Measuring innovation in tourism from the Schumpeterian and the dynamic-capabilities perspectives*	*Elsevier - Tourism Management*	2011
GUAN; CHEN	*Measuring the innovation production process: Across-region empirical study of China's high-techinnovations*	*Elsevier - Technovation*	2010
BLANCK	*How should we think about measuring innovation and change?*	*Survey of Current Business*	2010
EMRICH et al.	*Indicadores tecnológicos para a cadeia produtiva do tomateiro no Brasil*	*XIX Congresso de Pós-Graduação da UFLA*	2010
GRUPP; SCHUBERT	*Review and new evidence on composite innovation indicators for evaluating national performance*	*Research Policy*	2010
CHEN MING	*Is informal networks influence technological innovation of R&D team member: a topology measurement, and consequences*	*International Journal of Management Innovation Systems*	2009
DING; LIU; LIU	*Auxiliary model based multi-innovation extended stochastic: Gradient parameter estimation with colored measurement noises*	*Signal Processing*	2009
SONG; THIEME	*The role of suppliers in market intelligence gathering for radical and incremental innovation*	*Journal of Product Innovation Management*	2009
AIZCORBE et al.	*Toward better measurement of innovation and intangibles*	*Survey of Current Business*	2009
RANKIN et al.	*Initial metrics and pilot program results for measuring the performance of the Canadian Construction Industry*	*Canadian Journal of Civil Engineering*	2008
CHENG; SHIU	*Re-innovation: the construct, measurement, and validation*	*Elsevier - Technovation*	2008
SCHMIDT; DRUEHL	*When is a disruptive innovation disruptive?*	*Journal of Product Innovation Management*	2008
O'CONNOR	*Major innovation as a dynamic capability: a systems approach*	*Journal of Product Innovation Management*	2008
LETEN et al.	*Technological diversification, coherence, and performance of firms*	*Journal of Product Innovation Management*	2007
SALOMO et al.	*NPD planning activities and innovation performance: the mediating role of process management and the moderating effect of product innovativeness*	*Journal of Product Innovation Management*	2007
BECHEIKH et al.	*Lessons from innovation empirical studies in the manufacturing sector: A 18systematic review of the literature from 1993-2003*	*Elsevier - Technovation*	2006
DRAKE et al.	*Maximizing return on innovation investment: spending more on innovation does not necessarily translate into accelerating sales, market share or profit. Here's how three organizations would remedy this*	*Research-Technology Management*	2006
HAJIYEV	*Innovation approach based measurement error self-correction in dynamic systems*	*Measurement Journal of the International Measurement*	2006
O'CONNOR; DEMARTINO	*Organizing for radical innovation: an exploratory study of the structural aspects of RI management systems in large established firms*	*Journal of Product Innovation Management*	2006
FRISHAMMAR; HÖRTE	*Managing external information in manufacturing firms: the impact on innovation performance*	*Journal of Product Innovation Management*	2005

BRENTANI; KLEINSCHMIDT	*Corporate culture and commitment: impact on performance of international new product development programs*	*Journal of Product Innovation Management*	2004
MCDERMOTT; O'CONNOR	*Managing radical innovation: an overview of emergent strategy issues*	*Journal of Product Innovation Management*	2002
BABA	*Adopting a specific innovation type versus composition of different innovation types: Case study of a Ghanaian bank*	*International Journal of Bank Marketing*	2012
WHITE	*An old tool with potential new uses: return on investment*	*Managing Library Finances*	2007
LINDER	*Does innovation drive profitable growth? New metrics for a complete picture*	*Journal of Business Strategy*	2006
MULLER et al.	*Metrics for innovation: guidelines for developing a customized suite of innovation metrics*	*Strategic Direction*	2005
OKE	*Innovation types and innovation management practices in service companies*	*International Journal of Operations & Production Management*	2007
DABIC et al.	*Keynesian, post-Keynesian versus Schumpeterian, neo-Schumpeterian: An integrated approach to the innovation theory*	*Management Decision*	2011
EMERALD	*Reviewing innovation effort: Innovation culture*	*Strategic Direction*	2008
EMERALD	*Innovation metrics: Some progress but could do much better*	*Strategic Direction*	2009
EMERALD	*Reviewing innovation effort: Innovation culture*	*Strategic Direction*	2008
DOBNI	*The DNA of Innovation*	*Journal Business Strategy*	2008
LEAVY; STERLING	*Think disruptive! How to manage in a new era of innovation*	*Strategy & Leadership*	2010

Below are the theses and dissertations on innovation.

Table no 4: Dissertations and theses on innovation

Document	Title	Author	Institution	Year
Thesis (Doctorate)	Indicadores de mensuração de desempenho em pequenas e médias empresas (PMEs): estudo no setor calçadista de Santa Catarina	Antonia Egidia Souza	Universidade de São Paulo	2011
Thesis (Doctorate)	Análise da relação entre a gestão do conhecimento e o ambiente de inovação em uma instituição de ensino profissionalizante	Arleide Rosa da Silva	Universidade Federal de Santa Catarina	2011
Thesis (Doctorate)	Inovatividade no sistema brasileiro de inovação na agricultura uma análise baseada na política de cooperação internacional da Embrapa	Roselene de Queiroz Chaves	Universidade Federal Rio Grande do Sul	2010
Thesis (Doctorate)	Atividade de inovação em firmas de economias emergentes: proposta de um conjunto de novos indicadores	Luciana Manhães Marins	Universidade Federal Rio Grande do Sul	2010
Thesis (Doctorate)	Uma avaliação de sistemas de medição de desempenho para P&D implantados em empresas brasileiras frente aos princípios de construção	André Ribeiro de Oliveira	Universidade Federal do Rio de Janeiro	2010
Dissertation (Doctor)	*Complexity, innovation and economic growth: The competitive network of innovation and organizational size and growth in innovation*	Thomas F. Brantle	Stevens Institute of Technology	2010
Thesis (Doctorate)	Avaliação de redes de inovação em nanotecnologia - a proposta de um modelo	Mercy Escalante Ludeña	Universidade de São Paulo	2008
Thesis (Master's degree)	Medição de desempenho na cadeia produtiva do leite: proposta de cesta de indicadores estratégicos	Dejair Marcelo Senke Lustosa	Pontifícia Universidade Católica do Paraná	2008
Thesis (Master's degree)	Ambiente de inovação nas empresas de software de Blumenau	Terezinha Vicenti	Universidade Regional Blumenau	2006

In relation to complexity theory, searches carried out with the term "complexity theory in organizations" with the same sequence as the search for "measurement in innovation", resulted in 5271 documents, with only "articles" and in the area "social science humanities" resulted in 691 works, of which 33 had their content analyzed.

Table no 5: Articles on complexity theory

Authors	Title	Periodical/database	Year
SANGER; GIDDINGS	*A simple approach to complexity theory*	*Journal of Social Work Education*	2012
KASPARY; SEMINOTTI	*Os processos grupais e a gestão de equipes no trabalho contemporâneo: compreensões a partir do pensamento complexo*	*Revista de Administração Mackenzie*	2012
MITLETON-KELLY	*A complexity theory approach to sustainability: A longitudinal study in two London hospitals*	*Emerald*	2011
MORIN	*On complexity*	*Book Reviews*	2010
SKARZAUSKIENE	*Managing complexity: systems thinking as a catalyst of the organization performance*	*Emerald*	2010

SERVA et al.	*Paradigma da complexidade e teoria das organizações: uma reflexão epistemológica*	*Revista de Administração Eletrônica*	2010
HURTADO	*Recovering the root of design and convergence concepts: evaluation of strategy process approaches against a complexity theory*	*Competition Forum*	2010
ALHADEFF-JONES	*Challenging the limits of critique in education through Morin's paradigm of complexity*	*Springer Science Business*	2010
BITTICK	*Aspects of complexity theory in liberal political thought*	*Emergence: Complexity and Philosophy*	2010
MEEK	*Complexity theory for public administration and policy*	*Emergence: Complexity & Organization*	2010
SVETLANA et al.	*Exploring the complexity of projects: implications of complexity theory for project management practice*	*PM Network*	2009
KURT	*Managing complex organizations: complexity thinking and the science and art of management*	*ECO*	2008
MISCHEN; JACKSON	*Connecting the dots: applying Complexity theory, knowledge management and social network analysis to policy implementation*	*Binghamton University*	2008
PATHAK el al	*Complexity and adaptivity in supply networks: building supply network theory using a complex adaptative systems perspective*	*Decision Sciences*	2007
NUNN	*Complexity theory applied to itself*	*Complexity/Organization*	2007
WEBER; SCHWENTICK	*Dynamic complexity theory revisited*	*Theory of Computing Systems*	2007
CHELTENHAM	*Koen Frenken: innovation, evolution and complexity theory*	*Springer*	2006
PINA et al.	*Towards a complexity theory of strategy*	*Complexity Theory Strategy*	2006
CRUZ et al.	*Towards sustainable development strategies: a complex view following the contribution of Edgar Morin*	*Sustainable development strategies*	2006
SMITH	*Complexity theory for organisational futures studies*	*Journal of Futures Studies, Strategic Thinking Policy*	2005
GROBMAN	*Complexity theory: a new way to look at organizational change*	*Public Administration Quarterly*	2005
MEADE; RABELO	*Using complexity theory to formulate new product development strategies: a framework*	*IIE Annual Conference*	2003
PHILIP	*Assessment, change, and complexity*	*Management Communication Quarterly*	2002
STYHRE	*Non-linear change in organizations: organization change management informed by complexity theory*	*Leadership & Organization Development Journal*	2002

Below are the theses and dissertations on innovation.

Table no 6: Dissertations and theses on complexity theory

Document	Title	Author	Institution	Year
Thesis (Doctorate)	Dinâmica de configuração de regras para inovação: um olhar complexo e interteórico numa organização de pesquisa agrícola do agronegócio orizícola do Rio Grande do Sul	Marcelo Fernandes Pacheco Dias	Universidade Federal do Rio Grande do Sul	2011
Dissertação (Mestrado)	Um estudo sobre aplicações da teoria do caos e complexidade à gestão das cadeias de suprimentos	Rodolfo Leandro de Faria Olivo	Universidade de São Paulo	2010
Dissertation (Doctor)	*Organizational Change at the Edge of Chaos: A complexity theory perspective of autopoietic systems*	Domenico Susini III	*University of Phoenix*	2010
Dissertation (Doctor)	*Complexity and climate change: An epistemological study of transdiciplinary complexity theories and their contribution to social-ecological phenomena*	Jennifer Lynn Wells	*University of California, Bekerley*	2009
Thesis (Master's degree)	Relacionamento na cadeia produtiva da maçã brasileira sob a ótica da teoria da complexidade	Marcia Rohr da Cruz	Universidade de Caxias do Sul	2009
Thesis (Doctorate)	Perspectivas da complexidade aplicadas à gestão de empresas	Ricardo Borgatti Neto	Universidade de São Paulo	2008
Thesis (Master's degree)	Processo de formação de indicadores de desempenho logístico: uma relação necessária entre a abordagem sistêmica e a gestão da cadeia de suprimentos	Josenildo Brito de Oliveira	Universidade Federal da Paraíba	2008
Dissertation (Doctor)	*The application of complexity theory to the field of project management*	*Ralph M. McKinnie*	*Walden University*	2007
Thesis (Master's degree)	Organizações e portfólios de projetos sob a perspectiva da teoria da complexidade	Andréia Pereira Martins	Universidade de São Paulo	2007
Thesis (Doctorate)	Processo de formação de estratégias de desenvolvimento sustentável de grupos multinacionais	Luciano Barin Cruz	Universidade Federal do Rio Grande do Sul	2006

Thesis (Doctorate)	Modelo de gestão não linear: a teoria do caos e complexidade aplicada à gestão de empresas de alto crescimento em ambientes dinâmicos e imprevisíveis	Estevão Anselmo	Universidade de São Paulo	2005

These studies show the relevance and state of the art of the elements of this study, innovation, and complexity theory.

VI. Conclusion

The methods adopted were sufficient to achieve the objective of understanding the state of the art in the literature on innovation and complexity theory. This demonstrated a vast and diverse state of the art of academic production, with 4609 documents, 2209 articles and 740 in the social science humanities area with regard to innovation. The finding on complexity theory resulted in 5271 documents, with 691 articles in the study area, of which 33 had their content analyzed. The research contributes to academia and society to formulate a model and better social applicability.

References

[1]. Alves-Mazzotti, Aj, Gewandsznajder, F. O Método Nas Ciências Naturais E Sociais. São Paulo: Pioneira Thomson Learning, 2004.
[2]. Gil, Ac. Como Elaborar Projetos De Pesquisa. 4 Ed. São Paulo: Atlas, 2002.
[3]. Milbergs, E., Vonortas N. Innovation Metrics: Measurement To Insight. Center For Accelerating Innovation And George Washington University. National Innovation Initiative 21st Century Working Group, 2007.
[4]. Oecd . The Oslo Manual: The Measurement Of Scientific And Technical Activities. 1994.
[5]. Schumpeter, J. The Theory Of Economic Development: An Inquiry Into Profits, Capital, Credit, Interest And Business Cycles. Cambridge, Mass.: Harvard University Press. 1934.
[6]. Tidd, J. Innovation Management In Context: Environment, Organization And Performance, International Journal Of Management Reviews, V.3, N. 3. P. 169-183, 2001.
[7]. Ibge - Instituto Brasileiro De Geografia E Estatística. Pesquisa De Inovação Pintec - 2011. Available In: <Http://Www.Pintec.Ibge.Gov.Br/Downloads/Instrucoespintec2011.Pdf.> Accessed On: 12 Aug. 2012.
[8]. Morin, E. Ciência Com Consciência. Rio De Janeiro: Bertrand, 2000.
[9]. Morin, E. O Método 1: A Natureza Da Natureza. Porto Alegre: Sulina, 2002.
[10]. Wells, J.L. Complexity And Climate Change: An Epistemological Study Of Transdiciplinary Complexity Theories And Their Contribution To Social-Ecological Phenomena. Dissertations Of Doctor Philosophy In Environmental Science, Policy And Management. University Of California, Berkeley. Spring, 2009.
[11]. Kneipp, Jm. Et Al. Emergência Temática Da Inovação Sustentável: Uma Análise Da Produção Científica Através Da Base Web Of Science. Revista De Administração Da Universidade Federal De Santa Maria, 2011; 4(3), 442-457.